NextBUS: A Bus Transportation Advisory System for Metropolis

Ka Lok Ho*, Chak Fai Lee*, Yat Fung Wong*, Sheung Ting Choi*, Ka Ho Cheung*,
Sheng-Uei Guan, Ka Lok Man, Chi-Un Lei

***Abstract*—Living in such a busy metropolis Hong Kong, transportation is very important to Hong Kong citizens. As one of the most dominant transportation means in Hong Kong, unlike the metro in Hong Kong, it is often for Hong Kong people to spend an excessive amount of time waiting for buses to arrive. With the introduction of the proposed scheduling system NextBUS, unlike in the past that the potential passengers could only be held in a passive position that could only blindly wait, they can be better advised over their waiting. With NextBUS, people can know where the bus is and when it will arrive, together with the information of whether the disabilities facilities are available and the situation in the bus. The user interface, technical implementation concerns, societal concerns and possible future developments have been fully discussed in this positioning paper.**

***Index Terms*—Transportation, bus, advisory system, common core curriculum, route planning.**

I. Introduction

HAve you ever run into the following situations? Wanting to go to the toilet while you are waiting for a bus, but you do not want to miss the bus. Or you want to get to the destination earlier but you do not know which bus you should line up with. Living in such a busy city, transportations are very important to Hong Kong citizens. Many people choose to travel by bus. According to the Transport Department of Hong Kong, the total number of journeys which are traveled by bus are more than 110 million per month. As one of the most dominant transportation means in Hong Kong, unlike the metro in Hong Kong, it is often for Hong Kong people to spend an excessive amount of time waiting for buses to arrive. The majority of Hong Kong citizens are maximizers that highly value efficiency and try their best to avoid the waste of time.

Therefore, we propose “NextBUS”, a smartphone application. With the introduction of NextBUS, unlike in the past that potential passengers could only be held in a passive position to wait blindly,, they can be better advised over their waiting. Targeting the competitive nature of Hong Kong citizen living, NextBUS is intentionally designed to cater to the needs of the massive base of bus passengers, instead of being forced to embrace the uncertainty of not knowing about when exactly would the next bus arrive and would it be full, such instant information could be supplied at the tip of finger with the mobile applications. As such applications enable the users to highly enhance their time management means, it is expected that with the applications popularity, many of the users would be checking the approximate time of arrival of the buses they are supposed to get on, as well as its fullness, and to arrive at the bus stations only a few minutes before the bus arrival. With “NextBUS”, people will know where the bus is and when it will arrive, together with the information of whether the disabilities facilities are available and the situation in the bus. For example, he/she can use this application to check whether there are any accidents that delay the arrival of the bus, so that people would not waste time on waiting that bus. In addition, it can not only tell he/she information about the next bus but all buses upon that route, therefore people may know when his/her friend will arrive if a user is on a bus. Discussions of existing transport advisory systems can be found in [1]–[7]

In this positioning paper, Sections II, III and IV describe the user interface, technical implementation concerns and societal concerns, respectively. Finally, possible future developments are shown in Section V.

II. The User Terminal

Through the user terminal, users can search the bus they want to search by inputting the number of buses. A searcher will look for all possible buses and show their numbers and destinations for the user to choose, so it is fine for the users who forget the complete number of the bus. After the selection of the bus, the interface will show the list of bus stations of that bus to the user. The user can choose the station they are looking for. A map will appear after the user chooses the station, so the user can check whether they have chosen the right station. All buses on that route will appear on the map, so that the user can know the location of the buses easily. The user terminal will provide the following information to user.

A. Present Location of Buses

The electronic devices installed on every bus will continue reporting their locations to the Internet, in order to keep the data updated. Therefore, users can get the up-to-date locations of the buses, and make use of these data. For example, if people’s friend is on a bus which the bus station displayer is broken down, people can find out where he/she is, so that people can tell him/her where to get off the bus.

*: Equal contribution

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K.L. Ho, C.F. Lee, Y.F. Wong, S.T. Choi and K.H. Cheung are with The University of Hong Kong, Hong Kong.

Sheng-Uei Guan is with the Department of Computer Science and Software Engineering, Xi’an Jiaotong-Liverpool University, China.

K.L. Man is with the Department of Computer Science and Software Engineering, Xi’an Jiaotong-Liverpool University, China and Baltic Institute of Advanced Technology, Lithuania. Email: ka.man@xjtlu.edu.cn

C.-U. Lei is with the Department of Electrical and Electronic Engineering, The University of Hong Kong, Hong Kong. Email: culei@eee.hku.hk

Fig. 1. Motivation of Developing NextBus.

Fig. 2. Features of NextBus.

B. Estimated Arriving Time

"NextBUS" can also estimate the arriving time of a bus. With this service, people need not line up for the bus as people would not miss the bus. People can do something else while waiting for the bus that saves lots of time since people do not have to waste time on lining up. Estimating the arriving time is especially useful when there are accidents on the route of the bus. With the estimated arriving time, people may notice that easily and can think of other ways to solve their problem.

C. Compartment Status of Buses

Cameras will be installed in buses; these cameras can provide us the compartment status of buses. When people want to obtain the situation of a bus, the cameras will take a snapshot of the bus, and send it to people through the Internet. Knowing this information is useful because sometimes when the bus is full, people may not be able to get on the bus. If people know the bus is already full through "Next Bus", people can go lining up another bus instead of the full one.

D. Availability of Disabilities Facilities

One of the cameras installed in the bus is focused on the disabilities facility. The user can check whether the facilities for disabilities are in place or not. This service is very important to disabilities, because it is not easy for them to move from one bus station to another. If they lined up for a bus that cannot carry one more person, they might need to move to another station for a bus that they can get on.

III. Technical Design

The working principle of NextBus is specified as follows:

1) general information is saved in the database of the server originally e.g. the waiting time of each traffic light
2) when a user sends a request, the carriage cameras will capture pictures of the carriage situation and send to the server
3) the user send a request to the sever to check the arrival time of a specific bus
4) the location of the user is automatically sent to the main server by the user device
5) the server will send a request to the bus and the bus will send its driving speed to the server
6) the server will send the calculated results to the requesting user

The following subsections describe various aspects of the system.

A. System Configuration

The following components are needed for the system.

- Transmitters on buses
  - supporting GPS system for identifying the location of the bus,
  - sending information, such as location and speed, to the main server
- Receiving devices for users
  - sending requests to the server about which bus to check,
  - receiving the information from the system
- Cameras in the compartment
  - capturing the live carriage situation and availability of the disabilities facilities,
  - sending the detected carriage information to the server
- Central database
  - processing a large amount of requests at one time,
  - storing a large amount of data, including
    - information about different routes
    - information of buses in each route
    - actual carriage details received from the carriage cameras

B. Network Connections

Stable connection between the server and the bus and between the server and bus stop cameras are needed since this service is a kind of instant service that data should be up-to-date in order to provide accurate information to users. If the connection is not stable, say, disconnected for five minutes, the bus may have already gone a long distance or a car accident has already happened that may cause a traffic jam. Thus, stable connection is required.

The connecting quality of different areas should also be considered. Urban areas may have better connections because more receivers and transmitters exist while poor connection may occur in rural areas as there is more interference in rural areas.

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C. Accuracy of the Analysis

Accuracy of the analysis depends on the following issues.

1) Car Accident: In case of car accident occurs, the required time to clean up that mess is unforeseeable because it depends on the level of the accident. If the accident is a little crash that does not cause any casualties, the influences will not be big. But if the accident causes death, it may take a whole night to finish and a traffic jam with unlimited time may be created. Therefore in this case, the calculated results may not be accurate.

2) Traffic Jam: Traffic jam may occur in many situations, such as roundabout, multi-intersection road, and rush hour. All these may create a traffic jam and the time for a bus to pass it is not foreseeable because the bus may need to stop for a long period of time in the jam. In such a case, the server cannot give an accurate result.

3) Special Days: The following events may happen in special days (e.g. Christmas and New Year),

- there may be traffic jam,
- the time and route of buses may be changed due to special traffic arrangement,
- traffic light may also be modified in order to smoothen the flow of cars making the data in the server different from weekdays,
- bus companies may establish a new line in special days, users may not be able to check the new lines by this service since the new lines are not included in the database.

4) Broken Traffic Lights: The waiting time of a specific traffic light is fixed thus this can be used to help calculate the arrival time of a specific bus. However, if a traffic light is broken, a traffic policeman may be in place to facilitate the flow of cars. This will contradict with the original waiting time saved in the database, resulting in a wrong calculated arrival time.

D. Feasibility of Implementations

The problems of inaccuracies cannot be solved and this limits the good performance of the system. Furthermore, there may be hundreds to thousands of buses driving on the road in peak hours, so the workload of the server will be extremely large, which may slow down the system and the waiting time of each user will be long, reducing the quality of the service.

In terms of feasibility, the execution of the idea of NextBUS is only feasible with the fulfilment of two aspects, which are financial support and technological support. Abundant financial resources and full support from the three bus companies would be necessary for the plan′s success. As transmitters are to be installed on each of the bus of each company, the cost may be enormous. As detector for road conditions, the installation of cameras in each bus station is also an ambitious and complicated project. The system also requires a moderately scaled team of technicians to build up and monitor. Nevertheless, the maintenance expenses of them could be eternal. The actualization of the plan greatly depends on whether the plan would receive huge support by the potential three collaborating companies.

IV. Societal Reasons of Proposing NextBUS

A. Achieving High-Efficiency Transportations

"NextBUS" plays the role of providing accurate and instant information of bus traffic conditions to users and travellers. Since bus is one of the most famous and significant transportation in the city, a more accurate and on-time traffic network could enhance the mobility of the citizens as well as the efficiency of the city. "NextBUS" is a smartphone application which provides instant traffic related information of bus to the users. For example, people can acquire the information of where the next bus is right now, when it will arrive as well as the number of passengers by using people's smartphone at the bus stop. This results in a more predictable and controllable traffic journey for the reason that users can foresee how long it takes for waiting the bus and how would the journey be like throughout the journey. Hong Kong is an extremely busy city in which time carries high cost. As a result, citizens can benefit from a more accurate and foreseeable journey and a lower risk of being late. This can probably enhance the efficiency of the city and the mobility of the citizens.

B. Reducing Reliance on the Overload Railway System

Railway can provide travellers with an on-time and fast way of transportation. It is a more convenient and reliable way of transportation than bus. However, the railway system is reaching its capacity in recent years. The metro trains are always packed with travellers throughout the day. Most of the citizens tend to take trains instead of bus as bus is less reliable and foreseeable. With "NextBUS", bus can become comparable means of transportation with railway. Bus journey will be more certain and accurate in terms of time, capacity and also the comfort. As a result, bus can regain its popularity and lighten the burden of railway system of the city and hence enhance the overall quality and efficiency of transportation.

C. Facilitating Traffic Planning

"NextBUS" can function as a platform of organizing the commuting bus systematically. The database of the application collects numerous instant and updated data of traffic information. Those data can be used not only for the citizens, but also the authority. For instance, the information of traffic jam and road condition can be predicted according to bus traffic information. Corresponding measures can be made by using those data. This achieves traffic planning and dealing with accidental traffic incidents. In other words, the transportation system can be planned and created in a more down-to-earth and certain way.

D. Building a Smart City

Transportation is an important part of our daily lives. We take buses or trains to commute in this city almost everyday. A higher technological level can be introduced into our daily lives by promoting the use of "Next Bus" as well as other daily application. For example, "NextBUS" brings about conveniences by providing instant bus information which could save our time cost. Inserting this convenient application can enhance the technological level of the city and further enhances the quality of life.

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V. Future Development

A. Current Limitations

1) Estimating Bus Arrival Time: The bus arrival time calculated is highly related to the traffic condition. Traffic jam, special traffic arrangement, traffic light information, would all have a high impact on the time estimation accuracy. To counter against this, high cost would be needed for measuring entire traffic condition, which leads to an unresolved problem.

2) Predicting Availability of Bus Seats: With cameras installed in the buses, the number of bus seats available can be known by counting the number of passengers getting on and off. Unfortunately, it still does not allow us to know whether we can get onto the bus or not because, not only the people on the bus, but also the number of people waiting for that particular bus have to be considered. There is a deficiency in evaluating the bus seat availability.

B. Solutions to Current Challenges

1) Analyzing Passenger's Behavior: After "NextBUS" is deployed, a huge set of user behavior data is collected and analyzed. By observing the statistics of the data and events happened during that period of time, prediction of happening of a certain event can be made. Data are collected only after prediction of happening of an event or abnormal circumstances. Adjustment to the algorithm is then made to give a much more accurate bus arrival time estimation This provides a low cost solution to achieve a much better estimation result.

2) Monitoring Bus Stop Waiting Queues: To estimate the possibility of a passenger to take a bus at a particular bus stop, the bus stop waiting queue has to be monitored. Besides observing the historical data, a camera is placed at every bus stop to count the number of people in each queue of the bus stop. This provides a more precise number of bus seats available. Furthermore, bus stops usually have a number of buses travelling the same route and passengers may change their queue at any time.

C. Further Developments and Expansions

1) Adoption for Minibus Transportation Advisory: Competing with the metro transportation, the number of passengers taking buses drops dramatically. Less people would rather choose taking bus. "NextBUS" could be less attractive to people not used to take buses. Instead of servicing only bus passenger, "NextBUS" can be used to service also the minibus passenger. Without much extension, the whole system can be adopted for minibus advisory.

2) More Informative and Humane User Interface: "NextBUS" was originally designed to be a smartphone interface, which targets the majority of citizens using smartphones. However, people now are not using smartphone only, and the screen size of a smartphone is limited. Useful information and advertisements are limited by both the screen size and the smartphone market size. It set a hard limit to the expansion of "NextBUS". Tablet market is now expanding significantly. With a larger screen and greater computing power, more information can be processed in shorter time.

3) Personalized User Interface Improvements: For each user, a set of his/her everyday travelling pattern will be recorded and kept private. Since a person will have to work/study at the fixed place from his/her living place, the travelling pattern are valuable for analysis. "My Bus Journey" stores and analyzes the travelling data. After some days/weeks, the record could provide enough information to suggest one or more time-saving, cheap and/or convenient bus route(s) for the user to choose. This provides flexibility to different types of end users.

"My Travelling Plan" is another expansion for calender applications. After marking down the schedule on the calender, "My Travelling Plan" can suggest possible bus routes to the user, allowing him/her to travel from one place to another and catch up the schedule, without wasting time on searching how to get to the destination and prevent traffic jam. This can be powered by "NextBUS" databases and traffic prediction ability.

4) WiFi-base Station using "NextBUS": Given the wide spread bus network and knowing the position of each individual bus equipped with WiFi transceiver, the whole bus network can provide nearby users accessibility to the public Internet. Although buses are moving around the whole city, with well-designed data roaming plan, the bus WiFi system is capable to provide internet access to places the buses travel around, i.e. almost the entire city.

VI. Conclusion

A transportation advisory system "NextBUS" has been proposed in this positioning paper. With "NextBUS", people can know where the bus is and when it will arrive, together with the information of whether the disabilities facilities are available and the situation in the bus. The user interface, technical implementation concerns, and social concerns have been fully discussed in this paper. Furthermore, feasibility of possible extensions, such as adoption for Minibus Transportation Advisory as well as development of informative and personalized user interface have been studied.

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