Automatic Ticket Vending via Messaging Service (ATVMS)

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ABSTRACT

The passenger flow in the western division of Mumbai Suburban Railway system is multiplying day by day. The existing ticketing system is causing a considerable increase in the travel time due to a major drawback- 'long queues', which absorbs a significant portion of the travelling time. On an average, a commuter spends around 15 minutes in the queue at the suburban booking office windows of Mumbai. In this study we aim to explain the use of mobile services by looking at an area where it has been quite successful; that is, mobile ticketing in public transportation. Firstly, this paper provides a brief glance at ATVMs (Automatic Ticket Vending Machines) and (CVM) Coupon Validating Machines; technologies which are already implemented in the Mumbai Suburban Railways, along with a statistical insight of its drawbacks. Later it provides an insight into our proposed technology ATVMS (Automatic Ticket Vending via Messaging Service) which uses SMS (Short Messaging Service) as a medium to issue tickets. We provide a comprehensive description of our proposed architecture models along with the possible hurdles in our endeavour, and also real time solutions to it. The scope of this paper is particularly for the 'Mumbai Suburban Railways' (MSR) where cost effectiveness is of paramount importance. The challenge was to design a system that would be least costly, as MSR is massively used by middle class people who cannot afford even the slightest of increase in the ticket price. Hence something beyond NFC (Near Field Communication) and Automated Fare Collection (AFC) system (through contactless smart card technology) was needed. The concept and implementation of ATVMS put forth by the authors is completely "new and original".

General Terms
Mobile Computing.

Keywords
Mobile, ticketing, ATVMs, ATVMS, SMS, WR, CR, IR, gateway.

1. INTRODUCTION

Mumbai Suburban Railway (MSR) carries about 7.24 million passengers daily [1]. Due to rapidly increasing number of passengers, there is a bottleneck on the existing system due to long queues and something that will enable faster, smoother and better travelling is the need of the day. But technologies such as NFC and AFC cannot be implemented due to social and economic conditions around here. Such systems require huge financial resources which will indirectly lead to increased ticket prices and 90% of commuters travelling by MSR cannot afford this rise. Also such technologies require considerable infrastructure. With around 7.24 million commuters travelling daily, there are huge space constraints at the railway stations of Mumbai. So SMS ticketing can offer better prospects keeping in mind the financial and space constraints of Mumbai. But as of yet, such a system has not been introduced, because the main business limitation is that when premium SMS is used for ticketing, around 40% of the transaction value is retained by the mobile operator and SMS-aggregator, which is not viable when the ticket has a conventional profit margin. ATVMS overcomes this issue by eliminating the involvement of any of these. The existing systems, ATVM and CVM in the Mumbai Suburban Railways are now failing to deliver their promises of imparting hassle free travelling and there is dire need of introduction something innovative, promising and least costly.

On 10th October, 2007, 'ATVM (Automatic Ticket Vending Machine)' technology was introduced in the Mumbai Suburban Railway in order to curb the long queues for tickets [2]. The Mumbai Suburban Railway system is operated by the Western Railway (WR) and the Central Railway (CR) division of the Indian Railways (IR) [1]. Currently CR has 175 ATVMs, while WR has 115 ATVMs [3]. But the major drawback with the existing ATVM is the scalability issue. Only 6-7 tickets can be issued per minute through a ATVM [2]. Whereas with our technology 'ATVMS' any number of tickets can be issued as it involves use of commuter's mobile phones for issuing a ticket. Another major issue with this system is the cost of installing the machine. Each machine costs around 175,000 INR excluding the maintenance costs which vary according to the usage intensity. Whereas, with our prototype of ATVMS the cost of hardware only includes installation of gateways (currently in this paper we have demonstrated using GSM SIM-300 which costs only 1000 INR pp) and a LED display (its use shall explained in further sections) .Also various softwares used for programming are free wares. Another issue is that there are various public grievances reported regarding the functioning of the ATVM. Instead of hopping from machine to platform, passengers have to hop from one machine to another as most are non-functional. This is because the commuters instead of touching the screen while using the machines banged on the touch screen. This has drastically reduced the efficiency of the existing machines. Another major issue is that each machine occupies 2m x 3m x 3m which is a major concern in existing densely populated railway stations of Mumbai [4]. Also ATVM is not eco-friendly as it issues 'paper' ticket. Around 100 meters of paper per 2000 tickets are used. Nearly 40000 tickets in WR and 110,000 tickets in CR are issued per day through the machine [3] [5]. Also, normal paper tickets issued though ticket windows come to around 600,000 per day (WR only) [3]. Hence a lot of paper is consumed.

Another technology currently under use is the CVM (Coupon Validating Machine). CR has 343 CVMs while WR has 230 CVMs and it issues around 100,000 tickets per day in WR and 291,000 in CR. Major drawback with this system is that fraudulent coupons can be pushed into circulation as CVM network is not linked with Centre for Railway Information System (CRIS) operated unreserved ticketing system that accounts for all the transaction done through booking windows and ATVMs. [3] [5]

Our propose model 'ATVMS' eliminates all the above drawbacks.

2. RELATED WORK

In 2001, the Helsinki public transportation, introduced this service in Helsinki, capital of Finland. The service was initially introduced in trams and underground. It was later implemented in local train, ferries and certain buses. Here, the mobile ticketing service used the cellular devices as smart cards [6].

Another fine example of a SMS-ticket is given by the Czech bus reservation system AMSBUS, which, in February 2007, introduced the product "ejízdenka" on several bus routes. Since November 2007 it has been possible to buy an SMS-ticket (SMS jízdenka) for use on Prague's urban transportation [7].

In 2006 the Roman public transportation company ATAC introduced the use of m-Tickets via SMS and NFC (Near Field Communication). In order to access the service, the user had to perform a subscription to his mobile network operator; next the user has only to send a text message (with a particular syntax) to the service centre. The network operator will reply with another text message indicating the ticket type, validity time and other related information. This system has some weak spots, especially regarding the cognitive load of the user: some people, in fact, have some difficulty in drafting an SMS and must also have the burden of remembering the syntax of the text itself; moreover there are problems concerning security issues [8]. Later, they implemented the same using NFC.

Afterwards, electronic tickets were introduced in road, urban or rail public transportation as well. For example from January 2006, the East Japan Railway Company (JR East), NTT DoCoMo, Inc. and Sony Corporation (Sony) offer a service combining DoCoMo's i-mode® FeliCa® smart-card handset and Suica, JR East's IC card train ticket. The Mobile Suica service enables i-mode® FeliCa® handsets to be used as Suica cards. Mobile Suica customers, in addition to enjoying all current Suica features, are able to recharge stored fares and purchase commuter passes anytime and anywhere and also check the balance of stored fare usage on the screen of the handsets [8].

Finally, in 2008, the Indian Railways itself had come up with the M-Seva where the SMS was to be used as a medium to transfer ticket. But it is not yet launched.
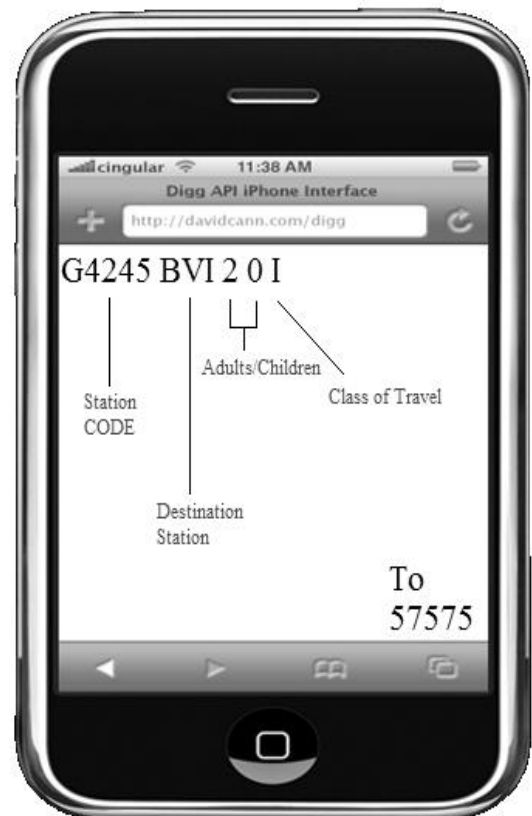
3. ATVMS ARCHITECTURE

ATVMS basically is structured in the form of two modules which can be broadly categorized in the following:

3.1 Role of Commuter:

The major advantage of ATVMS is that fare deduction with each request message will not happen from the commuters mobile phone balance. Before using the system, the commuter will have to first create account with the railways which can

be done at the ticket window. The account creation will involve showing necessary documentation that will verify his entire residential and miscellaneous details. This is included as a security feature keeping in mind the various terrorists attacks that Mumbai Suburban Railways has witnessed. He then has to refill his account with whatever amount he wishes to.   There is also a facility of viewing the account anytime, recharging it, transferring the balance to already existing account, deleting the account. This process will be guided JAR/Android application developed by us. Low end users will have to type in the specified format provided by us. In order to issue a ticket, the commuter has to send a simple SMS message whose format will also be guided by our JAR/Android application. But the user also has to enter a 'Unique Random Station Code' which will be displayed on the LED indicator near the ticket window of each station. This code will change at every time interval predefined. (Its use is discussed in the section 5). In case of absence of Java enabled feature, the commuter can also manually type the SMS. The format of the message is shown in fig. 1. After successful validation, he receives an SMS confirming his ticket and his account status and balance. It is the duty of the commuter to produce the SMS ticket to the Ticket Examiner whenever demanded. However many scenarios can arise from the process which also has to be handled. They are discussed in further sections.


Fig 1: Message Request Format

3.2 Role of ATVMS:
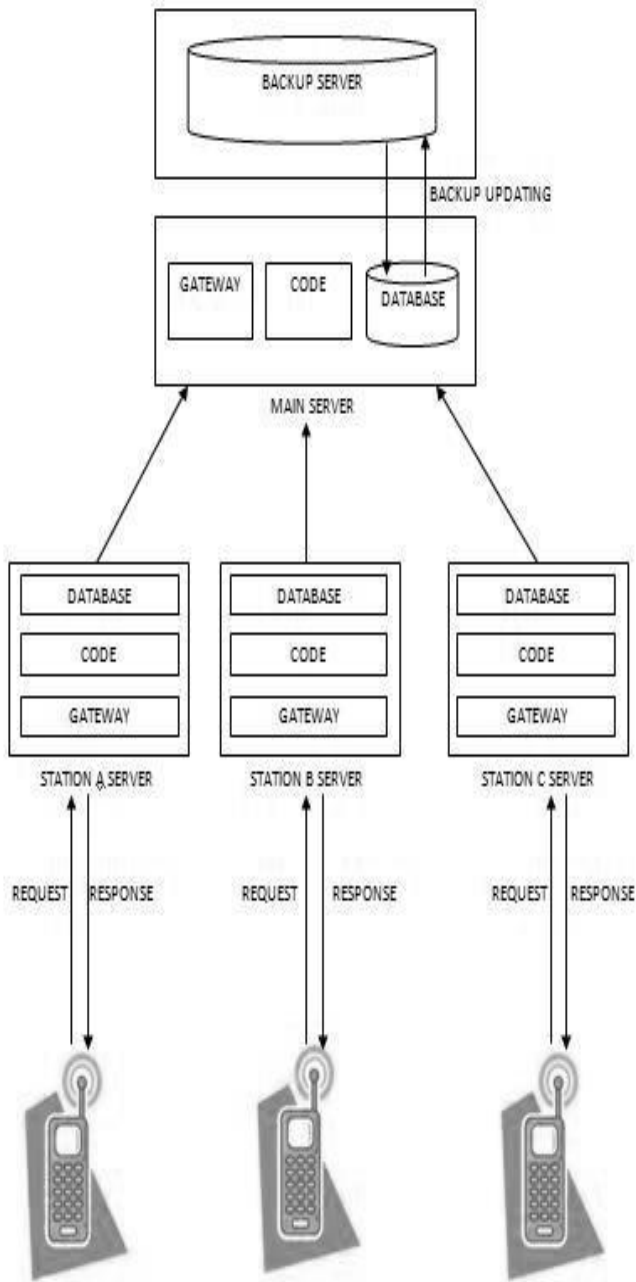
Fig 2: ATVMS Architecture Diagram

The ATVMS architecture is shown in fig. 2. Each station has its own server with the database of the commuters registered at that station, the code which forms the part of the application functionality and the SMS gateway which acts as the interface between the system code and the mobile devices of the users.

The database in the ATVMS server stores all the commuter information along with the account from which the transactions take place. When the server receives the SMS ticket request from a commuter, it first checks if the commuter is registered. The server verifies the source ID from the request. The balance of the commuter is checked before proceeding with the transaction. The response of the server in the form of ticket is shown in fig. 3.
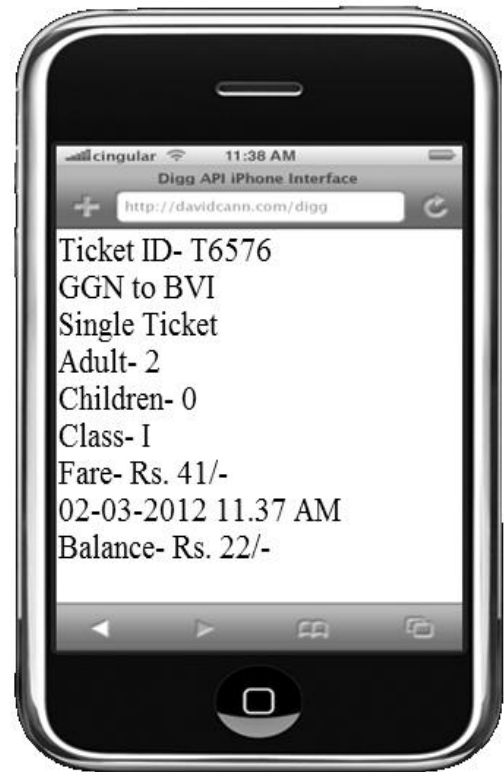
**Fig 3: SMS Ticket Sent By Server to Commuter**

3.3 Random Number Generation Scheme

A case can arise where the commuter tires to issue the ticket in between of his journey, to save money. Such a case is not possible, as while issuing the ticket the commuter also has to enter the LED code displayed on the station near the ticket window. So this keeps the commuter confined near the ticket window while issuing the ticket.

4. SCENARIO DISCUSSIONS

There arise a number of scenarios that showcase loopholes in this system. So we have discussed all possible scenarios and situations that can arise along with their possible solution.

The JAR application/Android Application shall also ask the commuter whether the ticket has to be messaged on same number or multiple numbers. This way each one of the commuter's companion can have the ticket. So the case where the commuter wants distributed tickets i.e. different tickets for each of his/her companions on their individual cell phones is possible. Now if the commuter's companion is caught by the ticket checker and he messages the companion's mobile number to the server and not the commuter's number who had issued the ticket then there might be a problem. But whenever a commuter chooses the option of multiple number ticket delivery, the server will store all the numbers to which the commuter had requested to send the ticket to and map them to the commuter's mobile number. So in this case the ticket checker will get reply from the server saying that the passenger is accompanied by the commuter who has paid for the ticket.
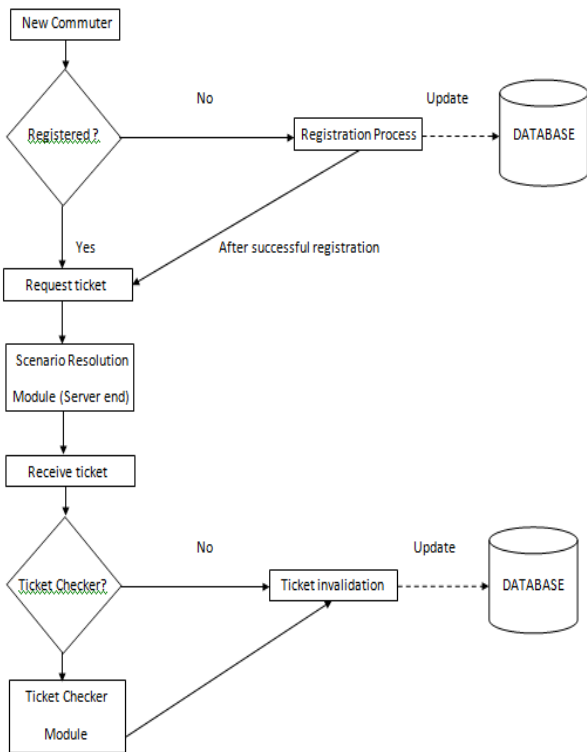
Fig 4: Client-Side Flow Diagram

The ticket checker's job in ATVMS is eased. The ticket checker has to just message the unique ticket code on each ticket or he can also put the commuter's mobile number. The server will provide him will all the relevant details. There can be a possibility where the commuter does not get the message ticket due to Network Problem and his journey ends. The ticket checker will have option of entering unique ticket code and also of entering commuter's Mobile number. So if the commuter gets caught without the ticket message, and in reality he has paid for the ticket, then the ticket checker can ensure by entering the commuters Mobile number. The server will give the ticket checker all the relevant details and he can hence verify the case. Ticket checker can also ensure that the commuter has started his journey within one hour of the journey. Whenever the ticket checker will ask the server for the authenticity of the ticket, the server will also give him the estimated time of arrival at the destination station. This estimated time will be considering the worst case scenario i.e. the commuter started his journey 59 minutes after the ticket time + estimated time for the train to reach the destination from source+5 minutes (extra). There might be a case where the commuter forwards the ticket message to his friend. Such a case cannot arise as the ticket checker will see from which number has the ticket message has come.

There might be a case where the ticket checker's message to the server doesn't get delivered. In this case there will be chaos as commuter has to wait. The ticket will have enough information by which the ticket checker can verify the authenticity. He need not send the message every time to verify. There might be a case where the verification message is not getting delivered from the server side. Such a case is averted by giving 'Special Privileges' for all the outgoing messages going to the ticket checkers numbers. There might be a case where the commuter accidently deletes the ticket message. The commuter can request another ticket message. It will be forwarded to him by the server only if the server finds that the request is genuine i.e. the commuter was issued a

ticket some stipulated time back. If the ticket has expired then he will not given the ticket message.
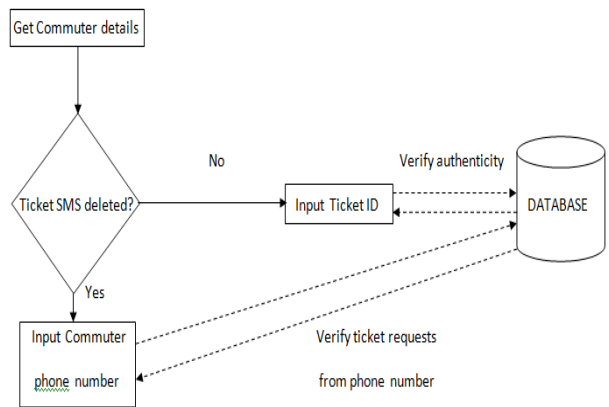
Fig 5: Ticket Checker Flow Diagram

Also there might be a case where the ticket message that server sends doesn't get delivered or the commuter does not receive it. In this case a timer will be maintained at the server side. If within that interval the server does not receive delivery report then it will send again. The process will continue till the server receives the delivery report. We cannot rule out the possibility that if the commuter might receive the ticket message after considerable time 't' after he had send the request for the same. Here, the time on the ticket shall be the request time or the time at which the server received the request. Even if the message gets delivered late, the time shall be the time of request and not the delivered time.
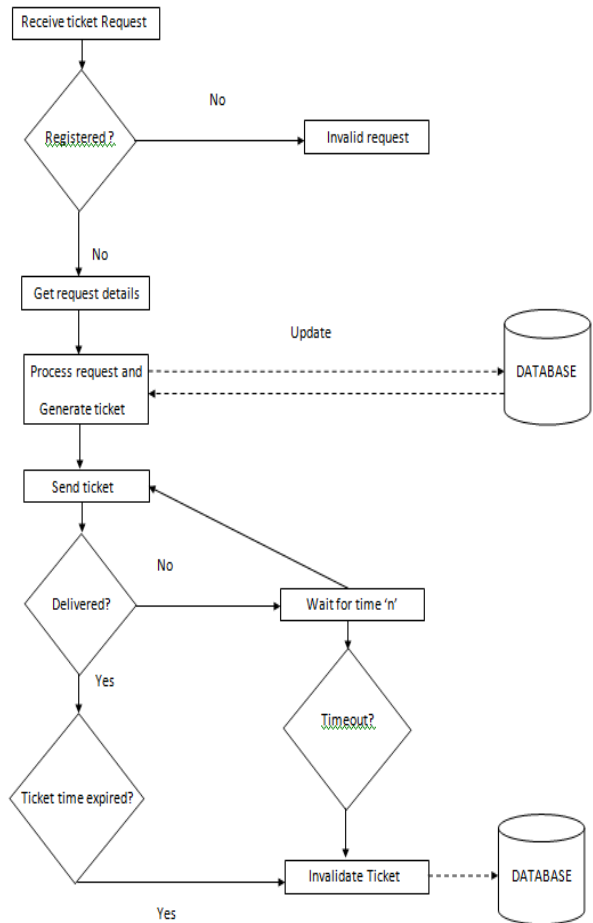
Fig. 6: Server-side Flow Diagram

There might be a case when the station server goes down. Then to serve the request there shall be two servers. Station Server and Main server. Every station will display main server and station server numbers. So if the station server goes down then main server will serve. But commuters with java or android enabled phone will have their application sending message to station number only by default. We will assign them their station number from the address that they will enter when registering. So there will be no unnecessary burden on main server. They will be able to download their Java or android application only after they have registered from the web site. There will be backup in case of main and station server failure. All the information especially registration and balance information will be transferred from station server to main server and from main server to parent server within small intervals of time. At the end of the day all the ticket issuing information will be destroyed that are two days old. But the account balance and registration information will persist.

5. IMPLEMENTATION

The implementation of the project consisted of the many modules. The MySQL Server 5.5.20 database was used for populating the application with data about the customer accounts, ticket fares, time constraints of travel, source and destination station codes, ticket checker information. The prototype was implemented using a GSM-300 Modem Serially connected to the server. The hyper-terminal of the GSM-300 Modem with the SIM card was controlled by the AT(Attention) commands issued by the java code specifically for reading SMS ticket requests and sending SMS ticket responses. For registering new customers, deleting and editing existing ones, and for recharging the customer accounts, the operators at the ticket window are equipped with a web-app with usernames and passwords pre-assigned to them. This web-app is installed on all terminals of all stations and connected to the central server through the internet for updating the customer account information. Also, the customers can use the "ATVMS.apk" android app or "ATVMS.jar" java MIDlet app for easy ticketing.

6. CONCLUSIONS

The major advantage of this project is its cost-effectiveness considering the scenario of Mumbai. Its feasibility also adds to the efficiency of its application in the Mumbai Western line. One may argue its limitations like scalability issues which may be overcome by multiple gateways on a single station-server and large scale implementation of the same. This is a preliminary model which on further deliberation and full-scale modeling will eliminate or at least reduce such limitations.

7. FUTURE WORKS

The future scope for planning and management of ATVMS includes the following aspects for betterment of the system as a whole and for improving the quality and user-friendliness.

Sending an additional informational SMS from the server after issuing the response SMS-ticket will inform the commuter about the schedule or the list of all the trains that he can commute from his source station. The ATVMS server uses the server time to compare the train times of the next 30 minutes or a particularly predefined period. The server then formulates an SMS including this information and sends it to the commuter. The commuter can also request for the list of trains at any time by sending a "schedule request SMS" from the JAR application for receiving any updates about the railways system status and the train time lists. Use of GPS

system as a potential successor of the proposed Random number technology can detect the real time location of the commuter device. This data can then be used in order to judge the legitimacy of the request by the commuter. This location finder technique can prevent ticket forging problem as discussed above.

8. ACKNOWLEDGMENTS

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