Outdoor meets Indoor at Numbered Gateways

Considerations about a cooperative Gateway Numbering Approach
for multiple GeoIT-providers and for multiple building operators
via an organisational and technical Infrastructure

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***Abstract* — This paper is a collection of early thoughts to refine last meter navigation based on observations in highly urbanized cities via numbered and published gateways (including entrances and exits). A new organizational and technological infrastructure can solve the distribution requirement from the building operators via internal or external editors to the GeoIT providers and finally into the hands of visitors. Because many buildings operators are slow in digitalization, an alternative external capturing and publication process via an association could push the approach in a consistent way forward. This paper fits into the Work-in-Process category and is an invitation to join.**

Keywords — indoor; orientation; multi building operator; multi GeoIT Provider; organizational infrastructure from local to global

I. INTRODUCTION AND REAL-WORLD OBSERVATIONS

A basic need is the orientation in our physical world. Mobile computing and navigation are considered as the most important inventions of the current century [1]. Although we have seen many approaches in the last decade, the indoor is still the digital terra incognita. Public transport with mass transit in dense urban areas requires enhanced description and organization to catch the correct train and to reduce delays.

A. Real-world examples

An established approach for better orientation is numbering of logical features, like railway tracks. Arabic or alphanumerical numbers are multi-lingual and therefore usable worldwide, avoid (long) place names and can be memorized. But the trade-off is a shared reference system with boundaries. Other examples are numbers for bus, trains or underground lines, wagons and seat numbers. An enhanced numbering was introduced in Japan in numbering the stations along lines (having multiple numbers at crossings) like “H28” for Noboribetsu and station exits. Long distance train stations with numbered exits are Vladivostok and Sydney. The station Shinjuku in Tokyo has 78 numbered exits covering also the related underground line stations.

B. General Observations

In opposite to the general observation of much lowed usage of voice communications with the introduction of smartphones, travelers in stations still need it to meet their partners due to a lack of indoor orientation, together with crowded rush hours and unknown areas.

C. Historic Examples

Historic buildings with multiple backyards, multiple companies on six levels also required the numbering of yards and entrances e.g. Berlin “Gewerbehöfe”.

D. Variations in orientation concepts

There are some variations with multiple numberings with combinations of (Latin-) alphabet, romaine numbers and symbols. The exit descriptions of Deutsche Bahn contain the directions to a geographical feature, e.g. “Bayrische Straße” in “Dresden Hbf”. Therefore, three exits with a distance of approximate 100 meters have the same description and no direct sight (therefore because of multiple same names some misunderstands are probably expected to meet there).

E. Most current numbering solutions are analogue island

The current approach of building operators is to solve the general need with local solutions around the buildings. Larger building operators, like airports, share these (gateway) numberings already digitally with major GeoIT-providers. But in most cases (car) navigation system do not have the same numbering of entrances, e.g. for a university building due to the lack of an established, digital and multi-operator publishing solution. Therefore, most current approaches remain analogue “island” without a digital outlet to geoweb-infrastructures and finally to smartphones.

F. Naming issues: Exits, entrances, doors and gateways

Although entrances and exits have a different meaning for in and out, the usage is very often combined. Some may have only a single door and others a large number of doors per entrance. (City wall-) gate were and are still very known like in Paris. Therefore, “gateway” is proposed as an umbrella term to cover these features. However, this issue is still to be decided.

II. Trends and Definitions

The trend of worldwide urbanization continues to raise. Tokyo is a highly developed open-air laboratory to observe developments with investing governments and companies.

The introduction of the Android GNSS raw data API with the possible integration of dGPS (also known as RTK) [9] and the announcement of dual frequency GNSS/GPS components of a major and leading mobile component manufacturer [10] will deliver much higher precision in outdoor positioning. That can lead to much finer capturing and navigation of and into doors and gateways.

Deep learning will also add object detection for better orientation. A very first mobile, offline, open source and open data implementation is YOLA based on TensorFlow ([13]). There are multiple demo apps available in the store.

A. Geo Web Infrastructure

The digitalization trend was pushed forward in this field especially with smartphones. Smartwatches and GeoIoT Technologies are upcoming new IT/GeoIT platforms for the IoT age. Looking backwards into the Internet / Web 1.0 age (1995-2005), Google Maps (web, mobile) / HERE Maps in the commercial sector, OpenStreetMap (OSM) in the social sector and Spatial Data Infrastructures (e.g. EU INSPIRE SDI) in the governmental sector, were established or are still in the process. An intermedia term between GeoIT and these concrete infrastructure technology solutions is still missing. Therefore, the term "Geo Web Infrastructure" is used. Better proposals are desired.

Navigation components

Although differently used and weighted in our field the term "Navi" consists today of three components: Geodata for Mapping, Positioning and Guidance.

III. Why: Motivation & Business Model

The introduction with real world examples, the current trends in urbanization and the general digitalization will shift the expectations of visitors (and regularly potential customers) to more detailed, in-hand but also displayed, orientation information. More and larger complex buildings and tunnels guarantee a comfortable passenger transfer (e.g. Montreal or Sapporo with cold winters) but require also more and more artificial orientation.

A "digital first" approach should be possible, but with backwards analogue compatibility.

A. Visitor Demand

A high frustration level because of missing orientation leads to rejection of costly buildings, e.g. Hanover's Passarella before the last renovation. The installation of a single app per buildings complex is unrealistic today. Visitors expect orientation by building operators. To some degree, also maps with advertisements are accepted. Because the outdoor navigation is solved and very useful, the last meter indoor/outdoor challenge gets relative to outdoor more a relevant as a pain point.

B. Building Operators

The basic need for visitor orientation is accepted and some budget is allocated for classical signs. The risk is that unoriented and frustrated visitors will lower optimized processes like costly passenger changing times in transport or avoid this kind of transport product at all. Although building operators are conservative in digitalization, a trade-off might be the split of the existing budget for physical and digital "signs".

Other extremes are many capacity limits in (transport) infrastructures especially in rush hours in large urban cities. Therefore, digitalization is a solution as optimization in between and as addition to new, but costly and long enduring building projects.

C. Media Departments or Companies

The isolated sign and numbering solutions of single building operator may be integrated into existing GeoIT solutions, if the commissioned internal or external or geospatial enthusiast editor finds a lower hindering interface to upload his data for global sharing. The willingness to pay for a digital service is unknown but expected to be low. A potential business model for the registry might be ordering service for long-lasting stickers and signs described in VI.B.

The current commissioned inhouse editors or media companies do not have capabilities and deeper interest for a harmonized, spatial and global solution.

D. GeoIT-Domain

Some established and startup GeoIT-players are already involved in the digital indoor terra incognita. In parallel third-party mapper, e.g. local guides and OpenStreetMap-Member started to define and created digital entrances in the case of low interest of building operators. These may be claimed later.

Although the indoor environment was subject of many developments like indoor maps and beacons in the last decade, the general digital indoor navigation is not solved.

E. Approach: Reduction to Gateways by Intention

Entrances and exits, or in general gateways, are the intersection between indoor and outdoor in the physical world but also the in GeoIT-subdomains. The numbering of gateways might be a realistic compromise and a step stone.

An open question is if the design should already consider indoor feature like office doors but face the risk of over-engineering or the risk of development of dead-ends?

F. Hackathons, Discussions and Workshops

The described approach was identified at the Hackathon of Deutsche Bahn (DB) and Japan Railways (JR) East in September 2017 in a joined team of Beuth University and University of Tokyo. A hack was created with the example of Berlin Ostbahnhof via OpenStreetMap and the derived OpenStationMap project [4]. The approach was later extended by the publication process concept (see VI.C) with the Association for Geoinformatics, GeoIT and Navigation [3] with the potential business model supporting ordering process (see VI.B) and the motivation creating editing process (see

VI.A). The challenge is the huge space of terra incognita with many gateways and without a distinct resource plan. Therefore, also an intended reduction on gateway numbering and not the full indoors feature world was the result of discussions as a "step stone". Additional discussions within the Association and participations were scheduled at the GeoIT Wherecamp Conference 2017 [4]. A one-day workshop was held at the University of Tokyo on February 13th, 2018.

G. *Re-use of existing physical signs*

Crowed places like train stations with passengers carrying luggage and therefore occupied hands, together with time pressure to catch the next train are challenging cases for digital solutions. Classic, physical signs are helpful. A distinct navigation concept like landmark navigation with long- and middle-distance direction is often already established.

This navigation concept might be digitally supported. A very detailed, on OpenStreetMap based and implemented study was developed by Julia Eifler together with a leading software provider for public transport Mentz GmbH in 2015 [6]. The required data capture efforts of the sign positions are significant, but feasible. A similar approach is the capturing and later visualization of autobahn signs in popular navigation systems.

Because of the still enduring lack of indoor navigation guidance component solutions, these physical signs are very relevant. They might be enhanced in an upcoming maintenance cycle with numbered gateways.

A new, distinct icon resulting from this required could help visitors to recognize these gateways with entrances and exits better. An example for this compatibility characteristic is the registered Bluetooth icon. More details about this enhancement are discussed later (see VII.A).

H. *Numbering of Gateways*

The introduction of a numbering order helps to derive an ordered structure as introduced in the observations (see I.D). Advantages are

- Ability to be memorize by humans
- Multi-lingual
- Multi-cultural
- Human-to-human interaction e.g. via mobile phone
- Human-to-Machine interaction with voice support like "Amazon Alexa"
- Allows with an URL pattern the simple support of popular messengers like Line, WhatsApp or WeChat with an example OpenStationMap.org.

Disadvantages are

- requires a consistent reference model
- requires the collection and description of these "abbreviations" and therefore investments
- that these investments may not pay-off in all cases
- that pure numbering does not contain semantics

I. *Naming of Gateways*

Another way to memorize is a meaningful semantic description. Although the order is lost in the sematic description, (place) names are also powerful. Therefore, an optional naming of gateways should be considered in the design.

J. *Numbering order concepts and orientation*

The spatial challenge is the 3D to 2D or even 1D reduction to allow the usage of 2D numbering with two dimensions, like "9A" known in the aircraft seat reservation. The reduction to a single dimension, 1D, therefore list, requires additional explicit or implicit rules. There are also many examples of solutions with a more or less logical or even up to pure identifications like solutions, like some postal address systems. Examples are Japanese addresses with three containing areas (4-19-7 Yoyogi, Shibuya-ku, Tokyo) or the "Bauernschaften" (peasantry) approach with very distributed farms in Münsterland, Westphalia, Germany. A very old farm had a low number from the initial numbering. The neighbour new house got the next free available and therefore higher number. This address system turned to out as not usable for mental navigation and required the usage of family or farm names again.

The public transport application domain uses in many cases "main" gateways, e.g. towards city, and "backyard" gateways. The relevance may also change over time or with the introduction of additional mass transport systems like undergrounds. How to solve these issues?

An identified numbering approach was a general geographical ordering approach clockwise starting with north. Because the sky directions are often unknown in urban areas, this approach was neglected.

The reflection of upcoming change, like the closing or opening of a new gateway will require reduction and extension rules. An example for a massive change and for the usage of semantical correct entrances and exit are security checks in the entrances of train stations in Russia. Although a closing of a gateway may result in the not harmful dropping of a given number, a new gateway will need a not disturbing extension. The annexation of a letter to a number, like 3A, may result in a collision if a 2D-reduction is used. The French approach of "3bis" is more explicit. In many cases the numbering or more general the ordering was already introduced directly or indirectly by semantical meaning or local knowledge. There are also installed local signs. There are also known und used contexts with higher or lower relevance for gateways, like "Stadtausgang" (towards city).

The current conclusion is to support existing naming and local relevance knowledge with local editors (see V.B) without a distinct numbering orientation concept. Simple Strings for gateway numbering should be considered on implementation level.

K. *Harmonzed approach for multiple GeoIT-providers*

An infrastructure solution combines multiple GeoIT providers, because visitors will use different products like in cars or while walking.

IV. WHY NOT: RISKS AND EFFORTS

A. *Competing trends and developments like GeoIoT*

The realization will require some investments to delivery long lasting, daily returns like any infrastructure. Another reason is that not every infrastructure approach pays-off and therefore alternative developments need to be considered. New technology ages like "Mobile Computing 2.0" with "Location Based Apps 2.0" are upcoming now. This will offer high precising outdoor positioning with GNSS raw data and dGPS integration together with dual frequency GPS chips in market smartphones [1]. Another development might be better indoor positioning creating a universal indoor positing like Ultra-wideband (UWB) but might be hindered by additional required hardware installation by building operators. The trend timing is difficult to assume and the last decade activities were not really successful as a breakthrough.

B. *Success factor and value: popularity*

Like many approaches the crucial success factor and later its value is the degree of general adaption. How to gain the required popularity is very difficult predictable. Another factor is the degree of frustration of not sufficient orientation, e.g. in large (transport) buildings.

C. *Machine-to-human compatible orientation*

Human orientated instructions like "go right or go left" are very successful in human-to-human (spatial) communications. New sensors like on glasses or within ears may detect the current direction of the head and enables a new way of machine-to-human orientation.

D. *Investments*

This concept for a numbered gateway and multi-GeoIT provider infrastructure requires significant investments. A crowed based approach might be feasible. On the other hand, there are many synergies with public transport and general building operator duties for better visitor orientation.

E. ORGANIZATION VS. TECHOLOGY MATURING

This approach uses existing (Internet-) technologies and could be realized already earlier since 2005 with introduction of Web 2.0. It is not technology driven. On the other hand, the conservative building operator's enhancements run in longer periods and therefore it might be the right time now?

V. WHO: ROLES

This chapter descripts the concept view on primary and secondary roles, their responsibilities and their interactions.

A. *Building operators*

Buildings are build for different functions and users. More or less public accessible users expect visitors. They have a more or less knowledge of the buildings. An example for this range is a station with one-time or frequent-passenger visitors. Another example is a university with students who start as visitors at the beginning. Some signs are required, because of emergency rules, but usually not helpful in practical life. But the degree of sign-installations and visitor information varies much. It depends on the interests of the particular operator. Frustration or demand could result in a digital capturing of public accessible buildings by third parties. OpenStreetMap-Mappers are a good example. But also, large GeoIT-providers capture the indoors on own expenses or buy available data for visitors using their applications. But often there is no direct contact between building operators and visitors. The author gives an example: Although many public buildings are observed by direct personal or indirect camera-based security, the experiences with building operator the USA train tour of the author in 2016 with capturing the stations Portland, Chicago Union, Washington DC Union, Grand Central Station in New York only resulted in a single meeting with approaching security staff. After explaining these efforts, the security personal expressed even their own demand for better indoor maps.

Another desired argument for large building operators is the challenge to cope with the permanent change, e.g. of shops. An example is Deutsche Bahn. The expectation of them to engage third party mapper like OpenStreetMap was that they are quicker to update indoor maps. An observed example was the opening of a new electronic store at the Berlin Central Station before even its opening. The experience is that indoor areal geometries are a threshold for mapper. The sematic updating of existing features like a new shop operator with new demanded offerings happens quickly. The capturing of geometries requires a laser distance measurement device, which is affordable today. This kind of capturing also does not disturb the general operations and is therefore very seldom detected by security staff. A very practical advice therefore is not to map with two persons. Buildings operators of public accessible buildings usually tolerate an indoor data capturing, if even detected. A relational might be from an economic point of view that the investments to gain some driving minutes by new tracks or signaling are very high. These gains may be directly lost in a case of required train change with a 5-10-minute time slot. Well-organized visitor information can reduce the required time for a change and can also result into an informed planning with detailed footways to calculate station or even train specific switchover time in routing. The overall performance from door-to-door is counted.

B. *Visitor*

The visit of an unknown building requires additional information for orientation. The expectation on signs and digital tools is high in terms of practically and speed. The alternative is always to spend a minute more to explore the environment manually. Major frustration appears, if a train is missed e.g. because of a not-operational elevator. The reaction of visitors ranges from general rejection to acceptance due to no alternatives.

C. Editor

The production of physical or digital signs and maps is a specialized procedure. Physical realizations of signs are usually done in cooperation and more often even commissioned by the building operator. A classic pattern is a commissioned media agency. But this data is often not uploaded for sharing. New, digital data for digital channels might be captured also as a third party without explicit permission or commissioning. Therefore, enthusiastic mapper can enhance the navigation by uploading. A later claiming by the building operator is a possible long-term solution.

To stimulate also other actors, who have much local knowledge, which is required to assign the numbering of gateways, a win-win situation is promising. If the tools are easy to use with existing software, "dataware" and hardware and free of additional charge also receptionist, security staff or event manager may edit their indoor environment, number them and give names. The organization of an event is a good use case to start this process. The required functions are described in paragraph VI.A. The component and its technology are lined out in paragraph VII.B.

D. Association as a building-operator independent actor

In almost all cases today the created value of the editor is not re-used digitally via GeoIT-providers and therefore not delivered digitally to the visitor. This is a major problem statement!

There are available, but propriety and therefore not synchronized upload tools for collection of these data, which were established with the introduction of indoor maps. An open data example of the current state is the amount of usually not numbered feature "entrances" in OpenStreetMap: 1.515.291 entrances by 17.965 different users [16]. An intended threshold in OpenStreetMap is to map only physical features like existing signs and numbers, e.g. for entrances. Therefore, a new third-party numbering concept is not feasible directly via OSM. An indirect solution is to use an association defining the numbered entrances with an open data publication process. This will be explained below in detail.

Facing the huge number of the terra incognita with existing entrances the fragmented constellation leads currently to a low amount of digital captured results for numbered gateways. How to push forward to get better visitor orientation?

There are examples that third-party associations are very successful in establishing of an operator / owner independent solution due to frustration with the incapability and non-combability of the responsible but inactive players. They pushed forward even without the responsible players.

The EPSG Code is a concrete example in the GeoIT realm [7]. Although focusing on petroleum search, the members of this group were frustrated with a large number of spatial reference systems used by different mapping agencies. The expectation was that a mapping agencies umbrella organization would define an umbrella reference. Because of their practical demand for their work this group needed to define and to publish their own list. These EPSG codes are the standard reference system in GeoIT today. This reference survived even after the European Petroleum Survey Group has merged.

Taking the EPSG role, the methods of definition and publication and the EPSG code as data, the organizational model to overcome current inability or low interest of building operators in the digitalization process, a GeoIT realm association may can adapt this (EPSG example) concept and take this role. If the definition and publication is done with an OpenStreetMap compatible license like CC0, OpenStreetMappers can also integrate these association defined numbered gateways into the core OSM data. Also, other GeoIT members can import these definitions and deliver a consistent visitor experience via digital means even in the case of an uncooperative (public accessible) building operator. The association can also take the role of a single and consistent point for supporting building operators. This might be a model to push forward.

There is also a relation to the address system operators like governmental cadastral agencies (see I below). The definition of a gateway entrance may also be added to the existing cadastral data. But the experiences with augmentation to 3D-models were very different. Some mapping agency pushed forward, because of a richer data model. Others pointed out to remain to 2D because that is sufficient for ownership administration and therefore their (at least historic and taxed based) main purpose.

An indirect business model for the association to run this registry might be the commercial production of practical (door) signs together with a registered trademark for the icon.

An association with membership can be a neutral, but also an influenceable actor. The association should not have a known role or offerings towards the visitor except of a combability icon like "VISA". The members act in competition with their offers to the visitor (end-user).

A task of the association may also be open-data compatible publication of data sets for re-use in OpenStreetMap. A detailed discussion is lined out in VI.C.

In the case of collisions in gateway numbering, because of different views, the association may take the role of a third body instance to solve the collision. It way also set up monitoring services to detect collisions.

E. GeoIT Industry (members)

Industrial GeoIT providers (and association members) are worldwide active spatial data capturer and running a geo-web infrastructure and / or application like navigation systems.

The development of the digital frontier into the indoor terra incognita is different than to public outdoors. Progressive building operators are for example shopping malls. Public transport, governmental buildings are open to public, but the (governmental) operators are often less active and fearing or argue undesired partisanship with single (GeoIT-)provider (de facto exclusive) contacts.

1. Case with progressive building operator and single GeoIT provider:
    - payment of GeoIT provider to operator or vice versa or without

- Consistently is managed by building operator in naming

2. Case with incapable or not active, but public accessible building
   - Tolerate, but now investments
   - Single GeoIT-provider cannot or may face difficulties to define gateway entrances alone, need to align with others.
   - May have a need to avoid apparently exclusive contracts

F. Mapper

The role of a mapper is specialized editor (see C), intrinsic motivated and unpaid. It is possible to map the indoors if the building is more or less public accessible. A laser-distance-measurement-device is much recommended. These devices are mass-market products below 100 USD/EUR [11][12]. Mapping as a special visitor in the indoors requires a different method than a commissioned contractor. An example is the capturing of building pillars to receive an indoor reference grid. Many modern buildings are based on these pillar grids and have often even the same distance between them. Capturing these pillars gives a first coarse grain reference, which may be used later (maybe even by other mappers) for more details around these pillars.

G. Public Transport Providers

Although the terra incognita of the indoors in huge, public transport play an important role. Public transport is public and has therefore low privacy considerations and a general need to provide usage descriptions for passengers. In general, the operator should have also a demand for visitor or customer signs or digital information. There are also some obvious trade-offs for a business model, like the permanent need for updating and the required inter-cooperation between different public transport operators.

H. Universities to contribute to critical mass

A key success factor of many infrastructures is the degree of adoption in the market. (Association's member) Universities can help to enhance critical mass because of many buildings, every year many new students and therefore an internal need, e.g. for room reservation.

I. Address Providers

The introduction and refinement of entrances, doors and gateways may also be considered as a refinement of the existing address systems. This refinement may be done together with the established address provider like municipalities or without by an association.

There are also other worldwide grid code providers, who might be interesting in using a definition of gateways.

J. Creator of long lasting Stickers and Signs

This role is a commercial printer and partner of the association with high-quality printers for door sticker and long-lasting signs with different materials. He receives the orders digitally and ships the physical products via postal services back. Because of commercial requirements, logistics and ease of use, an instance should be found in each country. The association may take the broker role in between or (better?!) the full commercial responsibility.

VI. How: Processes

There are multiple required processes. To stimulate the adaption of this concept, a win-win-win situation is helpful to face the success factor popularity (see IV.B). Therefore, the Definition Process is aligned to a directly usable product: the production of local signs and maps, e. g. for an upcoming event or for daily usage. The local editor might be a gatekeeper who is frequently asked for directions. He has the local and assumed best knowledge about the gateways and their relevance. The local sign and maps production with local printouts at the end are an incentive to edit. The trade-off for a tool free of charge is the transparent upload with a CC0- or ODBL-license type.

Arial maps or building outlines are basic references to set Point of Interest for Gateways with additional semi-geometrical and semi-semantical attributes like levels. An enhanced function would be to edit floor plans. Derived floorplans e.g. by emergency maps lead to license collisions. Therefore, a self-captured floorplan e.g. by the usage of modern and cheap laser-distance devices should be supported to gain license compatibility. The development of a useful editor is not trivial. In addition, the balance between simplicity and details is challenging. The software and hardware requirements should be on office level with smartphone, PC, internet and printer.

For the event case, it should be possible to add useful descriptions and pictures like logos to the signs. An enhanced solution would offer cooperated design features.

A. Definition and Editing Processes for local editor or operator

The process phase combines the following actions:

1) Download (available data and visualization)
2) Edit(POI, AOI)
3) View (map|signs with arrows)
4) Print (map| signs with arrows)
5) Install or tape physical signs and maps
6) Upload of new datat with common licenses for redistribution by IPR owner

B. Ordering Process

This process could be part of a business model, because for long lasting solutions higher quality stickers are required that simple paper printouts. Because of a wide range of materials and production costs, a cooperation with established media companies could be fruitful. The payment is solved by e-commerce systems and the products will be shipped by regular postal services. The market is worldwide. Therefore, also local business partners are helpful and can be integrated.

A concrete example might be practical push / pull stickers with exit names. These stickers are useful for visitors and established and could contain additional edited information, like the gateway number and optional the name.

C. Publication Process

After the editing of required data with the gateway definitions, a publication or distribution process to the association's members is the next phase. Some requirements are already identified, like

- Machine-to-human interface
- machine-to-machine interface
- Registration with an own maintained identificatory
- One-way Publication vs. Synchronization / Distribution
- Need to consider different IDs of GeoIT-providers; or is a GeoIT-provider internal matching is more suitable (example below)?
- URL compatible registration?
- Storage of geographical coordinates for second tier matching if first level matching fails.
- OpenStreetMap (OSM) as a public and geographical reference implementation?

The OSM case shows that double-side registration of both IDs might be required due to permanent changes on both sides. An example is the elevator campaign of Deutsche Bahn (DB) together with OSM. The internal DB-system operated an "equipment ID" for this feature with much more attributes. It is an SAP implementation. OpenStreetMap uses a unique, only one time assigned ID for each node or ways. It has a well-managed chronic with versioning. Although these OSM IDs are very stable in life time of the node or way, but they are not stable in relation of a feature. An example is if an OSM editor "redraws" a feature by using new nodes or ways and deleting old ones. Known attributes usually "survive" and edit by copy and paste. Therefore, first tier matching by IDs can and will fail. A matching by geographical coordinates is also not a primary alternative due to relocation of the feature.

Therefore, another matching approach by both site storage of opposite IDs was taken. The (elevator) operator's ID of (SAP) DB should be stored in OSM an vice versa. This "both sites" concept would not be directly applicable in OSM, because of the OSM license and concept rule philosophy to capture only real world physical objects which can be easily checked and proven by another neutral mapper. But because of the Open Data Strategy of Deutsche Bahn with OSM compatible licenses, free and public access, the published DB SAP "equipmentIDs" are allowed to be used within OSM as attributes.

It is assumed that other industrial GeoIT-provider infrastructures might have similar architectures and requirements. An association may also run this open-data publications on behalf of its members and therefore even large GeoIT-providers. This can be part of that role (see V.D). This pattern maybe re-used for this case.

This pattern maybe re-used for this case.

D. Orientation Process

In this process, visitors can arrive by cars, trains or by foot and using different GeoIT industry navigation solutions. Nevertheless, they can e.g. orientate their self with consisting physical and digital information about them. This is the goal of this concept.

E. Meeting Process

Although similar to the orientation case (see D above), the meeting case is very often and therefore relevant. Two or more visitors want to meet each other. Entrances and exists are very often suitable, reliable meeting places. A numbered (or even named) gateway can more easily coordinated via voice or written and analogue or digitally. A practical example could be the creation of URLs for the practical sharing of the intended meeting place via messenger. The usage of the established messengers avoids authentication sub processes between visitors.

VII. What: Components

This chapter focuses beside the "Who" with the role model and the "How" with the process model to the "What" with the architecture model.

A. New Icon for destinct Communication

Graphical Icons or symbols are very helpful to transport a defined meaning. They also help to separated different numberings.

Because of the established copyright and trademark registration systems, the association may protect this icon for this distinct purpose of easier orientation via numbered and named gateways. A unique and new icon can be used between the paper-based and digital-based solutions. A "digital first" approach is still possible. Stickers with this new icon can be added to existing signs in a maintenance process.

B. Editor Service or App

Because the usage of the editor component will be remotely at site, an app based or at least web-based service can be used as implementation technologies for the editor.

A PC-browser based desktop solution has the advantage of a large monitor to give good overview and a detailed mouse usage for detailed edits.

A mobile computing-based app has the advantage "to walk to the gateway" from the outdoors with GNSS/GPS coverage towards the gate indoors. The introduction of Mobile 2.0 with the new Android GNSS raw data API will deliver much more precision [9]. It can ease the capturing of indoors and also create demand for much more fine grain navigation (into doors) in future by visitors.

A crucial condition of the simplicity of gateways editing and numbering is availably of outdoor building boundary vector data and indoor corridor data including levels. Enhanced functions are required, if the approach would also like to take major indoor features into account. Also, a Bluetooth connected Laser Distance Measurement Device is an advantage. The device specific Android Bluetooth APIs are available after registration in 2018 now.

C. Ordering Service

The production of long lasting and high-quality door and sign stickers requires enhanced printers and therefore need to

be ordered by a third party. Therefore, the ordering service should have interfaces to the editor component and to third party manufacturers. The web service needs to connect the ordering editor component and the stickers and sign creator APIs. An e-commerce system with digital payment is required.

D. Registry Service

Some requirements for this component were already discussed but not finalized in this document above and still open. These concepts considerations are subject for architectural design and implemented functions.

The human and machine readably together with a web solution for easy references may reuse design patterns like URL compatible IDs, XML Data Schemas and Web Services. In addition, an HTML / XML compatible web service file structure with simple URIs can be the result. The registry might also be a simple list encoded as HTML and as XML with a numbered version control.

E. Extension of Address System

Entrances, doors or general gateways can also be referenced to simple exchange. The meeting process (see VI.E) using popular messengers can use valid, permanent and reproducible URLs to practical exchange within the Internet. A spatial and global reference is a (postal) address. There are some digital defined more or less detailed address schemas (see [14] and [15]). These schemas might be refined. A cooperation with a postal provider is possible, but not required.

F. Rules for multiple (Transport-)Building Operators

The numbering concept requires system boundaries like every other reference system. These boundaries are often organizational set by different building operators. But these boundaries very usually invisible from a visitor's point of view. An example is a passenger changeover from underground to long distance train services.

The boundaries focus is also a subject of an organisational view. An example might be a shopping-centre operator having an in out directed view and an underground transport provider having a station-to-everything else point of view. Therefore, different views and potential collisions may appear in future.

Guidelines for the required boundaries might be physical, pedestrian-only connections like around (underground) stations into buildings.

An observed solution at Shinjuku, Tokyo, was the introduction of another alphanumerical numbering starting with letters and with or without separators, e.g. "A-5". This kind of assignment is also often used in airports with multiple terminal buildings. If this intended numbering approach is so successful that the number of collected gateways to often results in collisions, a topological hub concept with higher nodes and lower nodes can be introduced. The topology may be based on transport network features like stations or organisational boundaries of building operators. A double assignment of a gateway might be manageable via alias entries. In some cases, a double assign might also work well, like the approach of the Seoul underground assigning multiple numbers to a single station in the case of multiple lines.

G. Geodata Model and Technologies

There are multiple and different indoor data models available and in use. Also, the geometric primitives starting from points (POI) via lines, areas and volumes are still very different in the GeoIT-industry. Therefore, a selection and expected transformation design is required. An approach is to start with simple POIs.

VIII. Conclusion

This paper is a collection of thoughts about the main idea of numbered gateways like entrances and exits in a more and more urbanized world. Gateways like doors are between the outdoor and the indoor "world" along the organizational borders. Similar to former city wall gates these gateways may play also in future a significant role in pedestrian orientation and navigation in the physical and digital world.

On the other hand, this approach requires an ordering infrastructure with numbers investments, much work and hopefully adaption of visitors. Therefore, this paper is work in progress.

The aim for more orientation in the urbanized world may also be archived by a single GeoIT-player realization without a neutral association and a direct contact to building operators.

The association approach has advantages in the case that (public accessible) building operators are slow in digitalization. An external association with GeoIT-providers might be more successful to digital civilize the vast dimensions of the indoor terra incognita. The Association for Geoinformatics, GeoIT and Navigation e.V. may can implement the described role of an association with its members.

Acknowledgment

These thoughts where stimulated in the urbanized Japan by a "Visiting Researcher" stay at Prof. Kaoru Sezaki, Center for Spatial Information Science, University of Tokyo and the assigned research semester of Beuth University.

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