Passive mobility measurement and analysis

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Context

The research community suffers from the lack of datasets reflecting the mobility of users in space and time. Existing mobility traces available to the research community are limited. Interesting datasets belong to private companies (such as telecom operators), but these traces are very rarely made available to researchers. To circumvent these issues, the ANR Mitik project (https://project.inria.fr/mitik/) proposes to deploy passive sniffers to measure spatiotemporal link-level activities of wireless devices in a target area. The project will bring solutions for related challenges such as context-aware infrastructure deployment, trace anonymization, and merging, as well as imprecise trajectory generation/reconstruction that will allow inferring individual mobility and plausible contacts among devices.

Thesis Summary

In this thesis, the candidate will focus on developing measurement strategies to collect mobility traces in some target areas without having to deploy any software at the user devices. There are two main ways of obtaining mobility data from real users. The first one relies on active measurement techniques, where measurement components are deployed at end-devices. The second approach, the one we will focus on during the thesis, is to rely on passive measurements. The main idea is to rely on an infrastructure composed of sniffers that analyzes the wireless traffic generated by the nodes to estimate their spatial and temporal displacements in the target region. The objective of such a non-intrusive strategy is to identify changing trends of movements and spatial occupancy without the need to identify the nodes explicitly.

Collecting sound, representative mobility datasets following the passive approach requires addressing several technical and scientific challenges:

- The accuracy of the measurement system depends on the inner wireless traffic generated by mobile users. It is then fundamental to determine the bounds of the measurement systems by assessing the threshold under which the packets captured do not provide enough granularity to help infer the displacements of the nodes.
- What is the impact of the topology of the target area? It is likely that measuring mobility indoors and outdoors will require slightly different algorithms and calibration parameters.

- What are the complementary technologies that could be put together to create richer datasets? We can think of communication technologies (Wi-Fi, BlueTooth, 4G, etc.) but also localization methods (ultrasound, accelerometers, area maps, etc.).

Achieving the goals of the project will require developing innovative approaches ranging from the efficient collection of wireless traffic on the fly to the analysis of mobility data using advanced data manipulation tools. The success of the thesis will depend on a balance between experimental and theoretical contributions. The candidate will come up with algorithms and tools to make advance the state-of-the-art and become a reference in the field.

Requirements

The candidate must hold an M.Sc. in Computer Science or equivalent field. She/he must show a high-level academic record and a strong motivation to pursue as a Ph.D. student. The candidate must have strong expertise in software development and data analysis. Fluent written and spoken English is mandatory.

Bibliography

[1] CRAWDAD. A community resource for archiving wireless data at Dartmouth. http://www.crawdad.org.

[2] C. Bertier, F. Benbadis, M. Dias de Amorim, and Vania Conan, "Centrality Maps for Moving Nodes", Complex Networks, Cambridge, UK, Dec. 2018.

[3] P. H. Cruz Caminha, R. De Souza Couto, L. H. M. K. Costa, A. Fladenmuller, M. Dias de Amorim, "On the Coverage of Bus-Based Mobile Sensing", Sensors, vol. 8, n. 6, Jun. 2018.

[4] T. Claveirole and M. Dias de Amorim, "Manipulating Wi-Fi Packet Traces with WiPal: Design and Experience", Software: Practice and Experience, vol. 42, n. 5, pp. 585-599, Apr. 2012.

[6] M. Sammarco, M. Dias de Amorim, and M. E. Mitre Campista. Scalable Wireless Traffic Capture Through Community Detection and Trace Similarity. IEEE Transactions on Mobile Computing, 15(7):1757 – 1769, September 2015.

[7] G. Chen, S. Hoteit, A. Carneiro Viana, M. Fiore, and C. Sarraute. Individual Trajectory Reconstruction from Mobile Network Data. Technical Report RT-0495, INRIA Saclay - Ile-de-France, January 2018.