Network harness: bundles of routes in public transport networks

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Public transport routes sharing the same grid of streets and tracks are often found to proceed in parallel along shorter or longer sequences of stations. Similar phenomena are observed in other networks built with space consuming links such as cables, pipes, neurons, etc. In the case of PTNs this behavior may be easily worked out on the basis of sequences of stations serviced by each route. To quantify this behavior we use the recently introduced notion of network harness [1,2]. It is described by the harness distribution $P(r, s)$: the number of sequences of s consecutive stations that are serviced by r parallel routes. For certain PTNs that we have analysed we observe that the harness distribution may be described by power laws. These power laws observed indicate a certain level of organization and planning which may be driven by the need to minimize the costs of infrastructure and secondly by the fact that points of interest tend to be clustered in certain locations of a city. This effect may be seen as a result of the strong interdependence of the evolutions of both the city and its PTN.

To further investigate the significance of the empirical results we have studied one- and two-dimensional models of randomly placed routes modeled by different types of walks. While in one dimension an analytic treatment was successful, the two dimensional case was studied by extensive simulations showing that the empirical results for real PTNs deviate significantly from those expected for randomly placed routes.

1. C. von Ferber, Yu. Holovatch, V. Palchykov. Condens. Matter Phys. Vol.8, No. 1(41), 225 (2005).
2. C. von Ferber, T. Holovatch, Yu. Holovatch, and V. Palchykov. Physica A 380, 585 (2007); Eur. Phys. J. B 68 2, 261 (2009).