Position Paper: Combining Mobility Services by Customer-Induced Orchestration

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ABSTRACT
This position paper discusses the customer-oriented combination of mobility services offered by multimodal mobility platforms. We present a process-oriented approach on the selection and provision of complex mobility services and give an overview of state-of-the-art mobility platforms in German-speaking areas. We exemplify the limitations of current mobility platforms with regard to customer-orientation and claim that these platforms do not consider travelers' preferences to a sufficient extent. Based on these results, we motivate the need for customer-induced orchestration platforms that support customers in combining mobility services with services of other domains. Contrary to operator-induced combination of services, customer-induced orchestration would allow customers the autonomous selection of component services and support their orchestration to bundles of mobility and complementary services.

CCS Concepts
• Applied Computing→Transportation • Applied Computing →Reference Models.

Keywords
Service selection; service platforms; reference models; customer context; customer-induced orchestration.

1. INTRODUCTION
Digitization and interconnectedness play an important role in the domain of mobility and transportation services. In recent years, traditional mobility services such as public transportation have been amended by innovative mobility services such as car and ride sharing. These innovative shared mobility services are characterized by their flexible spatio-temporal availability [1]. Flexibility is enabled through automated business processes that link travelers and service operators in a highly-efficient, automated manner. However, while the access to these innovative services is made as easy as possible through smartphone apps, the use of a single car sharing service, for example, is usually not sufficient to fulfill the demand of a traveler. For planning a trip from door to door, several *component* mobility services must be selected and combined to a *complex* mobility service, ideally considering complex preferences of the traveler [2].

Multimodal mobility platforms promise to integrate traditional, timetable-bound public transportation with innovative mobility services such as shared mobility services. In recent years, the number of multimodal mobility smartphone apps and online platforms has increased significantly. However, available platforms differ heavily in functionality and customer orientation. In this position paper, we discuss current functionality and limitations of mobility platforms based on an overview of existing platforms for German-speaking areas (see Sect. 2). We use the discovered limitations to motivate the need for a new paradigm, namely *customer-induced* orchestration of complex mobility and complementary services. The corresponding framework is discussed in Sect. 3 and extended to customer-induced orchestration of services beyond mobility services. The position paper is concluded in Sect. 4.

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2. MULTIMODAL MOBILITY PLATFORMS
Multimodal mobility platforms promise to support the selection and bundling of mobility services to complex services bundles. To investigate the level of customer orientation that is already provided by current multimodal mobility platforms, we have analyzed their functionality and customer orientation with regard to the support of the mobility service process. Fig. 1 shows the mobility service process, which was derived by [4] from a generic service process scheme proposed by [3]. The mobility service process distinguishes five phases, namely *search for information*, *consulting*, *booking*, *realization* and *payment*. In an ideal setting, multimodal mobility platforms would facilitate the configuration and execution of complex mobility services for all phases of the mobility service process.

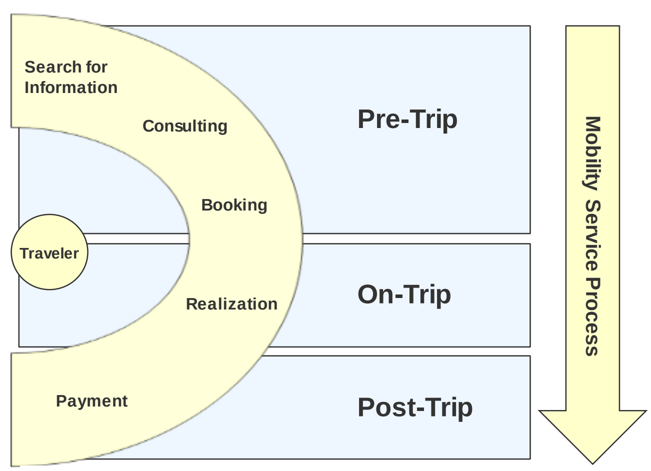

Figure 1. Mobility Service Process.

The *search for information* phase comprises all activities that help the traveler in discovering general information of available mobility services. The *consulting* phase discusses potential alternatives that could meet the traveler's needs, i.e., that consider the traveler's preferences. In the third phase, the traveler selects and *books* a particular mobility service, which is then *realized* by a mobility service provider. Finally, the traveler *pays* the stipulated fee for the utilized service. From a mobility research perspective, these phases can be understood as supporting the "pre-trip", the "on-trip" and the "post-trip" part of a journey with appropriate information.

Table 1. Selected Multimodal Mobility Platforms.

Provider	Type	URL	Local	Long-dist
Allryder	S	www.allryder.de	x	
FromAtoB	S	www.fromatob.de		x
GoEuro	S	www.goeuro.de		x
Mobility Map	P	www.mymobilitymap.de	x	
Moovel	E	www.moovel.com	x	
Qixxit	E	www.qixxit.de	x	x
Rome2rio	S	www.rome2rio.com	x	x
Route RANK	S	www.routerank.com		x
Waymate	S	www.waymate.de		x

Based on the above mobility service process and dimensions defined by the well-known architecture of integrated information systems (ARIS) [5], we have compared existing multimodal mobility platforms available in German-speaking areas. To analyze the platforms, we developed a criteria catalog including the five dimensions *organization, functionality, quality, data* and *technology* with a total of 22 criteria. We have limited our comparison to mobility platforms that are able to combine at least three different component services to a complex mobility service. The considered platforms as well as their main focus are summarized in Table 1. Five platforms are owned by innovative startups (Type = "S") and two by established mobility service providers (Type = "E"; *Moovel* belongs to the Daimler AG and *Qixxit* belongs to Deutsche Bahn AG, the main German train operator). One further platform is operated by a private person (Type = "P"). The columns "Local" and "Long-dist" identify the platform's focus, i.e., whether they claim to be the distinguished platform for information on and booking of local or long-distance mobility services.

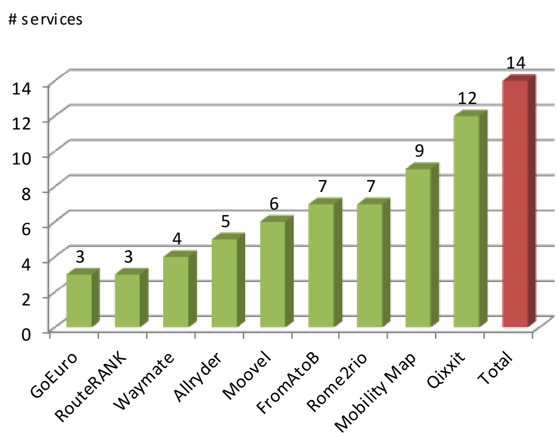

Figure 2. Component Services per Platform.

The number of considered component services per platform is shown in Fig. 2. The considered services are conducted by train, planes, taxis, rides, long-distance buses, private cars, local public transit, bike sharing, car sharing (free-floating/station based), walking, rental cars, private bike and ferry. The absolute number of considered component services varies significantly; platforms with a focus on local transport usually offer a larger number of component services than long-distance platforms. *Qixxit* provides the widest selection of component mobility services so far.

To investigate the functionality of the platforms, we developed the following three test instances reflecting a request for local travel, regional travel and long-distance travel:

- Local: Berlin/Breitscheidplatz to Berlin/Pariser Platz
- Long-Distance: Berlin/Main Station to Cologne/Main Station
- Regional: Karlsruhe/Main Station to Freiburg/Main Station.

To determine the appropriate complex mobility services that fulfill the above requests, each platform needs to combine component services according to travelers' preferences based on data such as expected time, location and price of a service. This is especially challenging for the long-distance request, where component services from different areas and of different modes need to be selected. Typically, at least one long-distance trip (e.g., per train or plane) and two local or regional trips (first/last mile to/from the long-distance trip) are to be combined. As a result, only six out of nine platforms are able to combine component services that operate on different modes (intermodal solutions), while the others are not able to augment long-distance with last-mile services. Travelers using these platforms end up in manually assembling their complex services by combining their preferred last-mile service with the help of other platforms or smartphone apps.

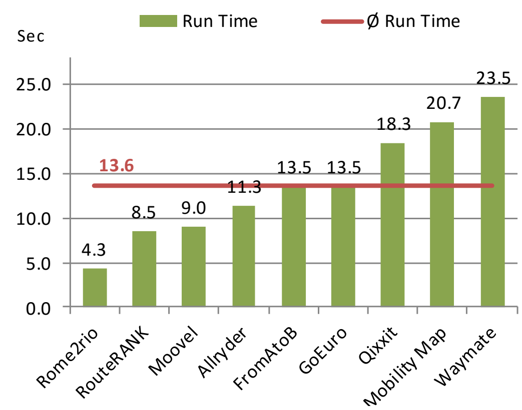

Figure 3. Overview of Run Times.

We have also measured the run time that the platforms needed to process the above requests. The results are shown in Fig. 3. Generally, there is a surprisingly large span between the fastest search at *Rome2rio* and the slowest search conducted by *Waymate*. One of the reasons is that some providers already start computing a possible combination of component services for the most likely origin and destination while travelers are still typing in the corresponding values into the app or on the website. Furthermore, some platforms obviously precompute service combinations for popular origin-destination pairs. Note that there is also a type-related difference in the run time: on average, the construction of a complex service for the local travel request required 10 seconds, and the long-distance travel request required 17 seconds. For the latter, we observed that a flight search engine was included in the search process, which seems to add significant complexity and run time.

To investigate the level of customer-orientation that is provided by today's multimodal mobility platforms, we have analyzed to which extent the mobility service process is supported by each of the platforms. We can state that all platforms offer sufficient support for the *search for information* and *consulting* phases. A choice of complex mobility services is generated from simple spatio-temporal information (when/where), and also types of component services can be selected (e.g. car/no car). It has also become quite common to provide information on the total cost of a service and of service combinations. However, there are limitations regarding the booking and payment phases, which are only supported by three platforms (*Moovel, Mobility Map* and *FromAtoB*). Booking and payment are also limited to selected component services only. The realization phase is only supported by *Qixxit* and *Allryder*. *GoEuro, Rome2rio* and *RouteRANK* also conciliate further, complementary component services such as hotel bookings.

The key to traveler-oriented selection of component services is the processing of detailed service and customer data. However, only five out of the nine investigated mobility service platforms ascertain *static customer data* (such as personal information) at all, and only four of them store them in a customer profile. This goes along with the insufficient support of the booking phase, where customer data is mandatory to finalize a booking. *Dynamic customer data* (such as the current location of a customer) is ascertained by five of nine platforms, and they are mainly used to improve the selection of currently available component services in accordance with the given spatio-temporal characteristics of the traveler.

In sum, only a small choice of service mobility platforms can actually handle a large variety of local as well as long-distance component services and can automatically assemble an appropriate combination of services according to travelers' preferences. In general, the considered traveler and service characteristics remain very simple, and the traveler has only limited control of the selection process. Having selected appropriate component services on a dedicated platform, the traveler usually cannot book the desired complex service, and it is not possible to modify it with hindsight.

3. CUSTOMER-INDUCED ORCHESTRATION

In the following, we embed the traveler-induced combination of mobility services to the customer-induced orchestration of services from several domains. Extending the idea beyond mobility services, customers in general expect improved support of services with respect to the control of selection and bundling today.

In Fig. 4, a selection of relevant domains and corresponding services is shown. For a variety of domains, intuitive apps for smartphones have simplified control of individual services to a great extent. However, apparent weaknesses can still be identified in the combination of component services and in the construction of complex service bundles. This observation does not only hold for mobility services, but also for services in education, finance, and health domains.

As demonstrated for mobility services above, existing platforms lack an intelligent and integrated support of customer preferences, because the control of services is mainly induced by the service provider. Hence, we aim at a *customer-induced control* of services by means of tailored IT platforms. Beyond service selection and bundling, a user centric conduct of services strives for a choice with respect to service providers and aims at the control of complex services during execution.

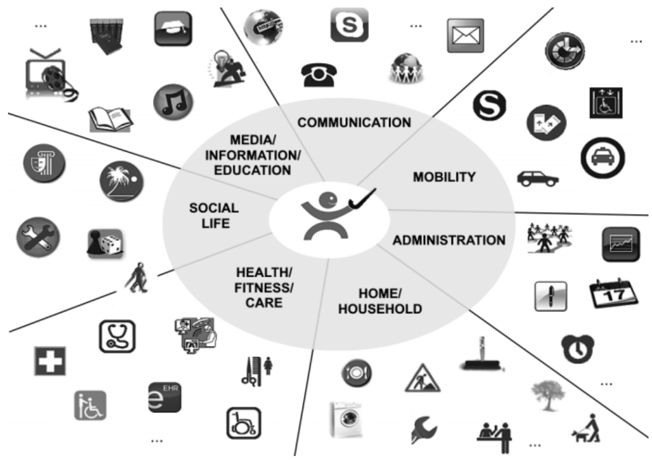

Figure 4. Services for Relevant Application Areas, Adapted from [6]

Abstracting from the mobility service process as shown in Fig. 1, traditionally, a service can be defined as a process of interaction between customer and service provider (Fig. 5). This process is induced by the service provider starting with a *setup of applicable resources*. In the next step, the customer attains *information* about the service from the service provider before the customer and service provider make an agreement and the service is realized (*booking*). The latter phase typically requires the direct interaction of customer and service provider. The process terminates with the *billing* of the service provider and the *payment* of the customer.

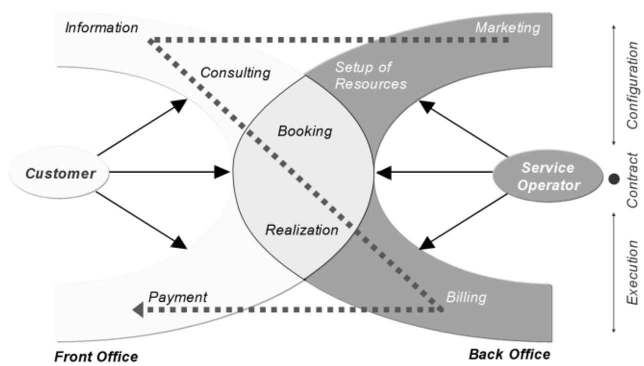

Figure 5. Generic Service Process, following [3].

If several component services need to be combined in order to fulfill the customers' needs, this results in a significant effort of coordination. Typically, a bundling of individual component services into a complex service is required. For each component service involved, the entire service process has to be executed repeatedly. Agents typically take over the control of selecting and combining the component services, hiding the complexity of the complex service from the customer. Today, in the digital economy, the provider of some core (focal) component service often conducts the selection of the remaining services to provide a complex service (e.g. German Railways as focal service on a long-distance trip in the Qixxit platform). As a drawback, the customer gives up control of the details finding him/her confronted with a one-size-fits-all complex service.

This phenomenon can also be observed in the orchestration of so called *smart services*, where control of the component services is achieved by automated service platforms. The black box paradigm of such platforms hinders transparency of service selection and may exacerbate the availability of competing services and/or new innovative component services, though. Furthermore, whenever component services from different service domains have to be combined in order to satisfy some specific customer demand, neither agents nor smart services are available to cope with the complexity of a complex service. Just think of interrupting a business trip in order to see a dentist due to a serious injury. No longer will smart services be available to coordinate the cancellation of a hotel, the re-booking of flights, the correspondence with health insurance and the appointment at a dentist's clinic. Moreover, the cancellation of leisure or sports activities may be involved. The customer himself/herself has to coordinate all combination activities.

The above example incorporates different domains and can be generalized by accepting that customers tend to act in different domains simultaneously. Under this assumption, today's smart services counteract the customer's need to manually control complex services at a detailed component level. Future customer-induced control of service selection and service bundles may alleviate the above sketched weaknesses [2].

To enable customer-induced orchestration, we propose to investigate the following topics using the example of relevant domains such as mobility, finance, education and health and combine the insights in a generic, domain-independent reference model. The core questions for modeling and execution of customer-induced orchestration are:

Modeling of the customer context. Customer-induced orchestration requires information about the situation of the customer, about the customer's preferences and about available component services. The customer context [7] accompanies configuration as well as execution of a component service or a complex service, respectively. While there are several approaches for the modeling of services for individual service operators [8], service operator independent solutions are not widespread yet. Hence, we propose to investigate how the customer context be represented such that suitable component services can be (automatically) selected, combined and configured while personal data is protected from misuse.

Representation of services. There is a semantic gap between the customer's domain language and service operator's domain language, which is a serious obstacle for automated, customer-induced service orchestration. Methods and models are required that present and represent complex and component services appropriately. Hence, we propose to investigate how complex service bundles can be modelled adequately in a domain comprehensive way, and how complex services can be presented to customers.

Methods of automated selection. To enable customer-induced orchestration, component services need to be selected and configured such that they are a good fit with the customer's preferences and such that they fit well together to define a reasonable complex service. Depending on the domain, there are different requirements at methods of automated selection. Hence, we propose to investigate how complex services can be matched with customer profiles and customer contexts, and whether it is possible to incorporate data of former service execution for this task.

Construction of a reference model. Customer context, representation and automated selection need to be condensed by means of a generic reference model which allows the domain-specific as well as domain-independent derivation and implementation of service platforms. However, it is an open issue to which extent domain-specific approaches can be generalized and whether they can be generalized at all. Hence, we propose to investigate whether a reference model does alleviate the above listed issues, and how the degree of user centric control be measured.

4. CONCLUSION

Travelers expect better support in the orchestration of complex mobility services. Mobility platforms promise to select and combine services according to the given preferences of the traveler. Based on an overview of mobility platforms available in German-speaking areas, we have found that the functionality of the existing platforms is rather limited. In particular, these platforms often consider only simple spatio-temporal parameters in the selection of mobility services. Furthermore, the capability of fast intermodal search is often underdeveloped, which leads to long run times and insufficient results of the search.

To ensure customer-oriented combination of mobility services and component services in general, we propose the paradigm of customer-induced orchestration. Our idea is to develop a generic reference model that allows for the conceptualization of mobility service platforms in particular and service platforms in general. A core part of this model is the design of the customer context, a choice of service selection methods such as recommender systems and/or mathematical optimization, and an appropriate representation of services and travelers/customers. We expect that the combination of recommender systems and mathematical optimization will be the methodological core of such a reference model and the derived platforms.

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