UBIQUITOUS INTERACTION AND COLLABORATION WITH TOURISTIC SERVICES

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Abstract.
In the past several decades, the internet, and especially the Web, have become extremely important sources for the planning and booking of business travel, flights, and holidays. In 2011, 55% of all travel bookings in Europe were made on-line, a figure which has steadily increased over the last few years and is predicted to continue to rise in the years to come. Obviously, services targeting tourists will only be used if properly visible, accessible, and bookable through these channels. The latest Web developments in the direction of user-generated content, information sharing, on-line collaboration and social media, have drastically increased the number of channels offering the opportunity to interact with potential tourists and book touristic offers. In addition to semi-structured information sources, data centric channels (e.g. Linked Open Data), on-line services as well as mobile channels provide a significant and growing potential to present and access travel deals. Data centric channels provide machine-processable information such as mountain bike routes or public transport schedules; on-line services allow the booking of ski passes, restaurants, etc; mobile channels, which differ in terms of types of devices and operating systems, bring new opportunities for tourism enterprises to advertise and access their services, as well as to engage with their customers. The need for ubiquitous access, interaction and bookability of touristic services is evident, including core services (e.g. booking accommodation) and enhanced services such as those composed of both core and added value services (e.g. booking accommodation and then ski passes). In general, the key challenge involves making tourism and travel-related services easy to find and bookable through a multitude of semi-structured data and mobile channels. This requires support in multichannel booking in order to increase Web traffic, generate higher yield management over heterogeneous channels (with particular constraints), and help support channels through offering little to no external booking fees, and thus optimizing pricing and revenues. Furthermore, all of these channels should be accessible and consumable on mobile devices, as this is where most bookings are expected to be made in the future. In this paper, we introduce an approach for the hospitality industry that will enable communication, collaboration and value exchange (i.e. booking) of users (i.e. tourists) through a multitude of on-line and mobile interaction possibilities based on the use of semantic technology.
1. Introduction

Tourism is a multi-billion euro business in Tyrol, which hosts around 43 million overnight stays per annum. These 43 million account for nearly 50% of the all overnight stays in Austria. No other economic sector has comparable influence on the economic and social situation in this region. It is also important to note that nearly 40% of tourist businesses in Austria are situated in this region. Possessing all of the required key competencies necessary for running this economic sector is therefore of strategic importance for the future of Tyrol. Losing a cornerstone of this process could lead to a significant loss of income and revenue for the region.

With the growth of the Internet, a considerable change in travel planning and travel behavior has taken place. Nowadays, more than 55% of all tourists in Central Europe inform themselves on-line about a certain destination before booking, and more than 27% of all tourists in this area use internet-based booking channels for travel reservations. Currently, the Web is one of the most important sources for planning trips, holidays and business travel. According to a European Commission survey from 2010, approximately 42% of tourists across Europe use the Internet to plan their trips. Furthermore, 70% of all on-line bookings are influenced by social media, and 80% of those making the bookings inform themselves about their destination via Web media. Overall, on-line travel bookings will represent almost a third of worldwide volume by the end of 2012.

The rapid advance of ICT technologies and their increasing importance in the tourism domain is fostering exponential growth in on-line communication opportunities. The ability to communicate and engage via the multitude of Internet, Web, Web2.0, social and mobile channels is becoming increasingly important for hoteliers. The growing number of communication channels and interaction opportunities is generating new challenges in terms of scalability. Small and Medium Enterprises (SMEs) require new skills and more efficient access means to scale and filter the exponentially increased offer. Assume the task of a small hotelier. How can it be ensured that the hotel is found by potential customers? The hotelier should have a website with high visibility on various search engines and must be present in a large number of on-line booking channels. We should find the hotel on the town’s website, and the hotel should have a Facebook Page, perhaps with a booking engine included. The hotel should also be present on social networks such as XING and LinkedIn in order to find new employees or business partners. The hotelier should also appear on popular travel websites such as TripAdvisor.com, and monitor the

1 http://www.statistik.at/OnlineAtlasWeb/start?kombinationen=57%3B107&selections=109%3B111%3B107%3B57%3B%3B&showStatistik=Karte+anzeigen
2 http://www.statistik.at/OnlineAtlasWeb/start?kombinationen=58%3B107&selections=109%3B111%3B107%3B58%3B%3B&showStatistik=Karte+anzeigen
3 http://www.newmediatrendwatch.com/regional-overview/103-europe/showall=1
4 http://www.newmediatrendwatch.com/world-overview/91-online-travel-market?start=1
reviews and opinions of customers, while engaging with them in order to maintain a good reputation and increase the hotel’s on-line visibility. Bookings made through mobile platforms are increasingly popular, and the hotelier would want to be found there too. The hotelier might also want her/his hotel to be bookable through hotel distribution channels such as (e.g. Booking.com, Expedia.com, HRS.de). Why not add a video about the hotel on YouTube and on Vimeo, an image on Flickr and Pinterest, a chat channel for instant communication, fast email and fax response capabilities, the old-fashioned telephone, and occasional tweets and emails that are clearly distinguishable from spam? Preferably the communication should be multi-directional, i.e., the hotelier should realize when one of his posts gets commented on (up to a full-fledged impact analysis), or even more importantly, the hotelier should know when someone talks about the hotel, and how much the customer liked it. To further spread news and small elements of content, the hotel should use RSS feeds and have its own Twitter page. Newsletters are also a proven means of keeping in touch with guests and updating them on the latest news and special deals. It is therefore evident that a scalable communication solution is needed in order to address “the growth of the multichannel monster” (Mulpur et.al, 2011).

This challenge for tourism enterprises extends from semi-structured information sources, to the exploitation of the Web Data and Web Services as a platform for data and information integration, as well as to informing customers and cooperation partners. The Linked Open Data (LOD) cloud provides additional information sources (mountain bike routes, public transport schedules, historical information) directly in machine processable formats. Public and company-internal data have to evolve but be kept synchronized. For example, a tour operator in the tourism domain might already have a database with tourist destinations and points-of-interest. In order to exploit additional structured data from the Linked Open Data cloud company, internal data has to be mapped to the RDF data model, links between the internal database and corresponding entities on the data Web have to be identified, and invalid or conflicting data has to be revised. All of these changes have to be preserved, even after updated datasets are retrieved from the Web of Data. Data centric services providing information such as mountain bike routes or public transport schedules, as well as on-line services such as the booking of ski passes, massages, etc. should be considered and integrated into touristic services in order to increase yield management. Our solution should empower touristic enterprises to help make sense of the wealth of structured data and services available on the Web.

Aside from the continuous growth of semi-structured channels and use of the Web Data and Web Services, we are witnessing a similar, even much stronger, trend in the mobile world. Moreover, using mobile devices in the tourism domain has become increasingly popular nowadays. Google projects that 8% of the mobile users will be booking travel from their smartphones by 2012\(^5\). In US alone it is expected that booking from mobile

\(^5\) http://www.newmediatrendwatch.com/world-overview/91-on-line-travel-market?start=1
devices will grow by 51% in 2012, according to the same source. The diversity of mobile channels, in terms of types of devices and operating systems, coupled with the significant increasing trend of moving from desktop to mobile, brings new challenges but also new opportunities for tourism enterprises to advertise and provide their services as well as to engage with their customers. Mobile devices are a widely-available class of channels with supporting communications infrastructures which can be appropriated and exploited to support ubiquitous experiences in accessing, interacting and consuming tourist services. A scalable solution is needed, which enables nomadic and pervasive communication, collaboration and value exchange with the hospitality industry via mobile.

These global shifts in customer behavior and the significant increase of using a multitude of channels, especially mobile, engender the need for a general change in the travel industry’s approach to providing services and content through on-line, social and mobile channels. Competence in on-line communication and marketing, as well as on-line sales is crucial for ensuring the competitiveness of a tourist region. Take for example the Austrian tourism market, where more than 12% of all on-line hotel room bookings are done through booking channels such as HRS or booking.com. A portal such as HRS takes 15% of the price of the room. Consequently, the Austrian tourist industry loses around 101 million EURO p.a. (Hiptmayr C. 2012). This leads to a significant transfer of resources to other countries such as Germany or the Netherlands, where these portals are based. On a global scale, we are also seeing rising worldwide competitors such as Google, that are defining and implementing new business models and techniques for on-line marketing and booking that may once again change the transfer and distribution of these fees. Losing control and competence in this cornerstone of the tourism value chain may generate significant risk for the economic and social future of Tyrol as a region. We may be confronted with the situation such that tourism in Tyrol will remain popular and continue to grow (since the mountains and their appeal will not disappear), but the generated value may immediately vanish in other regions along with their service providers. Maintaining competence and competitiveness in on-line marketing for tourist services coupled with ubiquitous access, interaction and bookability of such services through mobile devices may therefore be key to future prosperity.

Tourism enterprises need an integrated framework that provides management and execution of communication goals in a cost effective and automated fashion leading to higher visibility and increased value exchange. A maximum number of booking possibilities should be integrated to enhance the number of direct bookings coming from these sources. Booking opportunities are to be integrated smoothly into the booking channels and accessible through mobile devices, meaning that availabilities can be centrally updated for all booking channels. Furthermore, hotels could offer enhanced services that might be attractive during the stay. Enhanced services can be created by integrating external services from the web. A combined offer could include, for example,

6 http://www.slideshare.net/Roli1219/the-power-of-online-traval-agencies-ota (slide 25)
7 http://www.hrscorporate.com/corporate-hrs-for-hotels.html
in addition to an overnight stay, a ski pass and a ticket to visit an attraction, the ski pass and entrance ticket being provided by external service providers. However, the guest perceives it as a complete offer and the hotelier could earn on the commission received by external service providers. The distribution of such offers is currently limited on existing booking platforms.

In this paper, we introduce an approach for hospitality industry that will enable communication, collaboration and value exchange (i.e. booking) of users (i.e. tourists) through the multitude of on-line and mobile interaction possibilities based on the usage of semantic technology. Our approach combines solutions for multi-channel communication, direct and multi-channel booking. It integrates external data and services from Web and offers the possibility to interact and exchange value with touristic services via a multitude of mobile devices.

The remainder of the paper is organized as follows. Section 2 introduces the problems faced by hoteliers and derives the need for our approach. Section 3 describes our multi-channel communication solution. Section 4 details the multi-channel and direct booking solution, which is part of our approach. Section 5 discusses the integration of external data and services, while Section 6 discusses the implementation of the overall approach proposed in this paper. Finally, Section 7 concludes the paper and discusses our future work focusing on how mobile channels can be integrated into our solution for pervasive booking and interaction with touristic services.

2. Problem Statement

The tourist sector is one of the world’s largest industries. It is a leading economic contributor on a global scale, producing an incredible 10.2% of the world’s gross national product. However, the tourism industry is changing. While many tourists still plan their journeys via classic channels such as travel agencies, fax or telephone, the trend towards online travel planning and booking via different devices (web, mobile, tablets) is ongoing and growing steadily. In only a few years’ time, more than 70% of all bookings are expected to be executed online.

The internet web-based communication and booking channels are becoming increasingly important in today’s competitive world. Organizations of all sizes (commercial and not-for-profit), regularly face the challenge of communicating with their stakeholders using a multiplicity of channels, e.g. websites, videos, PR activities, events, email, forums, online presentations, social media, mobile applications, and most recently, structured data.

The social media revolution has made this job much more challenging because:

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9 http://www.wwwmetrics.com/travel.htm
• the number of channels has grown exponentially,

• communication has changed from a mostly unilateral "push" mode (one speaker, many listeners) to an increasingly fully bilateral communication, where individual stakeholders (e.g. customers) expect one-to-one communication with the organization, and the expected speed of reaction is shrunk to almost real-time, and

• the content of communication is becoming increasingly granular and more dependent upon the identity of the receiver and the context of the communication.

Due to this current trend, the booking market is moving online. Social media platforms are becoming new dissemination and potential booking channels, exponentially extending the booking possibilities already in existence (e.g. booking platforms, review sites, Online Travel Agencies (OTA) sites, meta-search and integrators, blogs, direct web sites and mobile channels).

In this context, the first challenge that needs to be addressed is visibility. To be found by a large number of customers, the hotelier needs to ensure his or her presence on as many channels as possible. This requires, apart from time and resources, competence in the field of online marketing and commerce.

This highlights the challenge of scalability, which is another problem that needs to be addressed in this context. The average time required for hoteliers to maintain a profile of a medium sized hotel at one portal is between 5 to 15 minutes a day. The work of maintaining a hotel’s profile on 100 portals would then require at least 20 hours of labor which, for a medium-sized hotel, means that a lot of time, effort and money has to be invested in something that distracts the hoteliers from focusing on the core business. Hoteliers are thus facing a challenging multi-channel problem by having to maintain the right balance of rooms’ availability across more than 100 channels on a daily basis. This obviously does not scale. Being accurate and visible in all the channels is a must in order to increase revenues. Yield management also plays an important role in this context. Adopting an offer and a price which responds dynamically to the behavior of the (on-line visible) environment, and selecting the right channel, will become critical to economic success.

In addition to the growing number of online channels, there are an increasing number of ways in which to access them. Mobile devices have become a popular means of accessing and booking tourist related content online. It is therefore crucial for hotels to also be bookable through mobile devices, since most of the bookings will be done via mobile applications in future.

Due to these recent developments, competence in on-line communication and marketing, as well as on-line sales, is crucial for ensuring the competiveness of a tourism region. Losing the value of bookings via payment of commissions should be limited as much as
possible. On a global scale, we are also seeing rising worldwide competitors such as Google, that are defining and implementing new business models and techniques for online marketing and booking that may once again change the transfer and distribution of these fees. Losing control and competence in this cornerstone of the tourist value chain may generate significant risk for the economic and social future of Tyrol as a region. Maintaining competence and competitiveness in on-line marketing may therefore be vital to future prosperity.

In conclusion, it is evident that organizations require an integrated solution that provides management and execution of communication goals primarily in an automated fashion, with costs equivalent to mass-media communication, along with the granularity of individual experts, and at the pace of real-time social media. We are aiming to mechanize important aspects of these tasks, allowing scalable, cost-sensitive, and effective communication for small-or-medium sized business units and comparable organizations for which information dissemination is essential, but resources are significantly limited. Considering these challenges, it is crucial for all hoteliers to introduce appropriate technical solutions to be competitive in a future online world and to maintain their current ability to participate in the economic tourist value chain.

In order to remove the obstacles of exploiting the vast resources available on the Web of Content, Data, Services and Mobile, we make the wealth of valuable structured data and knowledge exploitable for tourism enterprises by:

- **Efficiently and effectively supporting multi-channel communication based on machine-processable semantics.** Scalability is achieved by introducing a layer of abstraction over all communication channels as well as a layer for capturing customer domain information. These two layers can then be dynamically mapped and connected, depending on the particular use case and direction of information propagation (publishing of messages or collection of feedback).

- **Providing support in access, interaction, and value exchange (i.e., booking, multi-channel and direct) of tourism services and their combinations.** We would like to support the hospitality industry in optimizing their revenue and profit management through easy and liquid booking in numerous channels and through numerous devices. We provide support in empowering the service provider towards low-fee (e.g., direct) booking opportunities to reduce the share of the income that is taken by external booking providers.

- **Enabling the integration and interlinking of external data and services** with the tourism offers. The integration of external data and services will empower the hoteliers to offer new touristic products and services. Linked Open Data cloud

- **Interacting with this multi-channel solution through various and heterogeneous mobile channels.** Our solution integrates and uses mobile channels for value exchange with touristic services.
The implementation of our approach, including the elements mentioned above, is under development as part of the Seekda Social Agent (SESA) project. SESA should help the hotelier in dealing with the challenge to improve and maintaining his communication needs in a world with an exploding number of channels in order to maintain or better increase his market share (i.e., the number of bookings and the attached price) by keeping the related transactions costs for on-line communication and booking manageable.

3. Multi-Channel Communication

The core idea of our approach for scalable, cost-sensitive and effective online multi-channel dissemination is to introduce a layer on top of the various Internet based communication channels that is domain specific and not channel specific\textsuperscript{10}. In this section, we describe how the content and the multitude of communication channels are being managed and interweaved as part of our multi-channel communication solution.

3.1. Managing the Content

In our approach, information items being communicated are specified using a domain terminology that is easily understood by domain experts. Such a domain specific terminology is not an exhaustive formalization of the domain, but rather includes the concepts that are most frequently involved in the various acts of communication. The domain specific terminology is formalized as an ontology. For the touristic domain, we have developed the Accommodation Ontology. The Accommodation Ontology is an extension of the GoodRelations and provides the additional vocabulary elements for

- describing hotel rooms, hotels, camping sites, and other forms of accommodations, their features, and
- modeling compound prices as frequently found in the tourism sector, e.g. weekly cleaning fees or extra charges for electricity in vacation homes based on metered usages.

In typical hotel scenarios, we must distinguish between the legal agent operating the hotel (gr:BusinessEntity), the hotel as a whole (acco:Hotel), and the individual hotel rooms (acco:HotelRoom). This distinction is important, because we may want to represent hotel features and room features. For instance, a sauna can be a room feature or a hotel feature. All accommodations are at the same time instances of the GoodRelations classes gr:Location and gr:ProductOrService. Hotel rooms and hotels or camping pitches and camping sites can be linked via the acco:partOf relationship type.

\textsuperscript{10} See also as an excellent presentation on this idea: http://www.slideshare.net/reduxd/beyond-the-polar-bear
The Accommodation Ontology slightly deviates from the standard GoodRelation pattern, because a global standardization of room or hotel features is not possible without losing granularity. For instance, even features that look trivial at first sight, like "Wifi", "Star Rating", or "TV Set", are impossible to harmonize in a feasible and lossless way. For instance, a Wifi network may vary by the supported speed standard, and there are numerous different star ratings in use across the globe, which vary in scale and requirements. Technical equipment like TV sets or coffee makers can vary in quality and features, and hotels will typically want to preserve as much of their individual value proposition in any description.

Thus, the Accommodation Ontology follows a radically different approach for Web Ontology Engineering in that it implements the so called *Deferred Consensus Principle* (Hepp, 2012): Instead of consolidating product features in the ontology, it provides a consolidated conceptual model for encoding proprietary feature information in a way that is most useful for the automated, heuristical consolidation at the client side. So instead of defining properties for room and hotel features, the ontology provides the class acco:AccommodationFeature that can hold feature information in varying degrees of formality.  

Only for very few features, readily standardized conceptual elements are provided by the ontology, like

- acco:occupancy
- acco:occupancyAdults
- acco:occupancyMinors
- acco:petsAllowed
- acco:size

The following illustration shows how hotel and room features can be expressed using acco:feature and instances of acco:AccommodationFeature

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11 Information taken from: [http://ontologies.sti-innsbruck.at/acco/ns.html](http://ontologies.sti-innsbruck.at/acco/ns.html)
Scenario: A double room with two double beds that can be used by up to four persons and that has a minibar. The hotel is a 4-star hotel according to the DEHOGA rating and has a sauna as an optional feature, i.e. when you rent the room, the right to use the room does not automatically imply you can use the sauna for free. There may be an additional charge.  

UML class diagrams illustrate the conceptual structures of the Accommodation Ontology. The following diagrams are only approximations of the real OWL DL model, as they do not represent all details of the formal model. 

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12 Image taken from: http://ontologies.sti-innsbruck.at/acco/ns.html
13 Image taken from: http://ontologies.sti-innsbruck.at/acco/ns.html
The domain specific ontologies that provide the information models are one of the core elements of our approach. Additionally, three other core elements are required to build a scalable multi-channel communication solution, namely:

- a channel model (or communication model), that describes the various channels, the interaction pattern, and their target groups;
- mappings of information items to channels through weavers; and finally,
- a library of implemented wrappers for actual channel instances.

What is essential is to distinguish the communication or channel model from the conceptual descriptions of the information, in analogy to cascade style sheets (CSS) that separate the content from its presentation. Our approach requires the creation of a communication model (i.e., an increasingly complete model of channels), and knowledge models for each vertical (such as hotels, restaurants, tourist events, etc.), and finally linking the knowledge model with the communication model through a weaver that weaves concepts with channels. Data and information can be expressed at the conceptual level, which the domain expert understands. The knowledge models are formalized using

![Diagram of the Accommodation Ontology: Product Perspective](http://purl.org/acco/ns)
ontologies (Fensel, 2001) and are not full descriptions of the verticals but rather are focused on the information chunks that are disseminated about it.

3.2. Managing the Communication Channels

A core feature of our approach is to abstract information from the underlying online communication channels. The channels are the vast amount of on-line communication possibilities. In our view, channels are means of exchanging information in the on-line space, and include a wide range of online communication possibilities, such as static dissemination, dynamic dissemination, dissemination through sharing, dissemination through collaboration, and dissemination through group collaboration (see (Fensel et.al, 2012) section 2.2)

In the tourism domain, an established means for hotels to disseminate primarily static information is through a classic website. Content that changes regularly is usually published in a news section, which is included on the website. To further spread news and small elements of content, the hotel should use RSS feeds and have its own Twitter page. Newsletters are a proven means of keeping in touch with guests and updating them on the latest news and special offers. Videos and images are a good way of presenting a hotel or destination to a wide audience. Various hosting services exist which allow hoteliers to share files like YouTube and Vimeo for video files and Flickr and Pinterest for image files.

Social networks are another type of important channel for sharing and exchanging information, as well as for collecting feedback. Facebook, with its more than 955 million monthly active users, is especially notable in the realm of social networks. Facebook does not only offer many possibilities through which to disseminate information, but also offers the possibility to book hotel rooms directly on the hotel’s Facebook page. While social networks such as XING and LinkedIn might be unimportant with regards to acquiring new guests, they may be very useful for finding new employees or business partners.

The channels mentioned above are very heterogeneous in nature, having various interfaces, allowing different content type, and supporting different interaction modes—just to name a few of the heterogeneity of aspects. Our solution provides an abstraction from these channels, integrating and personalizing them. Basic interaction with each of these channels, e.g. the ability to read from the channel and write to the channel, is also supported. Finally, our solution supports the aggregation of channels into composed communication structures.

3.3. Weaving the Content and Communication Channels

The central element of our approach is the separation of content and communication channels. This allows reuse of the same content for various dissemination means. Through

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14 Information taken from: http://newsroom.fb.com/content/default.aspx?NewsAreaId=22
this reuse, we want to achieve scalability of multi-channel communication. The explicit
modelling of content, independent from specific channels, also adds a second element of
reuse: Similar agents (i.e., organizations active in the same domain) can reuse significant
parts of such an information model.

Separating content from channels also requires the explicit alignment of both. This is
achieved through a weaver. Formally, a weaver is a set of tuples of the following elements:

1. **An information item**: It defines an information category that should be
disseminated through various channels.

2. **An editor**: The editor defines the agent that is responsible for providing the content
of an information item.

3. **An editor interaction protocol**: This defines the interaction protocol governing
how an editor collects the content.

Elements 1 to 3 are about the content. They define the actual categories, the agent
responsible for them, and the process of interacting with this agent. Elements 4 to 9 are
about the dissemination of these items.

4. **An information type**: We make a distinction between three types of content: an
instance of a concept, a set of instances of a concept (i.e., an extensional definition
of the concept), and a concept description (i.e., an intentional definition of a
concept).

5. **A processing rule**: These rules govern how the content is processed to fit a channel.
Often only a subset of the overall information item fits a certain channel.

6. **A channel**: The media that is used to disseminate the information.

7. **Scheduling information**: Information on how often and in which intervals the
dissemination will be performed which includes temporal constrains over multi-
channel disseminations.

8. **An executor**: It determines which agent or process is performing the update of a
channel. Such an agent can be a human or a software solution.

9. **An executor interaction protocol**: It governs the interaction protocol defining how
an executor receives its content.

Based on these features, the publication process can be formally defined in a way that the
multi-channel publication is managed automatically. Figure 3 shows a sample definition
(not using any formalism, simply for educational purposes) of two tuple sets describing
the weaving process for the publication of a hypothetical Event in two different channels
(Twitter and Flickr), these tuples are processed by the weaver and the actions are launched
accordingly. We can see the flexibility of this approach in many ways. For example, in the
first one, the editor is a human (the hotel animator who has to define the event and follow
the pre-established internal protocol), while on the executor side we have references to software components that will publish the content in the appropriate channel. The definition of processing rules can also be interesting, as defined, for example, in the Twitter channel. In this example, the description of the event should be less than 140 characters, and a summarization is usually needed (adaptation). In the case of summarization, the rule has a different purpose; it serves to check that the event has an image defined, because it is mandatory to publish it on Flickr. Scheduling options are also defined to enable control of the timing of publications and additional information as meta-information. Reflecting the state of the tuple serves as a control mechanism for the weaving process.

<table>
<thead>
<tr>
<th>Information Item</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>Content Editor</td>
<td>Hotel animator</td>
</tr>
<tr>
<td>Editor’s Interaction Protocol</td>
<td>Event Organization Protocol</td>
</tr>
<tr>
<td>Information Type</td>
<td>Instance</td>
</tr>
<tr>
<td>Processing Rule</td>
<td>if event.description &gt; 140, summarize</td>
</tr>
<tr>
<td>Channel</td>
<td>twitter</td>
</tr>
<tr>
<td>Scheduling Information</td>
<td>once a week until event.date</td>
</tr>
<tr>
<td>Executor</td>
<td>TwitterChannelConnector</td>
</tr>
<tr>
<td>Executor’s interaction protocol</td>
<td>TwitterChannelConnector API</td>
</tr>
<tr>
<td>Meta-information</td>
<td>active</td>
</tr>
</tbody>
</table>

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</tr>
<tr>
<td>Information Type</td>
<td>Instance</td>
</tr>
<tr>
<td>Processing Rule</td>
<td>if event.picture == null, deactivate</td>
</tr>
<tr>
<td>Channel</td>
<td>flickr</td>
</tr>
<tr>
<td>Scheduling Information</td>
<td>once</td>
</tr>
<tr>
<td>Executor</td>
<td>FlickrChannelConnector</td>
</tr>
<tr>
<td>Executor’s interaction protocol</td>
<td>FlickrChannelConnector API</td>
</tr>
<tr>
<td>Meta-information</td>
<td>active</td>
</tr>
</tbody>
</table>

Figure 3: Tuple set example of the weaving process (no formalisms applied)

Currently, all commercially available solutions are only channel centric and do not provide any built-in support for what needs to be disseminated or where to disseminate what piece. In our approach, a knowledge-model is built and explicitly linked with the
channel model. This must be done once for a hotel, and can then be reused for millions of them. That is, we aim for the major elements of reusability:

1. The same information element can be reused for various channels through its channel independent formulation using the information model.

2. The information model is developed as domain ontology for a certain vertical area such as tourist accommodations, gastronomy, medical doctors etc. Therefore, it can be reused for various agents active in the same vertical domain.

These elements of reusability deliver a major contribution to the scalability of our multi-channel communication approach.

4. Multi-Channel Booking

The multi-channel problem is not only faced in the on-line communication context, but also in the hotel booking context. Online hotel booking possibilities are exponentially growing in number and heterogeneity. Nowadays, one can use booking platforms (e.g. Booking.com, HRS, Venere.com), review sites (e.g. TripAdvisor.com), OTA sites (e.g. Expedia, Orbitz, Travelocity, Priceline), meta-search and integrators (e.g. Kayak.com) blogs, mobile channels, and last but not direct distribution sites i.e. hotel website to book a hotel. The hotelier on the other hand needs to make sure that his hotel’s profile is consistent and up-to-date on the multitude of booking channels and bookable on all these channels. Hoteliers are thus facing a challenging multi-channel problem, having to maintain the right balance of rooms’ availability across a multitude of heterogeneous booking channels on a daily basis. This obviously does not scale. Being accurate and visible in all the channels is a must in order to increase revenue. The economic discipline that studies “how market segment pricing is combined with statistical analysis to expand the market for the service and increase the revenue per unit of available capacity” is called yield or revenue management. Many solutions to yield management are based on complex statistical methods and complex domain assumptions on how variation of the price can influence the number of bookings of a service. However, a multi-directional multi-channel approach must also rely on Swarm intelligence. Observing in real time the reaction of customers and competitors, will be the key to achieving on-line marketing. Adopting your offer and your price dynamically in response to the behaviour of your (on-line visible) environment will become critical to economic success.

Besides the multi-channel booking problems, hotels are also facing another problem that is diminishing their income. More precisely, an increasing number of hotel rooms are booked on-line via booking channels that are taking a significant share of the hotel profits.

15 http://en.wikipedia.org/wiki/Yield_management and Revenue_management

that are booked via the booking channel. To overcome this problem, a solution for direct bookability of hotels and thus keeping the profit with the hoteliers, combined with multi-channel communication approach to increase the visibility and trust in the hotel is required.

To help the hotelier be present with an up-to-date profile in as many booking channels as possible, seekda GmbH has developed a solution called seekda!connect that offers automatic support for online booking on multiple channels offering tools for the online multichannel distribution, and supporting the hotels to increase their online bookings and conversions. A single entry point provides a direct connection to different booking platforms (see Figure 4), which can be managed over a simple, web-based user interface.

![Figure 4: seekda!connect – multi-channel booking solution](image)

The multi-channel booking solution includes a booking manager for centralized online data management, a dynamic shop, a booking engine for hotel Web sites including online payment, portal software for multi-property search and a booking engine for marketing portals (including DMOs), Google Connect for direct connection to Google tools and direct channels for direct connection to other hotel distribution channels (booking.com, expedia.com, etc.). Automated interfaces to 3rd party providers e.g. travel insurance companies, translators' platforms or ski rental providers complete the application.

seekda also offers solutions for direct hotel bookings. Using seekda solutions allows the booking to operate quickly and directly via hotel Web sites. This allows hotels to keep the

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17 Available at: https://www.seekda.com/.
profit they would otherwise lose through booking channels, and accelerates the booking time for future guests.

5. Integration of External Data and Services

We are currently experiencing a paradigm shift on the Web towards more data integration, exploitation of recent technological developments (RDF, Microformats, Web Data etc.), and increased attention to structured data. Our solution empowers tourism enterprises and users to reclaim ownership of their valuable data such that heterogeneous, distributed tourism related data sources can be effectively integrated. The integration of data from external source i.e. Linked Open Data cloud is focused on lookup and integration of data about places and routes, time-tables for public transport, hiking trails, ski slopes, points-of-interest, etc. with the goal of providing more comprehensive and complete information relevant to the users. LinkedGeoData\(^{18}\), for example, a Linked Data resource provided by INFAI comprising all the OpenStreetMap data (currently more than 20 Billion facts) is a rich knowledge base that serves that purpose.

Linking Open Data (LOD) initiative (linkeddata.org) is implementing the Web of Data by publishing datasets using the Resource Description Framework (RDF) (Klyne, J.Carroll, & McBride, 2004), the metadata model primarily used on the Semantic Web, and creating links between the entities in these datasets. LOD cloud is growing constantly, reaching 295 data sets in September 2011, with over 31 billion triples and over 504 billion RDF links between data sources. LOD data sets range from those centrally stored, such as DBpedia (dbpedia.org), to those that are very distributed, for example the FOAF-o-sphere (where FOAF stands for Friend-of-a-Friend (Brickley & Miller, 2012)).

In the tourism industry, LOD is very often used in the description of touristic sites. As mentioned previously, LOD can be used to integrate and look up external data about places and routes, time-tables for public transport, hiking trails, ski slopes and points-of-interest. In a regional map for example, information about mountain biking trails could be integrated. The Tyrol, as an example, provides a geo-data set containing route and track data of officially certified mountain bike routes. The data can be accessed, for example, as GIS vector data or Google Earth files.\(^{19}\)

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18 http://LinkedGeoData.org
Figure 5: Linked Open Data cloud diagram illustrating the published data sets and the relationships that link them together (note: each node in the diagram represents a distinct data set published as Linked Data, as of September 2011)

External services will be integrated on-the-fly following a “pay as you go” approach, at first using Web scraping technologies for a quick integration, followed by APIs and backend integration in order to create a long-term, durable integration solution. Our solution provides the methods and tools detecting relevant touristic Web services and websites, extracting relevant data, abstracting them into service models, creating corresponding Semantic Web service descriptions and supporting their integration into the overall solution. Extraction of relevant information from the Web and Deep Web is performed using Web scraping technologies. Semantic Web service technologies are used for abstraction and integration. APIs and backend integration usually occurs as a second step, being coupled with contractual based integration of data, functionalities and services for mutual benefits. It will provide more fine grained integration, not only at the level of the Web but deeper, at the level of backend systems, and usually requires enterprise application integration solutions (e.g. Web services).
6. Implementing UbiBook

The concepts, methods, and techniques introduce in the previous section provide the solid ground to build an integrated solution for communication, collaboration and value exchange (i.e. booking) of users (i.e. tourists) through a multitude of on-line and mobile channels. In this section we introduce the general architecture of our approach (Section 6.1) and describe the current status of its implementation (Section 6.2). Finally, we provide a summary of this section and an outlook (Section 6.3).

6.1. General Architecture

The architecture of the overall solution for ubiquitous interaction and collaboration with touristic relies is depicted in Figure 6 and includes the following core components:

- **Content Manager**: it deals with the extraction and use of the content to be published, providing means to read (import) and write (export) content from different sources, based on the governing tourism ontology.
- **Weaver**: the weaver is the main component of the multi-channel communication approach. Its purpose is to align content and channels in an automated fashion. It provides a mechanism to adapt and optimize the distribution of content to the appropriate channel in its suitable format.
- **Channel Manager**: provides unified access to the different communication channels, enabling access (read/write), configuration or even aggregation of channels if necessary. It also enables part of the communication with users.
- **Communication patterns**: these patterns facilitate the management of online interactions, providing an adequate mechanism for response and operation to certain identifiable situations or objectives concerning customer relations.
- **Booking engine**: this component provides access to the booking process for the tourism business.
- **External Data and Service Integrator**: this component enables the integration of external data coming from sources such as the Linked Open Data as well the integration on the fly of external services.
- **Mobile adapters**: this component(s) provides the necessary mechanisms to facilitate mobile operation of the rest of the components.
- **Tourism ontology**: the tourism ontology governs the definition of the content that is pushed in the multi-channel communication and online management and provides the necessary abstractions to achieve a scalable multi-channel communication mechanism.
6.2. Implementation

The implementation of our approach for ubiquitous interaction and collaboration with touristic services is under development as part of the **Seekda Social Agent (SESA)** project\(^2\). The SESA focuses on the multi-channel communication element of our solution which is integrated with seekda’s multi-channel booking solution. The other elements, i.e. integration of external data and services, as well as access and usage of the overall solution through mobile channels, are part of SESA follow-up projects.

\(^{20}\) Website of the project: [http://sesa-project.sti2.at](http://sesa-project.sti2.at)
The main objective of SESA is to help the hotelier in dealing with the challenge of improving and maintaining his communication needs in a world with an exploding number of channels, in order to maintain, or even better, to increase his market share (i.e., the number of bookings and the attached price) by keeping the related transaction costs for on-line communication and booking manageable. In the scope of SESA, we specify and realise the concepts of channel model (Fensel et al., 2012), weaving process of content and channels and communication patterns, in order to achieve the aforementioned objectives.

SESA combines multi-channel communication and multi-channel booking, which are provided as two main components. The multi-channel communication component hereinafter called dacodi, is used to distribute information in various channels, as well as collect and analyze feedback from those channels and actively engage in conversations (i.e. reply to comments). The multi-channel booking hereinafter called Seekda Booking Manager, makes use of dacodi’s functionality by sending requests to the dacodi REST API. The data exchange is done via a REST interface, data being encoded in XML or JSON and sent to dacodi. The Seekda Booking Manager integrates the dacodi management frontend and widgets for the different steps, e.g. one for the publication, one for the feedback visualization. Each time a customer accesses the Seekda Booking Manager, the related widgets are loaded and communicate with the dacodi platform.

The dacodi component is implemented using Ruby on Rails\(^2\) and is conceptually split into two different sub-components. One sub-component is the Core part that includes the REST API and the other is the Adapters that are responsible for the communication with the different channels. The following functionalities are implemented in Dacodi:

- **Role Management/Single SignOn:** In order to support the different stakeholders, different roles are introduced and supported in the system i.e. system user and administrator. These roles map the real world users to the platform.

- **Publication:** The publication process dissemination adapted content to different channels. The adaption is made on the basis of the channel capabilities, e.g. shortened messages are posted to a microblog platform, such as twitter. The current implementation supports a number of channels including Facebook, YouTube, Twitter, Flickr and LinkedIn. To achieve scalability, dacodi uses a message-oriented architecture to implement an asynchronous publication process. For this purpose, the Advanced Message Queuing Protocol, short AMQP is used\(^2\).

- **Feedback Collection:** dacodi is able to collect various feedback across multiple channels. Feedback can have different forms. It can either be textual (comments,

\(^2\) [http://rubyonrails.com/](http://rubyonrails.com/)

\(^2\) [http://amqp.org/](http://amqp.org/)
replies, etc.), a certain amount of positive (like, +1, thumbs up, etc.) or negative feedback (thumbs down, bury, down vote, etc.), or some other measurement of a user’s response to a published item. *dacodi* can collect all these different types of feedback using various polling strategies.

- **Front-end:** The *dacodi* Front-end is composed of two types of components. One component is the server-side Front-end which can be accessed from the Social tab on *Seekda Booking Manager* Front-end, as shown in the Figure 7. Already integrated with help of iFrames, this prototype provides the basic functionality of *dacodi*, demonstrating the dissemination of different concepts like videos, microblogs, pictures, etc. on the different integrated social channels.

  Figure 7: Front-end integrated in Seekda Front-end – “Social”

The second component which will be developed during the integration with *Seekda Booking Manager* consists of more JavaScript widget based subcomponents.

One widget will be needed for the Main Page tab (Startseite) where the notification retrieved from the feedback collection component will be displayed. In this way, the
hotelier can maintain the relationship with the customers, react to their feedback (comments, likes, dislikes, etc.) and also build, maintain and grow an active community of engaged people around the business.

This subcomponent will show the additional bookings gained through the disseminated concepts on different social channels via dacodi. Therefore, the hotelier will instantly be aware of the benefits obtained by using dacodi in Seekda Booking Manager. Figure 8 shows how this widget looks integrated in Seekda Booking Manager.

Figure 8: Widget integrated in Seekda Front-end – “Startseite”

Another subcomponent widget will offer the possibility to extend the functionality of concepts in Seekda Booking Manager with the publish button, as shown in the Figure 9 below for Packages (“Pauschalen”).

This widget will integrate the dissemination of Packages on social channels using dacodi. The Package that is about to be disseminated will provide the content to the widget, and the widget which will show the Package to the hotelier as a post form. The hotelier will then have the possibility to edit the post, modify it by adding or removing elements, and to see on which channel the package is about to be published.
6.3. Summary and Outlook

In this section we presented the technical development status of the UbiBook approach that aims to supports ubiquitous interaction and collaboration with touristic services. We introduced the general architecture and then we described the implementation performed as part of the Seekda Social Agent (SESA). SESA focuses on the multi-channel communication component of our solution integrated with multi-channel booking. We presented the first advances on the technical implementation of the multi-channel communication component called dacodi and its integration with the multi-channel booking solution i.e. Seekda Booking Engine. dacodi functionality includes publication, statistics, impact and engagement. The current implementation of dacodi includes the Single Sign On for authentication, the Feedback collection module, the Publication module and finally a first introduction to the Graphical Interface of dacodi, as well as the foreseen integration in the Seekda Booking Engine.

Future work includes a further extension on the functionalities for the multi-channel component, as well as better integration with the multi-channel booking solution. The other elements of UbiBook solution, i.e. integration of external data and services and access and usage of the overall solution through mobile channels, are part of SESA follow up projects.

23 Website of the project: http://sesa-project.sti2.at
7. Conclusions and Future Work

In this paper, we proposed an approach for ubiquitous interaction and collaboration with touristic services. Our approach combines technical solutions for multi-channel communication, direct and multi-channel booking, integration of external data and services, and the access and value exchange through heterogeneous mobile channels for a better service experience. Combining these technical solutions and making them accessible in an integrated way, allows for a more direct social interaction between tourists and hospitality service providers (i.e. hotels, restaurants, etc.).

The multi-channel communication enables various actors to listen, communicate and engage with each other and thus increase their visibility, online presence and ultimately, their profits. Direct and multi-channel booking enables scalable yield management over a multitude of heterogeneous booking opportunities and enables tourism enterprises (i.e. hoteliers) to save on commission fees requested by booking channels. Furthermore, pooling data from the Web and integrating services on the fly, will enable the creation of combined packages and services, making the overall solution easily extendable with new functionalities. The multitude of external data sources which are exposed and integrated as Linked Data, enable us to provide more comprehensive and complete information relevant for touristic destination website users. Finally, the mobile aspect of our solution enables mobility as an integrated feature, facilitating as an ultimate goal, the value exchange with customers.

Development of the mobile aspect of our approach is part of our future work. We plan to use contextual information in order to provide the right service at the right location and time. **UbiBook** will support the delivery of location-based services that will incorporate data and content, making it available and consumable through a multitude of channels and devices. New types of businesses can be developed on top of **UbiBook** including, for example, last-minute booking via mobile devices. We believe that the ability to answer customer demands wherever they are, and using the channel and device of their choice, will make a huge impact on their experience and consequently on the business itself. **UbiBook** will enable instant interaction between various heterogeneous mobile channels (e.g. Hotel Apps, Tourism Board Apps, Special Touristic Apps or Native Mobile Websites). A mobile toolkit will be provided that can be used to develop adapters, integrate and use mobile channels for on-line communication, and the booking of services provided by hotels. Mobility will be an integrated feature, facilitating as an ultimate goal, the value exchange with customers.
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\textsuperscript{24} Website of the working group: http://oc.sti2.at

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