Dominik Stingl, Björn Richerzhagen, Fabio Zöllner, Christian Groß, Ralf Steinmetz: PeerfactSim.KOM: Take it Back to the Streets. In: IEEE: Proceedings of the 2013 International Conference on High Performance Computing & Simulation (HPCS 2013), p. 80-86, IEEE, July 2013. ISBN 978-1-4799-0837-0.

PeerfactSim.KOM: Take it Back to the Streets

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***Abstract*—Mobile peer-to-peer networks, utilizing ad hoc communication between hand-held communication devices, serve as an alternative to cellular networks for the deployment of applications. To evaluate a new communication mechanism in mobile peer-to-peer network, simulations constitute a useful and frequently applied evaluation technique. Besides initial simulations on plain and empty maps, it is crucial to evaluate if and how the developed communication mechanism performs in the envisioned scenarios dealing with obstacles as well as node mobility. Therefore, this paper introduces a framework that provides two procedures for the creation of arbitrary environments, ranging from simple environments to complex models of cities or regions. Additionally, the framework provides different strategies to model the mobility of nodes. Together with an extended version of PeerfactSim.KOM, a simulation platform is presented that supports the complete workflow for the simulation of mobile P2P networks. The simulation platform provides (i) the modeling of purpose-based environments based on SVG-images, (ii) the modeling of realistic environments based on data from Open Street Map, as well as (iii) synthetic and realistic mobility models.**

***Keywords*—Simulations, mobile peer-to-peer networks, environment model, mobility model**

I. INTRODUCTION

The technological progress in the area of mobile communication accompanied with the success of mobile hand-held communication devices enables the establishment of mobile peer-to-peer (P2P) networks. Typical application scenarios comprise (i) the delivery of multimedia content between arbitrary [1] or socially related nodes [2] to offload a cellular infrastructure or (ii) the provisioning of location-based services [3], [4] to exploit the locality of interaction.

To evaluate a new communication mechanism for mobile P2P networks, simulations are a valuable and frequently used approach [5]. Compared to mobile testbeds, simulations provide several advantages including, e.g., the repeatability of experiments or the variation of system or external parameters. To minimize the step from simulations to experiments in mobile testbeds, simulations must go beyond scenarios that consider mobile P2P networks solely on plain and empty maps. Instead, simulations must model the surrounding environment of a mobile P2P network to facilitate the evaluation in realistic scenarios. The resulting model may range from the creation of *purpose-based environments*, examining the influence of specific topologies, to *realistic environments*, which recreate the characteristics of the envisioned scenarios, such as larger places or cities. Therefore, an appropriate model comprises the definition of obstacles, pathways and special places (e.g. parks or sights), which limit the accessible areas on the map [6], influence the wireless communication [7], and define so-called force points [8] that attract or repulse mobile nodes. The corresponding mobility model does not limit the calculation of a node's mobility on its current context, but incorporates the environment, e.g. the specified force points.

Several simulation tools have been developed, which address the modeling of the environment and node mobility to create meaningful simulation scenarios. They enable (i) the design of purpose-based environments based on a specific input format [6], [9], [10], (ii) the creation of realistic environments based on data from a geographic information system (GIS) [8], [11], such as OpenStreetMap[a] (OSM), or (iii) do both [12]. The manual creation of an input file enables the definition of purpose-based environments of arbitrary complexity. Purpose-based environments can be designed to focus on certain characteristics, but might lead to simplified environments. In contrast, the creation of realistic environments based on data from a GIS facilitates the recreation of existing but highly complex places or cities. Given such realistic environments, it is difficult to identify if the detected incorrect behavior results from an error of the communication mechanism under test or if it results from the complexity of the environment.

To bridge the gap between the aforementioned manual and GIS-based creation of an environment, a framework is introduced that supports two procedures to model the environment and provides different strategies for the mobility. As displayed in Figure 1, the framework is integrated in PeerfactSim.KOM [13], which has been extended to facilitate the simulation of mobile P2P networks. Together with the new framework, PeerfactSim.KOM constitutes a single simulation platform that supports the complete workflow for the simulation of mobile P2P networks, ranging from the initial definition of a scenario to its subsequent simulation. To ease the manual creation of the environment, the simulator relies on scalable vector graphics (SVG). Created with an ordinary graphics editor, the SVG-image is used to model the environment. In terms of the GIS-based creation, the required information is parsed from OSM to create realistic environments. On top

[a] http://www.openstreetmap.org/

of the modeled environment, different strategies are provided to calculate a node's mobility, incorporating the resulting topology of the environment and possible attraction points.

The remainder of the paper is structured as follows. Section II outlines the extensions of PeerfactSim.KOM to model mobile P2P networks. The framework, comprising the environment and mobility models, is described in Section III and IV. In Section V, a brief evaluation is presented, giving a proof-of-concept and outlining the impact of the environment and selected mobility model on a simulation. After the discussion of related work (cf. Section VI), the paper is concluded in Section VII.

II. Extending PeerfactSim.KOM for Mobile P2P Networks

The overall structure of PeerfactSim.KOM is depicted in Figure 1, consisting of a layered host model for each simulated node as well as a number of global components. The layered host model is based on the ISO-OSI model of communication systems. Previous versions of PeerfactSim.KOM [13] provided models for message-level communication on the Transport Layer with a simplified end-to-end Network Layer, allowing large-scale simulations of global P2P networks. In such simulations, scalability is achieved with a loss of precision, as the communication model relies on statistical data for transmission properties, such as latency and drop rate. The herein presented version of PeerfactSim.KOM extends this communication model by adding a Network Layer capable of packet routing and a Data Link Layer to support various physical network types with their respective access control strategies. The Data Link Layer contains a communication model that is oriented towards the IEEE 802.11b standard and based on measurements by Anastasi et al. [14]. To coordinate access to the medium, the model implements the Distributed Coordination Function (DCF) as proposed in the standard.

In addition to the communication layers, the new version of PeerfactSim.KOM also provides an *energy component* and a *topology component* for each node. The energy component interacts with the communication layer and provides state-based energy models for wireless communication [15] and battery models for mobile devices. This enables an evaluation of protocols and applications regarding their energy consumption in a mobile scenario. The topology component contains physical properties of a node, e.g., its current position and movement state. The information is used to model the environment and mobility within a scenario, as described in the following.

A. Modeling the Environment and Mobility

In PeerfactSim.KOM, the environment of a scenario for mobile P2P networks is defined as a rectangular space (hereafter referred to as *map*) that serves as a boundary for moving nodes. To allow for more realistic scenarios, *obstacles* can be placed on the map, as detailed in Section III. Moreover, different

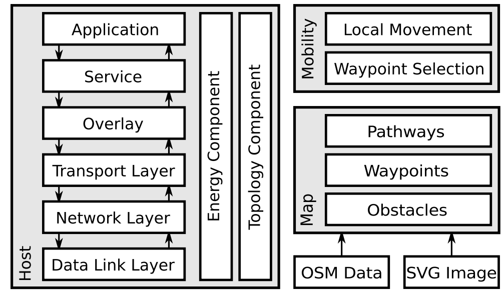


Figure 1. Simulation platform for mobile P2P networks

properties can be set for an obstacle to characterize its behavior during a simulation. Examples comprise the damping factor, which influences the communication between two nodes as well the physical neighborhood of a node. The map also serves as basis for advanced mobility models. As shown in Figure 2(a), it can contain additional elements, such as *waypoints* and *pathways* to support realistic mobility models. A waypoint serves as a destination for a node's movement, while the corresponding pathway determines how the waypoint can be reached. It is up to the mobility model to select waypoints and suitable pathways, enabling a broad range of algorithms, as described in Section IV.

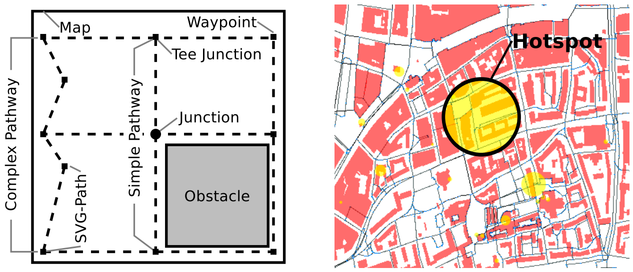
III. Environment Model

The presented new framework facilitates the creation of purpose-based and realistic environments to enable the evaluation of mobile P2P networks in reasonable scenarios. For the proper creation of the corresponding map, the framework requires information about obstacles, pathways, and waypoints. This information can either be obtained by reading SVG-images or parsing the data from OSM. Based on the two procedures, purpose-based and realistic environments can be created as described in the following.

A. Image-based Modeling of the Environment

For the creation of purpose-based environments, PeerfactSim.KOM relies on common SVG-images that serve as input for the simulator. While the user exploits the graphical representation of an SVG-image, PeerfactSim.KOM relies on the XML-based data representation to extract obstacles, pathways, and waypoints. The prefix of an ID, which is assigned to each element, specifies the type of the element in the modeled environment. Valid prefixes of an ID comprise *map*, *way*, and *obstacle*. As displayed in Figure 2(a), the mandatory map-element defines a rectangle, which specifies the shape and the size of the modeled environment. Any other element must be placed inside the given boundaries, otherwise it is ignored and the corresponding information cannot be extracted.

The way-elements are used to specify the pathways through the map. The resulting pathway of a way-element either consists (i) of several SVG-paths, which form a complex pathway (e.g. a zig-zag pathway) or (ii) of just one SVG-path representing a simple pathway. Bézier curves and ellipses



(a) Example of a SVG-image serving as input for the environment

(b) Snippet from the inner city of Frankfurt displaying the hotspots, which are extracted by the OSM Hotspot Strategy

Figure 2. Examples of the different inputs for the environment model

are currently not supported. The endpoints of a pathway as well as the junctures of the connected SVG-paths are used to identify the waypoints. The purpose of waypoints is twofold: on the one hand, they serve as possible destinations for a node, on the other hand, they are used to calculate the path to a selected destination. Based on the extracted pathways, PeerfactSim.KOM combines the different pieces and constructs the resulting *connectivity graph* for the environment. During the construction of the graph, intersecting pathways are automatically detected and converted to a junction. For the creation of a tee junction, two waypoints of the intersecting pathways must overlap.

The obstacles are defined by elements, whose prefix of the corresponding ID matches the term obstacle. The corresponding element either specifies a rectangular obstacle or consists of several SVG-paths, which are used to create an obstacle of a polygonal shape.

B. OSM-based Modeling of the Environment

For a selected area, OSM provides the corresponding data in an XML-file, which consists of so-called OSM-nodes, -ways, and -tags. OSM-ways are used to connect different OSM-nodes, which belong together. The corresponding OSM-tag classifies the resulting object. Out of this information, PeerfactSim.KOM generates and displays the identified elements, such as obstacles, paths, or waypoints.

OSM-nodes and -ways that are marked with the *building*-tag, are used to create obstacles. Per default, each obstacle with a building-tag gets a damping factor of 1 indicating that the communication through a building is blocked. In addition, a further OSM-tag, denoted as *amenity*, specifies the type of the building. Based on a pre-defined list of valid amenities, buildings can be weighted with a certain popularity. In this context, the popularity indicates if the respective building is highly frequented by nodes. PeerfactSim.KOM uses this popularity to define attraction points, which influence the mobility of nodes, as outlined in Section IV.

Besides the creation of obstacles, the data serves as basis to identify pathways through the modeled environment. Similar to Section III-A, the combination of all pathways results in a connectivity graph. In contrast, the connectivity graph consists of weak and strong waypoints. Strong waypoints specify the next destination of a node, whereas weak waypoints are only used to calculate the path to the selected destination. For the creation of pathways, PeerfactSim.KOM parses OSM-ways, which are marked with the *highway*-tag. The identified OSM-ways are used to create a pathway, while the adjacent OSM-nodes represent weak waypoints. The resulting connectivity graph ideally spans over the whole modeled environment. Since the OSM data partially exhibits some inaccuracies, a tolerance function is introduced that connects nearby OSM-nodes below a certain threshold. Smaller subgraphs are deleted if they cannot be connected to the larger graph.

Given the environment with the obstacles, the connectivity graph, and the weak waypoints, PeerfactSim.KOM provides three strategies to create and distribute strong waypoints.

- **OSM Hotspot Strategy** At the beginning of a simulation, PeerfactSim.KOM marks each building, which is labeled with an amenity-tag, as *hotspot*. As displayed in Figure 2(b) the hotspot is represented by a simple circle that is placed over the building. The size of the circle depends on the popularity of the building's amenity. A higher popularity results in a larger hotspot. Given the overall number of strong waypoints, the OSM Hotspot strategy proportionally distributes the strong waypoints among the hotspots according to their size. Popular amenities obtain a larger number of strong waypoints, increasing the probability that nodes will move towards the corresponding building.
- **Weak Waypoint Strategy** This strategy does not create additional strong waypoints, but marks each weak waypoint as a strong one. Applied to the OSM data, each OSM-node with a highway-tag becomes a strong waypoint. SVG data, as shown in Figure 2(a), also serves as input for this strategy. In this case, each waypoint becomes a strong waypoint for the mobility model.
- **SLAW Waypoint Model** This strategy generates the strong waypoints based on the SLAW algorithm [16]. As presented by the authors, waypoints are modeled by fractal points, irrespective of the position of obstacles on the map. To prevent nodes from moving into obstacles, the mobility model selects a weak waypoint outside of the obstacle but next to the generated strong waypoint as destination for the next movement phase.

IV. MOBILITY MODEL

The environment model serves as an input for the mobility model. In PeerfactSim.KOM, a mobility model consists of two strategies: a *waypoint selection strategy* and a *local movement strategy*. The waypoint selection strategy is used to select the next destination of a node, while the local movement strategy determines the path from a node's current position to its destination. Depending on the modeled environment and the available information on the map (e.g. obstacles, hotspots,

Table I
DESCRIPTION OF THE SELECTED ENVIRONMENT MODEL AND MOBILITY STRATEGIES FOR EACH SCENARIO.

Scenario No.	Environment Model	Strong Waypoint Creation Strategy	Waypoint Selection Strategy	Waypoint Selection Strategy
1	SVG-Image	-	Gauss-Markov Mobility Model	-
2	SVG-Image	Weak Waypoint Strategy	Random Waypoint Model	Shortest Path Waypoint movement
3	OSM Data	Weak Waypoint Strategy	Random Waypoint Model	Shortest Path Waypoint movement
4	OSM Data	OSM Hotspot Strategy	SLAW Waypoint Model	Shortest Path Waypoint movement

or waypoints), appropriate models for both strategies can be selected.

A. Waypoint Selection Strategy

The simulation platform currently implements three waypoint selection strategies that select a node's next destination. These strategies are derived from existing movement models that range from authentic to pure synthetic movement models.

- **SLAW Waypoint Model** In addition to the placement of strong waypoints, as described in Section III-B, the SLAW model [16] contains a walker model to generate realistic movement between the identified waypoints. This walker model is implemented as a waypoint selection strategy in PeerfactSim.KOM and requires the existence of strong waypoints on the created map. The resulting node movement closely resembles human behavior in that nodes tend to move only between strong waypoints in a segment of the full map (i.e., between workplace and home) and sometimes spontaneously leave this area for other destinations.
- **Random Waypoint Model** Similar to the random waypoint mobility model [17] that constitutes a synthetic movement model, this model randomly selects destinations, which are chosen from the set of strong waypoints. Since any of the aforementioned three strategies for the creation of strong waypoints can be used, this waypoint model can be applied to SVG- and OSM-based environments.
- **Gauss-Markov Mobility Model** This model represents the Gauss-Markov mobility model as described by Liang and Haas [18]. It is a synthetic movement model, which ignores the modeled waypoints, obstacles, and pathways on the map. Instead, it calculates the movement direction and speed as described by Liang and Haas, thus, constituting an appropriate mobility model for empty maps without any additional information.

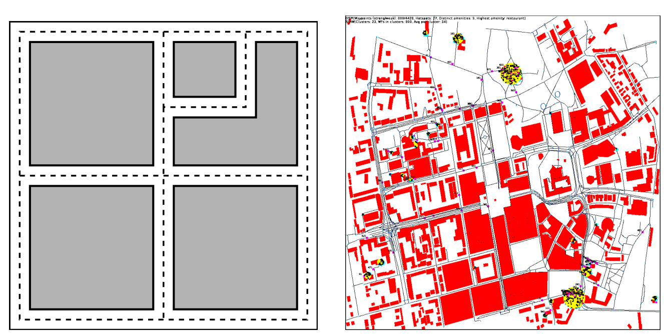
B. Local Movement Strategy

Since the three detailed waypoint models are only used to select a node's destination, the local movement strategy is applied to guide a node from its current location to the selected destination. Currently, PeerfactSim.KOM provides two strategies. The *Linear Movement strategy* provides a basic mobility model, where nodes move on a direct line between waypoints. The movement is not affected by obstacles or pathways defined in the map. The *Shortest Path Waypoint movement* requires the provided weak waypoints to determine the path from a node's current position to its selected destination. Based on the weighted edges between the weak waypoints, the model uses the Dijkstra-algorithm to calculate the path to the destination.

V. EVALUATION

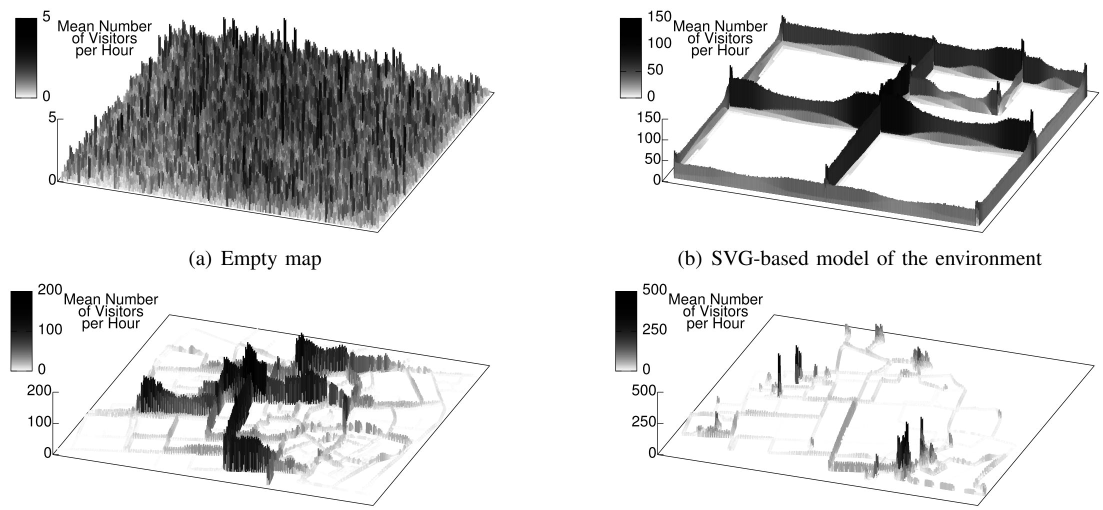
The following evaluation serves as proof-of-concept and reveals the proper functioning of the presented framework, which is responsible to model the environment and mobility. In addition, the impact of the modeled environment and the selected waypoint and movement strategies is examined. The evaluation consists of four scenarios that model the environment based on SVG-images and OSM data and apply different waypoint and mobility strategies. The *first scenario* consists of an empty map, whereas the *second scenario* uses an SVG-image (cf. Figure 3(a)) to model the environment. The *third* and *fourth scenario* both rely on a model of the inner city of Darmstadt based on OSM data (cf. Figure 3(b)). The corresponding strategies for the creation and selection of waypoints as well as for the local movement are summarized in Table I.

To evaluate the impact of the different environments and the corresponding waypoint and mobility strategies, (i) the *mean number of visitors per hour* as well as (ii) the *mean number of neighbors* are plotted. The first metric outlines how often a position of the map is visited on average during an hour. It reveals if nodes always move on pathways and do not cross obstacles. Moreover, the metric assesses the impact of attraction points (e.g., as modeled in the fourth scenario) and how they influence the selection of strong waypoints. The second metric is calculated based on the neighboring nodes that currently sojourn in a node's communication range.



(a) Visualization of the SVG-based environment model (b) Visualization of the OSM-based environment model

Figure 3. Visualization of the two environment models for the evaluation



(a) Empty map

(b) SVG-based model of the environment

(c) Model of the inner city of Darmstadt

(d) Model of the inner city of Darmstadt with hotspots

Figure 4. Mean number of visitors per hour

Based on the measurements from Anastasi et al. [14] the communication range is set to 120m. The metric assesses the influence of the modeled environment (e.g., blocking obstacles or open spaces) on the number of neighbors and how the number varies due to empty or frequently visited places.

A scenario is simulated for 90 minutes. The first 30 minutes are used to reach a steady state of the simulation, while the measurements are taken during the remaining 60 minutes. During the measurement phase, a node's current position as well as the number of neighbors at that position are captured every second. Each map is populated with 200 nodes that move with a maximum speed of $1m/s$ through the modeled environment. Each scenario is repeated ten times and the results display the average for both metrics.

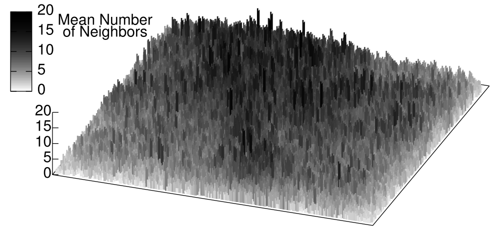
A. Evaluation Results

Starting with the first scenario, the results in Figure 4(a) show that the mean number of visitors is evenly distributed over the modeled map. Due to the random mobility model, no area is favored, while obstacles do not restrict the accessible area. As a result of the even distribution, each location is less frequented on average compared to the other scenarios, while the whole area is covered by the nodes. The results for the mean number of neighbors (cf. Figure 5(a)) confirm this even distribution over the whole map. At the borders, a decreasing number of neighbors becomes apparent, since nodes do not move outside of the map's boundaries.

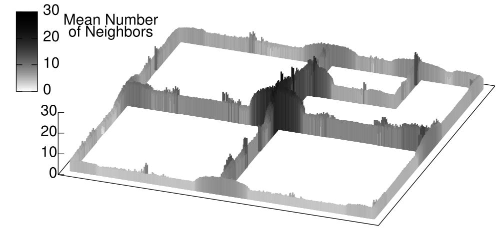
The depicted results for the mean number of visitors and neighbors in Figure 4(b) and 5(b) outline that the image-based environment, comprising the obstacles and pathways, is correctly modeled and that the moving nodes are restricted to the pathways. The limitation to pathways results in empty regions and in an increased mean number of visitors per position. The definition of waypoints, which are situated on corners and junctions, already influences the behavior of nodes, since these waypoints serve as destinations for the nodes: while slight peaks can be observed at the four outer corners, the high peaks at the junctions indicate that these points are frequently visited, because they are reachable over three or four directions. Figure 5(b) displays the results for the mean number of neighbors, which indicate that the average number of neighbors increases at junctions, because potential neighbors can be found in several directions.

The displayed results in Figure 4(c) and 5(c) confirm that the environment is correctly modeled based on OSM data. The nodes are restricted to the pathways and the obstacles reproduce the topology of the inner city of Darmstadt. The increasing mean number of visitors at the center of the modeled map (cf. Figure 4(c)) points towards the well-known phenomenon of density waves [6], [19] due to the random waypoint selection strategy. The phenomenon describes the temporary clustering of nodes at the center of a map when trying to reach the chosen destination. Based on the random selection of waypoints, there is a high probability that a node traverses the map to reach its destination. Due to the resulting topology and the selection of the shortest path to the destination, the majority of paths leads through the center of the map always relying on the same pathways. As a result, the mean number of visitors increases at the center and on the paths that pass through the center. The mean number of neighbors (cf. Figure 5(c)) confirms this observation. Along the paths to the center of the map, the mean number of neighbors increases, reaching its maximum at the center.

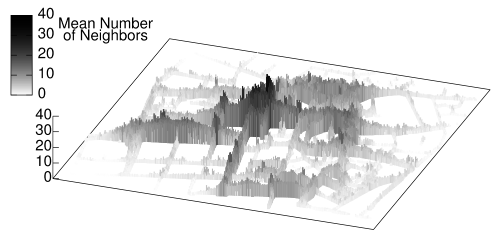
The fourth scenario models the same environment as the third scenario, while the OSM Hotspot strategy is used for the creation of strong waypoints, which are subsequently selected based on the SLAW Waypoint model. As displayed in Figure 4(d), the considerable peaks for the mean number of visitors outline that certain places are highly frequented and favored. The concentration of nodes at certain places results from the strategies for the strong waypoint creation and selection. Due to the consideration of a building's popularity, the OSM Hotspot strategy tends to generate clusters of strong



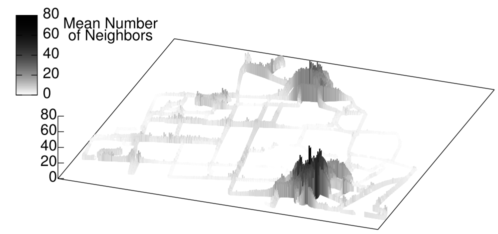
(a) Empty map



(b) SVG-based model of the environment



(c) Model of the inner city of Darmstadt



(d) Model of the inner city of Darmstadt with hotspots

Figure 5. Mean number of neighbors

waypoints around popular buildings. The SLAW Waypoint model uses these clusters as input to select a strong waypoint. With a high probability, the model selects the next strong waypoint from the same cluster, whereas the probability is low that a strong waypoint from another cluster is chosen. Thus, a node remains in the vicinity of a location for a longer period of time. Figure 5(d) displays the same trend for the mean number of neighbors.

VI. RELATED WORK

For the simulation of mobile networks, comprising also mobile ad hoc and P2P networks, several network simulators, such as ns-3 [20] or OMNeT++ [21] exist. They focus on an authentic simulation of the wireless communication, whereas the simulation of the environment and mobility is of lower interest. Contrary to these network simulators, several tools have been developed, which focus on the modeling of realistic environments and mobility models. These tools can be divided into (i) separate mobility trace generators and (ii) integrated solutions, which simulate the environment, mobility as well as the communication. In the remainder of this section, both classes of simulation tools will be discussed.

Martin and Nurmi [9] present an integrated solution, which relies on a set of images to model the environment. These images specify (i) the appearance of the modeled area, (ii) obstacles and boundaries, as well as (iii) attraction points. Based on the resulting map, a gradient map is created and used to calculate a path between any two points. The modeled environment of the MobiREAL simulator [7] consists of polygons, which serve to model buildings and attraction points. To model the mobility of nodes, a Condition-Probability-Event (CPE) model is created that decides on a node's next destination dependent on external variables (e.g., daytime or crowded places) or internal variables (e.g., movement speed or next appointment). Jardosh et al. [6] present an extension for the GlomoSim simulator that uses polygons to model obstacles in urban environments. Each obstacle consists of doorways so that nodes can enter or leave the obstacle. Besides, Jardosh et al. introduce a movement graph that calculates the paths of the graph based on Voronoi diagrams. The mobility model relies on a random waypoint mobility model, using a shortest path algorithm to calculate the route through the movement graph. Similar to PeerfactSim.KOM, the three integrated solutions facilitate the creation of purpose-based environments using images. For the creation of complex environments, an equivalent image must be provided as input, whereas the data from a GIS cannot be used to create the environment. The ONE simulator [12] supports the creation of environments based on data files that are written in Well Known Text. The files can be manually created or parsed from a GIS. The simulator offers parameterizable mobility models comprising random, human behavior-based, and map-based models, which can be combined. Both PeerfactSim.KOM and the ONE simulator facilitate the creation of purpose-based and realistic environments. While the input must be written in Well Known Text for the ONE simulator, PeerfactSim.KOM facilitates the easy creation of input files, using either SVG-images or directly integrates the data from OSM.

In contrast to the integrated solutions, a mobility trace generator calculates the movement traces for each node, which subsequently serve as input for other simulators. Bradler et al. [10] introduce the First Responder Communication Sandbox (FRCS) that models the mobility of users in first responder scenarios. FRCS relies on a model of the environment that splits the corresponding map into cells, which store information about the environment. Given the surroundings, FRCS provides two different movement models: the random mobility model randomly generates waypoints for each node, whereas the behavior-based mobility model selects the destination based on the environment and the current state of the node. The cell-based modeling of the environment enables the definition of purpose-based maps that can heavily influence the mobility and behavior of nodes. But in contrast to PeerfactSim.KOM, a GIS-based creation of realistic and complex environments is not supported. Aravind and Tahir [8] present a framework that generates the environment based on OSM data. The data is parsed to create (i) pathways, (ii) junctions and (iii) connecting points that represent intersections of pathways with simulation boundaries. Moreover, the data is used to create so-called force points, which specify attraction or repulsion points in the modeled area. Based on the resulting map and the different node categories (e.g., pedestrians or cars), Aravind and Tahir create the corresponding mobility traces. Similar to the previous approach, MoNoTrac [11] is a mobility trace generator that creates traces for nodes in urban areas based on OSM data. During the parsing of the corresponding XML-file, additional attributes of that file are preserved to serve as input for the subsequently created mobility models. In contrast to the majority of the previously discussed approaches, both trace generators rely on OSM data to create their maps, which enables the evaluation of mobile networks in realistic environments. On the other hand, a highly complex environment makes it difficult to identify if the degrading performance of the mobile network results from a conceptual error or from the complexity of the map. Therefore, PeerfactSim.KOM enables the creation of arbitrary environments, ranging from simple SVG-based environments to complex OSM-based models of a city or region. Thus, new protocols can be evaluated in the full range of scenarios, starting with simple proof-of-concept simulations up to complex simulations of real-world scenarios.

VII. CONCLUSION

In this paper, a framework has been introduced that facilitates the creation of realistic scenarios to evaluate mobile P2P networks. The framework provides means to model the environment as well as the mobility of nodes. Two different procedures are presented to ease the creation of environments. Common SVG-images serve as input for the creation of purpose-based environments, which can be of an arbitrary complexity or exhibit special characteristics. For the creation of realistic environments, the second procedure reads data from OSM to facilitate the easy reproduction of real places or cities. On top of the modeled environment, the framework provides different strategies to calculate a node's mobility. The included models range from purely synthetic mobility to models that take the environment as well as possible attraction points into account. Combined with the extended version of PeerfactSim.KOM, this paper presents a simulation platform that provides (i) different procedures to model the environment, (ii) appropriate mobility models, as well as (iii) a simulator to simulate and evaluate the designed scenarios. The presented evaluation confirms the proper functioning and reveals how the modeled environments and the different mobility models influence the course of a simulation.

For future work, it is planned to extend the simulator with further mobility models and additional possibilities to combine the different strategies for the creation and selection of waypoints as well as local movement strategies. Regarding PeerfactSim.KOM, the previously sketched models for the wireless communication as well as for the battery and energy consumption shall be improved. Information about PeerfactSim.KOM and its source code are available at `http://www.peerfactsim.com`.

ACKNOWLEDGMENT

This work has been funded by the DFG as part of the CRC 1053 MAKI.

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