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Standardization, Modeling and Implementation of Points of Interest – a Touristic Perspective

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Abstract

Points of Interest (POI) are crucial content elements in various applications and services. Numerous use cases (e.g., navigation, mapping, or location-based services) causes that POI data is described in different, mostly proprietary formats. That prevents the use of POI across application boundaries. One reason is that there is no acknowledged POI data standard. However, the World Wide Web Consortium (W3C) released a promising working draft – the POI Core data model. Within this paper, the POI Core is analyzed and an XML schema for POI is presented from a touristic perspective. This schema is implemented using the GPS Exchange Format and a novel GPX extension. The extension enables a significantly improved inclusion of context information into POI descriptions. Finally, a concrete example of a touristic attraction, which is a specialization of POI, will be presented to show the value of the novel approach.

Keywords: *Data Modeling, GPS Exchange Format, Points of Interest, Standardization, Tourism*

1. Introduction

Points of Interest (POI) are considered to be the most fundamental requirement of any spatial data infrastructure [19]. They are used in various applications and services, such as navigation systems, mapping, augmented reality, tourist information systems, mobile guides, social networks, recommender systems, location-based services, and many others. The term POI is used in a broad sense with similar meanings such as Object of Interest [7], Places of Interest [1] or Landmarks [25]. This study follows the definition provided by the Open Geospatial Consortium (OGC) according to which a POI is "a location (with a fixed position) where one can find a place, product or service, typically identified by name rather than by address and characterized by type, which may be used as a reference point or a target in a location based service request, *e.g.*, as the destination of a route" [18]. However, with reference to the composition of the term POI, this definition neglects that the part "of interest" represents a problem due to the fact that one and the same POI might be of interest for one user, or application, but uninteresting for another. Here, a rather subjective component comes into play. Therefore, "interest" must be dealt with in a way, which enables an application to assess, whether a POI could possibly interest a user, or not. This depends from the user context. The term context is defined as "any information that can be used to characterize the situation of an entity. An entity is a person, place, or object that is considered relevant to the interaction between a user and an application, including the user and applications themselves" [3]. Nevertheless, there are two major concerns in dealing with POI.

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First of all, they are not sufficiently described, because, among others, context information is lacking. In most applications and services POI are simple sets of coordinates with an identifier, and equipped with a few attributes such as name or category. However, the correlation of POI to the users' context (*e.g.*, time, weather, means of transport) requires comprehensive data descriptions to implement individual services. Consider a simple question like: Where is the cheapest available parking near the museum? To answer this question information regarding parking fees, real time data about (available) parking lots, and spatial relations between POI, namely the proximity of parking lots around the museum, are needed. In addition, temporal attributes such as opening hours of the museum or the maximum parking time can play an important role. Limited POI content descriptions, as they exist today in most applications, cannot satisfy the requirements of individual services according to the users' context.

Until recently, there is no acknowledged POI data standard. POI are used in different, mostly proprietary formats depending on the application they are part of, or the manufacturer of the device. Having a uniform POI standard would increase the interoperability between applications or services. It would contribute to avoiding the acquisition of new POI data due to the opportunity of using existing ones. Furthermore, such a standard will lead to higher quality location information, provide unique POI attributes, and allow the comparison of location data from multiple sources [21].

This paper investigates existing POI descriptions and formats. The main focus is on a data model, which was published as a working draft (POI Core) developed by the Points of Interest Working Group of the World Wide Web Consortium (W3C) [28]. Within this paper, the POI Core is analyzed whether it is a suitable model for the description of POI from a touristic perspective, such as attractions, which are a main motivator for most tourist trips [12]. For this purpose an extension of the POI Core will be presented including an Extensible Markup Language (XML) Schema, and an implementation based on the GPS Exchange Format. Finally, an example data set will be presented as proof-of-concept.

2. Related Work

The research concerning POI is characterized by specific use cases. That includes the 3D visualization on mobile devices [27], recommender systems [2], the semantic enrichment of POI using ontologies [23], or the adaptation of POI to the context of the user [14]. Furthermore, POI data occur as content elements in OGC standards such as Open Location Service [16], Open GeoSMS [17], and Keyhole Markup Language [15]. However, it is surprising that international efforts to develop a uniform POI standard have not led to remarkable successes in the past.

First steps toward standardization have been discussed with experts in the field of mobile technology, navigation systems, digital maps, and specialists from the car industry. They developed the Point of Interest Exchange Language (POIX) and provided it as a note to the W3C [13]. POIX defines a general-purpose specification language for describing location information using a Document Type Definition (DTD) and XML. The intention of POIX is the exchange of POI data via services of the Internet (*e.g.*, e-mail, WWW) and the embedding in HTML and XML documents. The specification includes the POI attributes "name", "point" (latitude, longitude, altitude), "move" (*e.g.*, speed, direction), "contact", and "access" which indicates the moving method (*e.g.*, by car). However, POIX was only a preliminary proposal and some weaknesses can be observed. One drawback is the lack of information concerning POI categories, detailed descriptions, or temporal aspects (*e.g.*, opening hours). In general, the structure is defined in a simple way and reflects a strong connection to car

navigation systems. POIX was not further developed since version 2.0 in the end of the nineties. Since then, no real new approaches were presented in this respect.

In September 2010, the Points of Interest Working Group (POIWG) was established aiming at defining a flexible, lightweight, and extensible data model for the representation of POI on the Web. Initial proposals of the data model have been published as a working draft under the headline "Points of Interest Core" (POI Core), which is intended to become a W3C recommendation [28]. The POI Core consists of eight categories, which can be combined to describe POI with attributes (*e.g.*, id, name, categories) and different location types such as the center point of a POI, which is mainly used for map representations, the navigation point (*e.g.*, parking lot), or the entrance of the POI. In detail, the data model (see Figure 1) consists of the POI entity, or a list of them within the POIS entity.

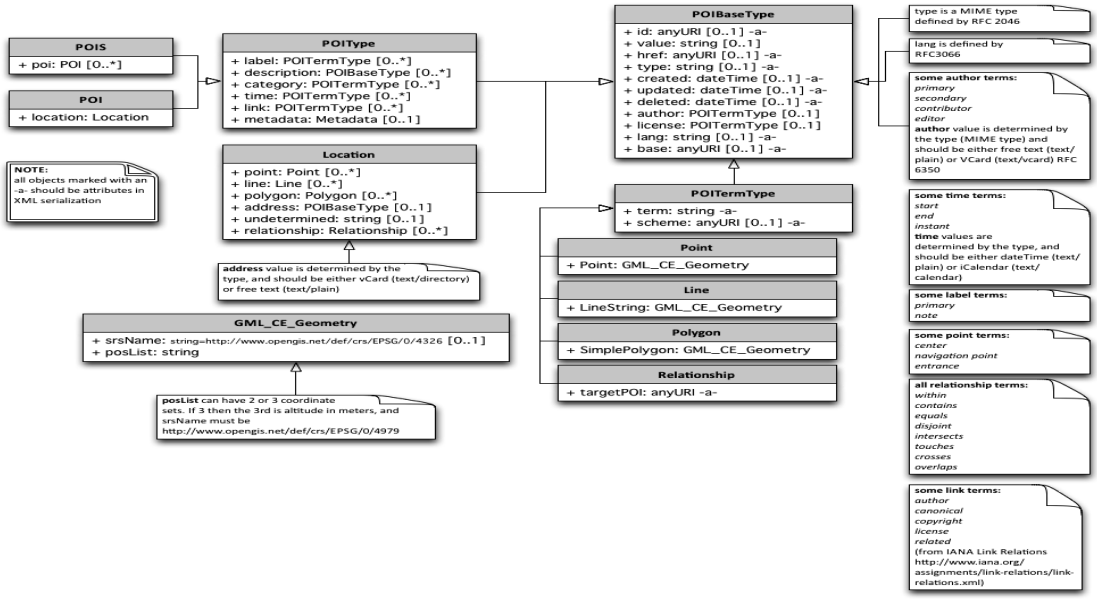

Figure 1. POI Core Data Model [22]

Both entities are derived from the POIType, which consists of a number of properties such as a human readable label, descriptions, multiple categories, and time-related attributes. The POIType adds the Location entity, which provides a description of different location data types, such as points (single coordinates), lines (*e.g.*, roads, trails), polygons, or civic addresses. Relationships between POI can be described within the Location entity using topological properties (*e.g.*, intersection, crossing, or overlaying between POI). The POIType is derived from an abstract POIBaseType entity with additional properties such as unique identifier, license, language, and author information. In addition, the POITermType is an abstract entity from the POIBaseType and includes a character string (term attribute), and an absolute reference (Uniform Resource Identifier) to a schema [9].

In conclusion, the POI Core is an extensive approach opening many possibilities for POI descriptions. It is not understandable that the W3C POIWG was closed in September 2012. However, the OGC is now in process of standardizing a conceptual POI data model including an XML encoding based on the POI Core [19].

3. POI from a Touristic Perspective

3.1. Specialization of POI

The common use of POI data needs a flexible data model. In this study POI from a touristic perspective, referred to as touristic Points of Interest (tPOI) are analyzed. The term "tourist" is used to cover all visitors, including local residents, day-trippers, as well as foreign visitors. The focus here is on attractions, defined as a "physical or cultural feature of a particular place that individual travelers or tourists perceive as capable of meeting one or more of their specific leisure-related needs. Such features may be ambient in nature (*e.g.*, climate, culture, vegetation or scenery), or they may be specific to a location, such as a theatre performance, a museum or a waterfall" [8]. In [26] four types of attractions are identified, namely natural environment attractions, man-made attractions that were not originally designed to attract tourist (*e.g.*, cathedrals, churches, or castles), man-made attractions that are designed specifically to attract tourists (*e.g.*, theme parks, zoos, museums), and non-physical, temporary attractions, such as events or festivals. Other types of tPOI are tourism related categories, such as accommodation, gastronomy, transport and services. In addition, a hotel or a restaurant can also be an attraction. Therefore, multiple categories can be associated with one single tPOI. A general categorization of tPOI is shown in Figure 2.

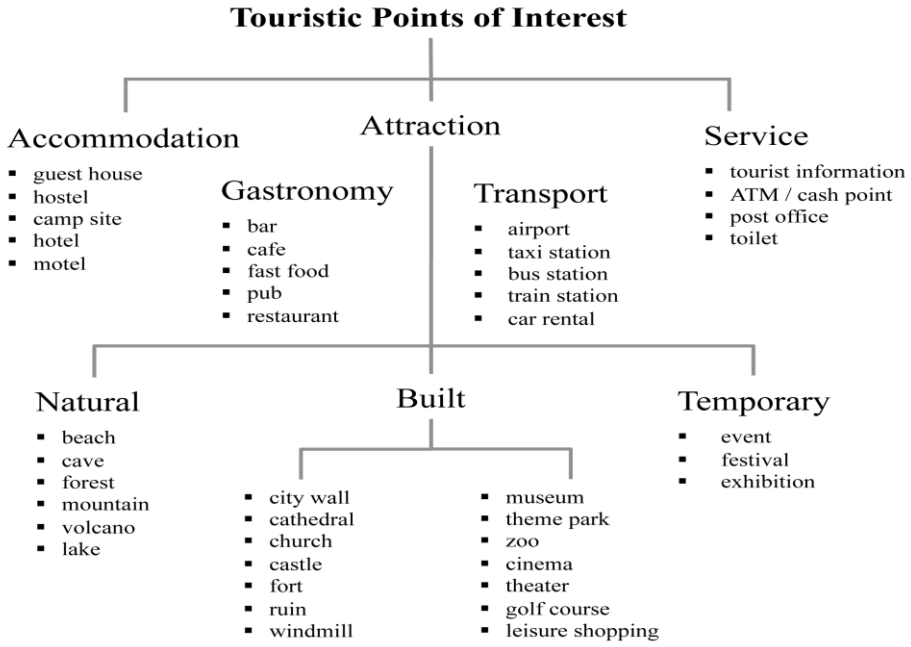

Figure 2. Categorization of tPOI

3.2. The Suitability of the POI Core for tPOI

On the basis of the POI Core the question arises, whether it is a suitable model for tPOI. The properties of tPOI are divided into spatial, temporal, and descriptive features. From the spatial viewpoint, tPOI can be described with several locations, such as the center point, the entrance, the navigation point, or the parking lot in reference to the tPOI. Even though the name "touristic Point of Interest" suggests that it represents only

points, tPOI also represent line (*e.g.*, historic roads, trails) or polygon data (*e.g.*, beaches, national parks). Additionally, spatial relations characterize them. For instance a tPOI included in another (*e.g.*, a shop in a mall) or the intersection of two tPOI (*e.g.*, on a trail). Temporal features are among others the opening hours, the duration of stay (*e.g.*, visiting time of an attraction), or time primitives that represent an individual point in time (*e.g.*, events, festivals). A key feature of tPOI is the extensive content description. This includes the assignment to one or more categories, and comprehensive, multilingual descriptions (*e.g.*, historical information for attractions). Often tPOI are equipped with reviews and ratings published in community portals. In addition, they can have admission charges, or contain media information such as photos, videos or audio recordings. Table 1 shows to what extent the POI Core data model meets the requirements of tPOI.

Table 1. Requirements of tPOI

Spatial	POI Core	**Temporal**	POI Core	**Description**	POI Core
multiple locations	✓	opening hours	✓	multiple categories	✓
different geometries	✓	duration of stay	✓	admission	–
relationships	✓	timespan, season	✓	reviews, ratings	–
address	✓	Events	✓	media information	–

From the spatial and temporal point of view the most important requirements are fulfilled. However, the descriptive features are only partly realized, regarding the multiple categories. For instance, there are no elements for admission charges, POI reviews, or media information. Aiming at removing this deficit, the data model of the POI core needs to be extended. The missing properties (media, admission, review) are added to the POIType entity. Each property is described by the abstract entity POIBaseType of the POI Core data model.

Since this is only a general model and the POI Core itself represents still work in progress, a concrete implementation of the model will be presented in the following section too.

4. Implementation of the Data Model

4.1. Motivation

The first working draft of the POI Core is intended to encourage discussions. Raj Singh, a Director of the OGC Interoperability Program, wrote on the POIWG mailing list: “It seems to me like a chicken and egg problem. A lot of people I talked to didn’t want to implement until there was an approved standard, and W3C didn’t see demand because of the lack of implementations. So the W3C angle has been to move the work to a community group” [24]. This paper contributes to that discussion through the analysis of the POI Core data model and probing its flexibility for extensions (tPOI), including a prototypical implementation.

4.2. GPS Exchange Format

The GPS Exchange Format (GPX) is a lightweight XML format for sharing GPS data between mobile devices such as smartphones, tablets, or car navigation systems [6]. The benefits of GPX are the acceptance as an open standard and the massive proliferation [5]. GPX is highly spread and supported by hundreds of software applications (*e.g.*, Google Maps, Garmin MapSource, ESRI ArcGIS, Quantum GIS), POI Portals (*e.g.*, www.poiplaza.com), and libraries (*e.g.*, OpenLayers). The usage of GPX ensures that POI can be part of various existing applications and services.

However, GPX offers only limited POI descriptions within the complex type "wpt" (waypoint) and the associated attributes listed in Table 2.

Table 2. GPX Waypoint Elements

Name	Description	Count
lat / lon	Latitude / longitude of the center location	[1]
ele	Elevation in meters	[0..1]
time	Creation, modification timestamp in UTC	[0..1]
geoidheight	Altitude with respect to the geoid	[0..1]
name	The name of the POI	[0..1]
cmt	Waypoint comment	[0..1]
desc	A text description of the POI element	[0..1]
src	Source of data or device name	[0..1]
link	Link to an external resource	[0..*]
sym	Name of the symbol	[0..1]
type	Classification / category of the POI	[0..1]
extensions	GPX extension by adding another schema	[0..*]

These attributes are not detailed enough to satisfy the requirements of the POI Core and tPOI as specialization. Several items such as the entrance of POI, or a navigation point cannot be described. All attributes (besides "link") may be used only once. Thus, multiple categorizations and multilingual descriptions are not possible. Attributes for additional items, such as admission charges, POI reviews, or opening hours are missing too.

As part of this study, GPX was extended aiming at describing POI data more comprehensively. However, a simple addition of attributes is not possible because the resulting document would not be accepted as a valid GPX file for a wide range of applications and services. The solution is the embedding of custom extensions into GPX. This can be achieved by adding elements from other schemata into the "extensions" element, which are not part of the current GPX specification. This is a way in which software developers can write a GPX file that contains additional elements without losing the validation of the GPX file.

Based on such an approach, a GPX extension has been developed within the framework of this study. It realizes both, the representation of the POI Core data model and the consideration of tPOI specific characteristics.

4.3. The POI Extension

To prepare GPX according to the requirements of the POI core, an extension called "poiExtension" is included as an XML schema. The extension enhances the GPX "wpt" element in considering additional attributes from the POI Core data model, and the tPOI specialization. Figure 3 shows the structure of the extension.

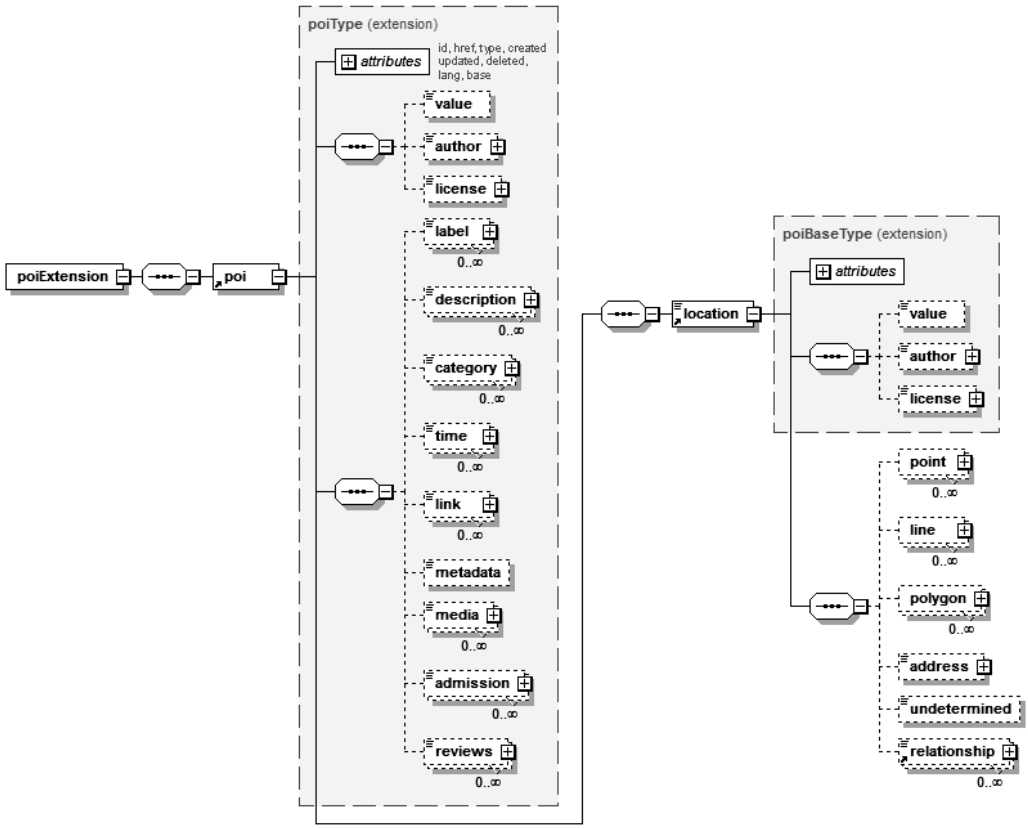

Figure 3. POI Extension Schema

The "poi" type includes all information about a single POI and contains one or more "location" elements. A list of POI objects (similar to the POIS object in the POI Core) can be implemented through a list of "wpt" elements. The "location" element refers to an identifiable geographic place [11], and consists of different point locations (*e.g.*, navigation point) with latitude and longitude coordinates. The spatial reference system is described by the European Petroleum Survey Group Geodesy (EPSG) codes [4], where the identifier 4326 represent the commonly used World Geodetic System 1984 (WGS 84). The "label" element specifies any number of human readable labels and represents the name of the tPOI in different languages. The language is identified through a two digit language code, listed in the ISO 639 standard that is concerned with the representation of names for languages [10]. The "description" element expands the

GPX "desc" attribute to an arbitrary number of multilingual POI descriptions. In addition, the description can be extended with the exemplary new attributes, media information, admission charges and POI reviews. Since the GPX "type" element only allows one classification of the POI, the complex type "category" was introduced, which offers associations with any number of categories. Ownership rights, contact person, and other information are added in the "author" element of the POI extension. Temporal descriptions of tPOI are possible in the "time" element. Some recommended time terms are "start" and "end" (as defined in the POI Core), which can be applied for tPOI events. "Instant" refers to a single time slot during which an event happens, and "open" stands for POI opening hours. For opening hours a simple, but effective mapping schema from OpenStreetMap (OSM) is used, which can be expanded easily. OSM defines opening hours in the map feature "key:opening_hours" by separating different values by comma (see Table 3).

Table 3. Definition of Opening Hours

Value	Description
24/7	Open 24 hours and 7 days a week
Su 11:00+	Sunday from 11 to open end
sunrise-sunset	Opens every day between sunrise and sunset
Mo-Sa 07:00-11:00; Tu off	Mo. - Sa. from 7 to 11, Closed on Tuesday
week 1-53/2 Fr 09:00-12:00	Open from 9 to 12 on Fridays of odd weeks

4.4. An exemplary XML-implementation of the Extended tPOI Model

In this section an example of a tPOI – the "Wernigerode Castle" – is given using the POI extension as suggested before. The example in figure 4 indicates the possibilities for comprehensive POI descriptions aiming at making them usable for touristic purposes.

The root element is "gpx" and contains one or more "wpt" elements. Each "wpt" element represents one single tPOI. The namespace "gpxx" is used, because the extensions implements similar attributes (*e.g.*, time, type) as GPX. The spatial description of "Wernigerode Castle" consists of three different point locations. The center point is used for the map visualization. Due to the location of the castle on a mountain, it cannot be reached directly by car. To facilitate the arrival for the tourists, the navigation point provides the location of the parking lot near the castle, with a reference to the entrance point. Temporal features, such as opening hours, are included in the "time" element. In addition the term "duration" is introduced to specify a time interval, such as the POI visiting time. The value "P" indicates the period and "nM" the numbers of minutes. The average duration of stay at this tPOI is for instance 120 minutes. With the help of this information, tourists can determine whether the visit of the tPOI is possible in their remaining travel time regarding to the opening hours of the "Wernigerode Castle". Furthermore, the "description" attribute describes the tPOI in detail, using Wikipedia as source of content. Through the "link" attribute additional information and references, such as an URL to the webpage of the "Wernigerode Castle" are given.


```
<?xml version="1.0" encoding="UTF-8" standalone="no"?>
<gpx xmlns="http://www.topografix.com/GPX/1/1" version="1.1" creator="name" xmlns:gpxx="http://geoserver/xmlschemas/PoiExtension"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xsi:schemaLocation="http://www.topografix.com/GPX/1/1
http://www.topografix.com/GPX/1/1/gpx.xsd http://geoserver/xmlschemas/PoiExtension
http://geoserver/xmlschemas/PoiExtension/poiExtension.xsd">
<wpt lat="51.83050581" lon="10.79489081">
<ele>240.86</ele>
<time>2013-06-08T10:29:03Z</time>
<name>Castle Wernigerode</name>
<sym>waypoint</sym>
<type>point of interest</type>
<!-- Content of the PoiExtension -->
<extensions>
<gpxx:poiExtension>
    <gpxx:poi id="12441poi" created="2011-09-25 11:34:01" updated="2013-06-08 09:03:33">
    <!-- Location -->
    <gpxx:location updated="2010-03-02T21:30:32Z" href="http://www.openstreetmap.org/">
        <gpxx:license href="http://www.creativecommons.org/CC-A/3.0/license/xml" type="text/xml"/>
        <gpxx:point term="center">
            <gpxx:Point srsName="http://www.opengis.net/def/crs/EPSG/0/4326">
                <posList>51.83050 10.79489</posList>
            </gpxx:Point>
        </gpxx:point>
        <gpxx:point term="navigation">
            <gpxx:Point srsName="http://www.opengis.net/def/crs/EPSG/0/4326">
                <posList>51.83273 10.79377</posList>
            </gpxx:Point>
        </gpxx:point>
        <gpxx:point term="entrance">
            <gpxx:Point srsName="http://www.opengis.net/def/crs/EPSG/0/4326">
                <posList>51.83031 10.79461</posList>
            </gpxx:Point>
        </gpxx:point>
        <address>Am Schloss 1, 38855 Wernigerode, Germany</address>
    </gpxx:location>
    <!-- Time -->
    <gpxx:time term="open" scheme="http://wiki.openstreetmap.org/wiki/Key:opening_hours">Mai-Oct 10:00-18:00</gpxx:time>
    <gpxx:time term="open" scheme="http://wiki.openstreetmap.org/wiki/Key:opening_hours">Nov-Apr 10:00-17:00; Mo off</gpxx:time>
    <gpxx:time term="duration" scheme="http://www.w3.org/TR/xmlschema-2">P120nM</gpxx:time>
    <!-- Label -->
    <gpxx:label term="primary" xml:lang="en">Wernigerode Castle</gpxx:label>
    <gpxx:label term="primary" xml:lang="de">Schloss Wernigerode</gpxx:label>
    <!-- Description -->
    <gpxx:description href="http://en.wikipedia.org/wiki/Wernigerode_Castle" lang="en" updated="2013-02-28T21:01:00Z">
        <gpxx:author id="http://en.wikipedia.org" type="text/plain">Wikipedia</gpxx:author>
        <gpxx:value>Wernigerode Castle is a castle located in the Harz mountains above the town of Wernigerode in Saxony-Anhalt,
        Germany. The present-day building, finished in the late 19th century, is similar in style to Neuschwanstein Castle, though
        its foundations are much older. The castle is open to the public and one of the most frequently visited in Saxony-Anhalt.
        </gpxx:value>
    </gpxx:description>
    <!-- Category -->
    <gpxx:category term="tPOI" scheme="http://geoserver/poitypes" >attractions</gpxx:category>
    <gpxx:category term="tPOI" scheme="http://geoserver/poitypes" >built attractions</gpxx:category>
    <gpxx:category term="tPOI" scheme="http://geoserver/poitypes" >castle</gpxx:category>
    <!-- Link -->
    <gpxx:link term="homepage" href="http://www.schloss-wernigerode.de"/>
    <!-- Media -->
    <gpxx:media type="image/jpeg" href="http://www.schloss-wernigerode.de/images/1.jpg">The castle in winter</gpxx:media>
    <gpxx:media type="video" href="https://www.youtube.com/watch?v=4vdgzwtWWZ8">Castle Wernigerode</gpxx:media>
    <!-- Admission -->
    <gpxx:admission type="adults">6,00 EUR</gpxx:admission>
    <gpxx:admission type="students">5,00 EUR</gpxx:admission>
    <gpxx:admission type="children">2,50 EUR</gpxx:admission>
    <!-- Reviews -->
    <gpxx:review type="5 stars" href="http://www.tripadvisor.com" created="2013-05-11" lang="en">
        <gpxx:author id="dylan3spot"/>
        <gpxx:value>Fantastic views, and well worth the 6euro entrance fee. You get the views without paying, but the inside of the
        castle is brilliant. And get the audio guide for 2.50. The little train also goes up to the castle if you don't fancy the
        walk.</gpxx:value>
    </gpxx:review>
    </gpxx:poi>
</gpxx:poiExtension>
</extensions>
</wpt>
</gpx>
```

Figure 4. GXP Example of "Wernigerode Castle" using the POI extension

5. Conclusion

Within this paper, deficits and resulting challenges concerning the description and standardization of POI were discussed. On the basis of the POI Core data model, developed by the W3C POIWG, an extended XML Schema was introduced which fulfills the requirements of POI from a touristic perspective (tPOI). It serves as an example that such an extension could also be used in other application areas and would contribute significantly to more interoperability and context-awareness of POI data. The GPX format was used for the implementation, because GPX is an open standard, and is supported by various applications and services. Due to the limited features of POI description in GPX, a novel approach (POI extension) was presented which expands the GPX waypoint element. The example of a tPOI ("Wernigerode Castle") demonstrates that the approach is applicable for detailed POI descriptions and the implementation of the POI Core data model.

This approach offers significant expansion potential. The POI Extension, as an XML-based approach, could be used for web services, or location-based services. In this way it could offer information concerning results of POI methods. For instance the consideration of the means of transport could be used to calculate, how much time is still available to visit the POI in relation to the travel time or the POI opening hours, and whether it is worth a visit (*e.g.*, by including POI ratings of users with similar profiles).

In particular, the recent effort of the W3C POIWG shows the high relevance of the topic, and the need for a standard that provides interoperability. In addition, the OGC announced a press release on May 30, 2013 and seeks for public input on a charter for a proposed working group to draft a POI encoding standard based on the W3C POI Core [19]. Supporters of the proposal are among others, Google, Interactive Instruments, the University of Seoul, the Department of Resources, Energy and Tourism in Australia, and the National Geospatial-Intelligence Agency.

Furthermore, the collection of POI content and the ubiquitous access to the data are essential requirements for sharing POI between different applications. The OGC OpenPOIs Registry, which is currently a beta version, provides a database with a reference implementation of an early version of the POI Core [20]. It is a comprehensive directory of links to other POI databases (*e.g.*, OpenStreetMap, DBPedia, GeoNames), including the actual information about the places themselves. The OpenPOIs Registry can be queried by a web service API or via an OGC Web Feature Service (WFS). However, it does not follow the purpose to provide detailed and extended POI descriptions as the approach presented in this study suggests.

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