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Trip and tourist tour planning with integrated fare and ticketing management

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Abstract

Nowadays, all regular route planners try to incorporate multimodality to various degrees. In addition, truly well-equipped route planners take into account dynamic variations along the route. HoPE, standing for 'Holistic Personal public Eco-mobility' has the objective to explore ICT-based measures to radically strengthen the role of public transportation. The framework provides a well-tested and validated complete end-to-end solution that can be implemented in any city, thereby offering services such as route planning, event planning, tourist tour planning, fare management, ticket management, and ticket payment functionality. As a result, the user always has a set of possible route options that can be customised based on personal preferences. The HoPE platform was successfully piloted, tested, and validated at three European cities (Coventry in the United Kingdom, Gipuzkoa and San Sebastian in Basque Country, and Athens in Greece), and was applied to a wide set of local and regional transport means.

Keywords:

Trip planning, tourist tour planning, integrated fare management

Background

As there is more ubiquitous data being shared and the personal possession of mobile devices increases, various new sorts of route planners have emerged during the past decade. Developers are trying to devise solutions for end-users, whereas policy makers face various challenges in creating accessible and useful route planners. Furthermore, by 2030, six out of every ten people will live in a city, and by 2050 this proportion is expected to increase to seven out of ten. New urban mobility services in metropolitan areas are thus urgently needed in order to reduce congestion and carbon emissions and to provide sustainable mobility. It is with this in mind that the HoPE project was created under the umbrella of the European Commission's Seventh Framework Programme. HoPE, standing for '*Holistic Personal public Eco-mobility*' (whereby the project emphasises the importance of the whole and the interdependence of its parts), has the objective to explore ICT-based measures to radically strengthen the role of public transportation. It does this by making it more user-friendly and widely adopted using an open platform that incorporated new approaches in Interoperable Fare Management (IFM) and Intelligent Transport Systems (ITS). The overall platform is intended to be user oriented and user centric, in a way that fosters and promotes user awareness and consciousness about public transports and eco-mobility, other than providing for a significant mix of services including info-mobility, trip planning, ticket reservation, fare calculation, and mobile payments.

The fruition model of the HoPE platform is primarily based upon mobile devices and is intended to complement and enhance pre-existing information and payment systems, by adding useful forecasts about partial/overall journey time and partial/overall greenhouse gas emissions (in addition to fare calculation and mobile payments). Smart ticketing features implement secure payment procedures exploiting different technologies (NFC and QR codes) and seamlessly support the entire buying process, as well as the ticket validation.

This leads to a flexible and advanced framework in which several transport operators can join the system by adhering to a set of technical specifications and without undergoing long and complex administrative processes or strict legal agreements. Smart trip planning features provide for an unprecedented, reliable, and comprehensive user experience, always proposing to travellers the best available options for the next part of their journey, enhancing one or more key metrics associated to their trip (fare, duration, or emissions). This is obtained exploiting static and real-time information used by several optimisation engines to enforce customisable policies and strategies. The HoPE platform was successfully piloted, tested, and validated at three European cities (Coventry in the United Kingdom, Gipuzkoa and San Sebastian in Basque Country, and Athens in Greece), and was applied to a wide set of local and regional transport means.

Advances in route planning

The role of public transportation

Nowadays, all regular route planners try to incorporate multimodality to various degrees. The archetypical example in this case is the inclusion of public transportation, as described in Maerivoet (2016). There is certainly a clear need for this kind of information by travellers, as it makes an objective comparison possible of the alternatives to private transportation. As explained by Maerivoet et al. (2014), a case study in Belgium uncovered that only 8% of all daily trip chains (including one or more trip legs) can be ad hoc replaced by public transportation. We could state that in this case the public transportation is not up to par with the mobility needs of the population, but we rather argue that it just means that our current car-mobility behaviour is not adjusted to just being supplanted by public transport (wishing the same time comfort) and we need to change ourselves in order to cause a larger modal shift.

Beyond classic route planners

Looking at private car-traffic, a typical route planner is able to give you an estimate of the time it takes to reach your destination. These travel times are necessary in order to calculate what we call the route with the least generalised cost. The earliest route planners based their calculations on the physically shortest distance, after which this was replaced by the shortest theoretical travel time (which in turn was based on, e.g. the stated speed limit for each road segment). Later on, with the onset of statistics on available historical data, these estimations were substituted by the experienced travel times on each road segment. For a long time, most route planners remained actually stuck in this position. But with the appearance of more dynamical, real-time data feeds (like smartphone's GPS and Bluetooth tracking, Twitter feeds, …), this has totally changed the game. A good route planner can first and foremost detect the occurrence of congestion, which has a huge impact on the travel time. Based on historical data, this estimate can even be broadened to provide a range in which, say 85% of the to-be-experienced travel times fall.

As revolutionary (and necessary) as this may seem, it still falls short of what we really need. Truly well-equipped route planners take into account dynamic variations along the route. We are not talking about the sudden incoming information of an accident, at which point the route planner plainly suggests an alternative route. Rather, we would like to stress the state-of-the-art in this respect, by which a route planner takes into account the changing traffic conditions as time goes by. So, whereas a classic route planner estimates the travel time based on the traffic conditions along the entire route at the time of departure, these new types of route planners predict traffic conditions as they change along the route and for the entire duration. In practice, this requires the implementation of either an underlying traffic flow model (that represents the propagation of traffic), or the dedicated statistical analyses of historical travel times on each road segment. This is exactly where route planners, such as the ones developed in the HoPE research project excel, in which such a dynamic component is present. An example for route planning in all of the three earlier mentioned pilots is shown in the following figure.

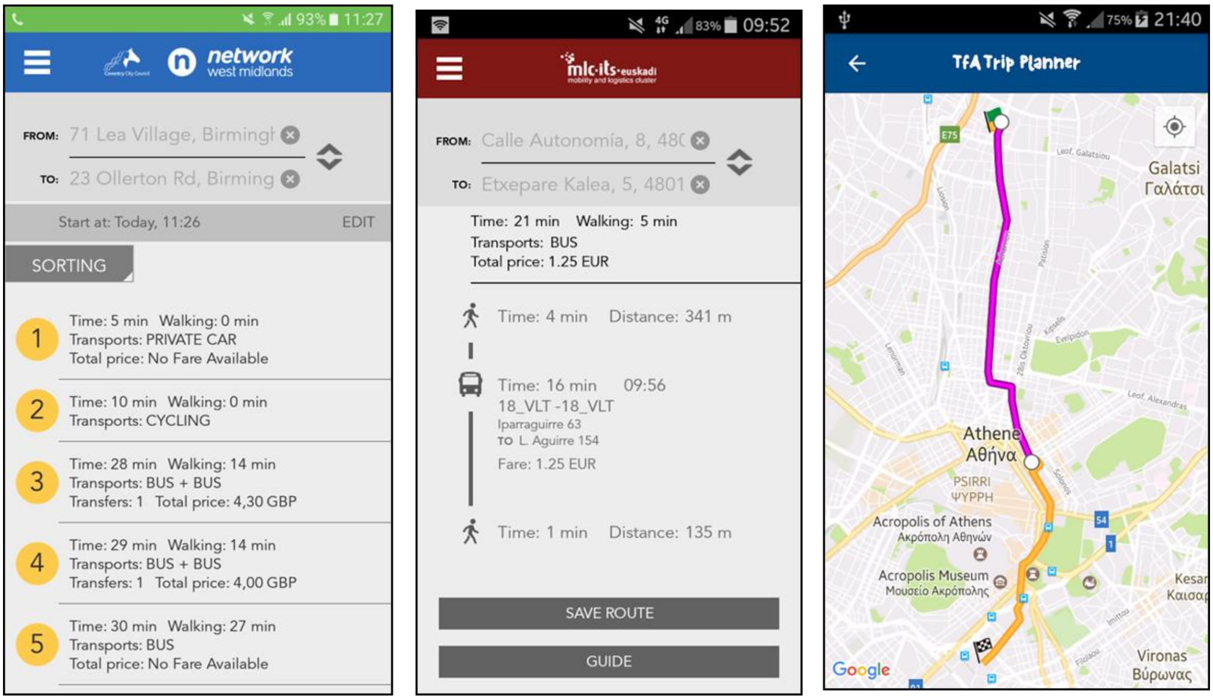


Figure – Screenshots from the HoPE route planning apps running under Android during the field trials.

An example of tourist tour and event planning is shown in the following figure. The idea here is that a user (tourist) initially specifies his/her preferences for visiting certain accommodations (like museums, nature, archaeological sites, neighbourhoods, churches, …), the amount of days willing to spend and the time during the day. The app will then generate routing advice in order to plan the most optimal visit to a selection of these establishments, taking into account both the duration of travelling (both via public transportation and walking), as well as the opening and closing hours. This allows cities to open up a new market whereby tourists in these domestic or foreign cities are provided with real-time advice on how to plan their journeys, given their *interests* in the local shops, museums, …

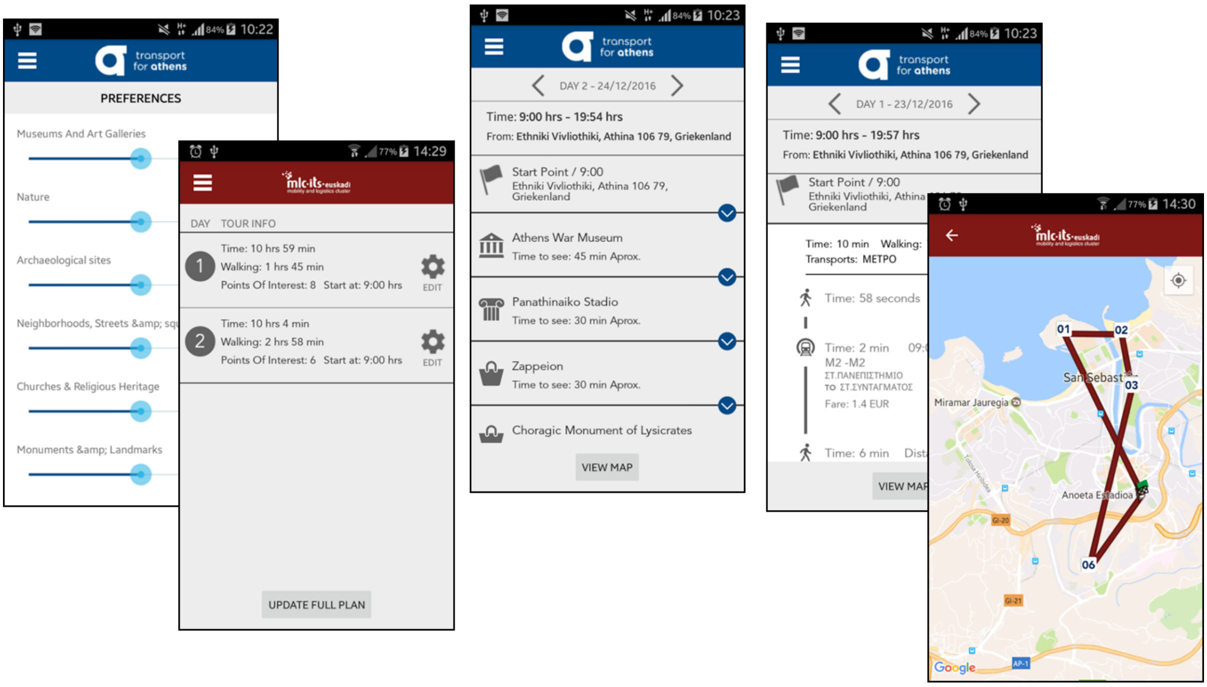


Figure – Screenshots from the HoPE event and tourist tour planning apps running under Android during the field trials.

HoPE's architecture

The HoPE platform is composed of a back-end and a front-end. The back-end provides access to advanced routing functionalities, and handles all fare management and ticketing payment transactions. The front-end provides the graphical user interface to the traveller, providing him with a set of possible route options that can be customised based on personal preferences. The back-end infrastructure operates via different integrated modules, each providing a specific service, as shown in the following diagram.

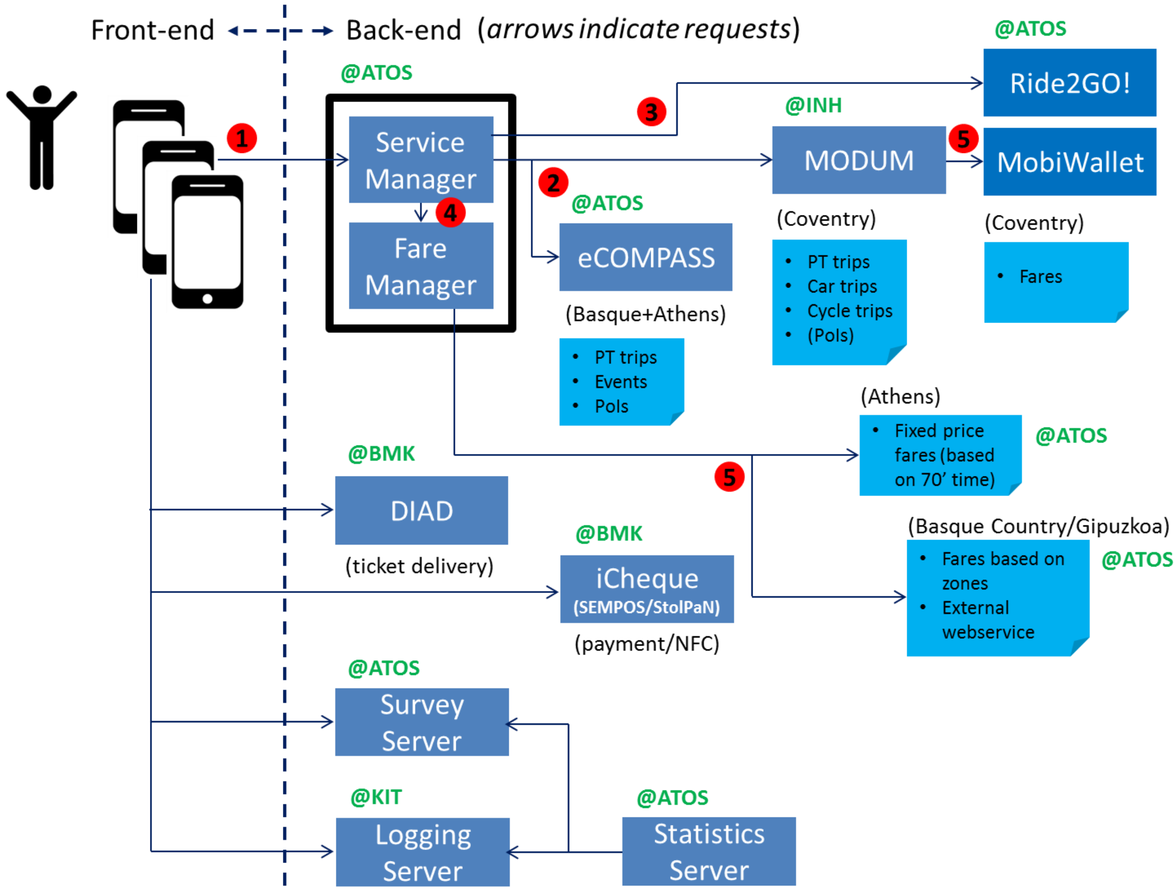


Figure – Service architecture of the different modules in HoPE's back-end framework for the field trials.

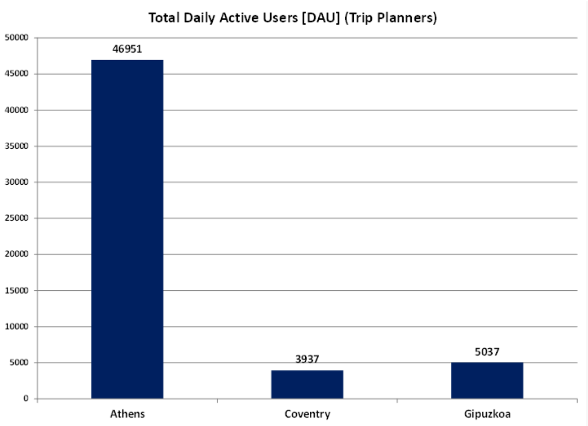
The basis for the integration with public transport is the eCOMPASS module (*eCO-friendly urban Multi-modal route PlAnning Services for mobile uSers*), which provides a methodological framework for route-planning optimisation, addressing the environmental impact of urban mobility, providing multi-modal public transportation route planning for both urban travellers and tourists. The module also provides event and tourist tour planning. In addition, HoPE integrates with the MODUM module (*Models for Optimising Dynamic Urban Mobility*), thereby adopting a new approach for pro-active, demand-responsive management of traffic, enabling energy-efficient (environment-friendly, congestion-free) multi-modal route guidance (transport choices). The important part here is that it also accommodates dynamic variations in an urban setting, taking congestion patterns into account when providing routing advice. In addition, the module provides an estimation of CO_2 emissions based on the car trips that would be undertaken if the routing advice is followed, thereby allowing the user to become aware of the environmental impact of his/her decisions. Ticket payment transactions are handled via three dedicated modules. These are the SEMOPS module providing a real-time payment solution that is based on the state-of-the-art of mobile communication technology and legacy banking architectures, the StoLPaN module that allows to store logistics and perform payment transaction via quick-response (QR) codes as well as near-field communication (NFC), and finally the iCheque module that provides a certified payment system with built-in payment functionality (in the form of an Android library). The tickets are delivered from these systems to the smartphone (running the route planning apps) via the back-end DIAD module. The developed system thus asks a user to specify his (i) departure location, (ii) destination location, and (iii) personal travel preferences. It then calculates the quickest route (based on the dynamically changing travel conditions on the network as explained earlier, and the available public transportation schedules), and in the case of public transportation it provides the option of directly and securely purchasing all the necessary tickets (with roll-back options in case the journey should change). The ticket is then digitally stored on the smartphone, after which it can be validated at the vehicle itself, thereby relinquishing the need for a printed ticket.

Pilot operations

When developing the HoPE framework, we adopted a deployment scheme composed of three consecutive release cycles, each having its own preparation period as well as a deployment phase and a period for analysing the acquired results. Pilots started with basic multi-modal route planning, after which real-time fare calculation was added, as well as event and tourist tour planning. In the final releases, we integrated ticket payment functionalities. The pilots' field trials were organised in three European cities, i.e. Coventry in the United Kingdom, Gipuzkoa and San Sebastian in Basque Country, and Athens in Greece. For the latter two the apps were localised by providing translations into the countries' native languages. During the field trials, we organised focus group interviews, set up surveys, organised raffles to attract more feedback, performed widespread local dissemination via various websites, dedicated Facebook groups, newspapers, flyers, television interviews, and general workshops.

Main results

In order to analyse the impact of our framework's front-end GUI, we performed typical measures that gave us insight into the apps' uptakes. These measures were the Daily Active Users (DAU), i.e. the number or unique app installations across all devices that were active on a specific day, the Monthly Active Users (MAU), i.e. the number of unique app installations across all devices that were active over the last 30 days, and the DAU/MAU Ratio (DMR), i.e. the apps' 'stickiness'. A high and steady DAU characterises a healthy app; it is a determinant of popularity. As an illustration, a DAU/MAU ratio close to 1 indicates that more of the users are returning to the app daily. The impact over time is shown in the following graphs. In total, there were over 2300 installs on different devices.



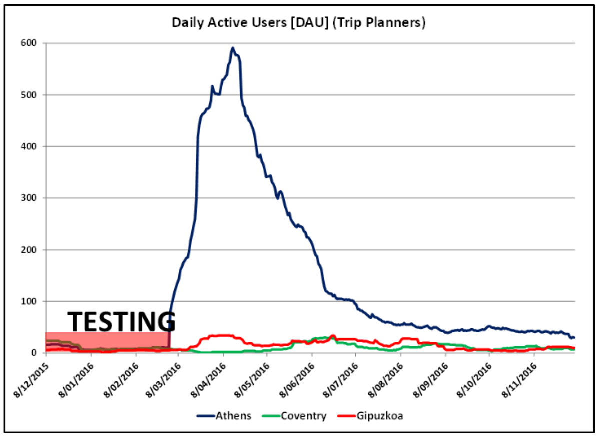


Figure – Total Daily Active Users for the trip planners.

In addition, we also looked at how widespread the apps were used, e.g. by understanding from what origins people departed and to which destinations they travelled, as shown for example in the following map of the pilot in Athens:

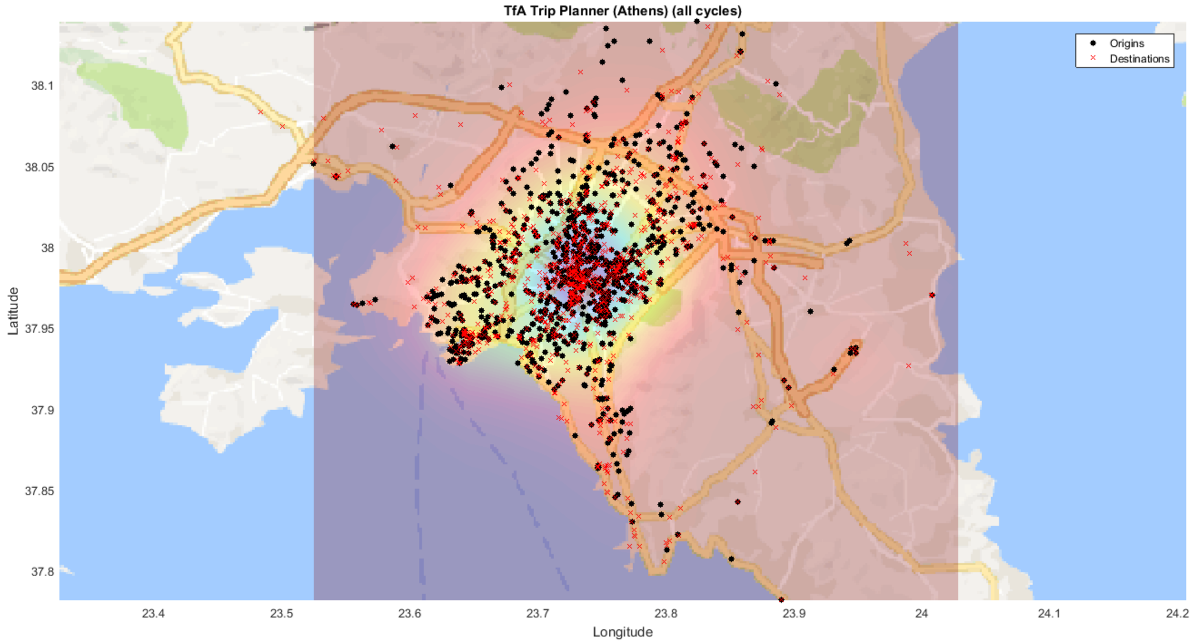


Figure – Geographical map showing Daily Active Users for the trip planners.

Finally, we also logged and analysed various performance statistics such as the number of trip requests per time of day, in addition to the more detailed surveys. Of these, we obtained the following responses:

- Users were satisfied with the route plans that we suggested to them
- It affected users' transport habits such that they altered their transport mode
- Users could be motivated/nudged to use public transport when provided with high quality route planning applications
- Having the option to use several criteria proved to be a rather useful aspect
- Showing fare when using public transport was an important functionality for the users in all pilot sites

Business models on top of the platform

In order to take the research from the project one step further, we also analysed the European market at a country level to understand its barriers, trends, and major competitors. This allowed us to define the business approach as a technology or a service provider, explore and evaluate business models, choose the most suitable for HoPE's market deployment, carry out a preliminary business and deployment plan, and create a final business and deployment plan to attract investors. Furthermore, we identified a common approach related to HoPE's IPR management. In that respect, HoPE is a cloud modular solution using the PaaS model (Platform-as-a-Service).

Conclusions

The HoPE framework provides a well-tested and validated complete end-to-end solution that can be implemented in any city, thereby offering services such as route planning, event planning, tourist tour planning, fare management, ticket management, and ticket payment functionality. The potential impact of adopting a system such as HoPE is that there is a wide deployment of the solution, allowing interoperable fare management through different cities and countries, and thus enabling end-users to enjoy their journey using a seamless integration of various transport alternatives. Most importantly: the user has one single application for different places and different transport modes at his fingertips! There are also various exploitation opportunities, the most important ones being to cities and software providers. The former can have customised applications using the platform (route planners, tourist planners, event planners, integrated fare and ticketing management, payments, …) and can integrate their data into HoPE fostering the development of service for their cities. The latter can use HoPE to leverage services and access to cities' data. The services provide routing algorithms, access to real-time data, ticketing and payment functionalities, … They can then also enhance their current solutions through the use of HoPE platform.

Acknowledgements

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