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WSN Based Public Transport Vehicle Failure Reporting System

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Abstract—**Public transport vehicle can face emergency or failure during travel, which requires an urgent calling for better on-line assistance and need to inform in response to adjacent bus stop. The system has notification and security for travelling transport vehicles with identifying all arrival buses at all bus stands with the help of low cost RF Trans-receiver system, Packet switching based WSN communication and specialized protocol design. This system is capable for detection of failure buses by passes away another bus from same route and carrying alert failure signal including failure type along with failure bus identification to inform adjacent bus stops for quick and appropriate action.**

Index Terms—**Bus On-Board System (BOBS), Bus Stand Module (BSM), Intelligent Public Transportation System (IPTS), Vehicle Logic Unit (VLU) and Vehicle Alert System (VAS).**

I. INTRODUCTION

Intelligent Transportation Systems is an application of current information and communications technologies to the transportation area. One of the major problems faced by developing countries transport around the world is safety and security.

There are many uncertain and unavoidable reasons for delay in rescue operations after transport bus failure on the way due to late information reaches which cause delay inschedule arrival time in next stop as well asmore delay for treatment of casualties in case of accident.

Currently, many technologies are involved for vehicle detection and position.The geographic information system (GIS) or GPS tools used in a transit system for monitoring the movement of buses can also be used to create a digitalroute map [1-4]. Most of the GPS based intelligent public transport system not feasible in developing countriesdue to high cost GPS system.In 2011, a GSM based systempurposed, in which GSM Machine fitted on buses, isused to transmit a 32-bit binary code, which is received by the receiver which encodes it[5].

This system is expensive due to using GSM machine on all buses and SMS service used for data transmission.

II. SYSTEM DESCRIPTION

This system consists of Bus On-Board System (BOBS) and Bus Station Module (BSM). Each module is used one microcontroller P89V51RD2 for data processing and decision making purpose. A short range wireless communication is used between bus to bus or bus to bus stop, where low cost RF Transmitter Module STT433/315 and RF Receiver Module STR-433/315 which operates on 433.92/315 MHz Frequency with 3^{18} series of encoders and decoders.

A. *Bus On-Board System (BOBS)*

Each transport bus is equipped with, BOBS unit which captures and indicates all vehicles current status to bus stands. BOBS consists of two modules, Vehicle Logic Unit (VLU) and Vehicle Alert System (VAS) as shown in Figure 1. VLU stores predefined information in memory like own bus identity, route number, direction of travel (up or down) and travel among bus stop numbers on the route. It collects, processes, facilitates data exchange with the BSM, manages significant schedule information and also use for send and receive RF signal from trans-receiver.

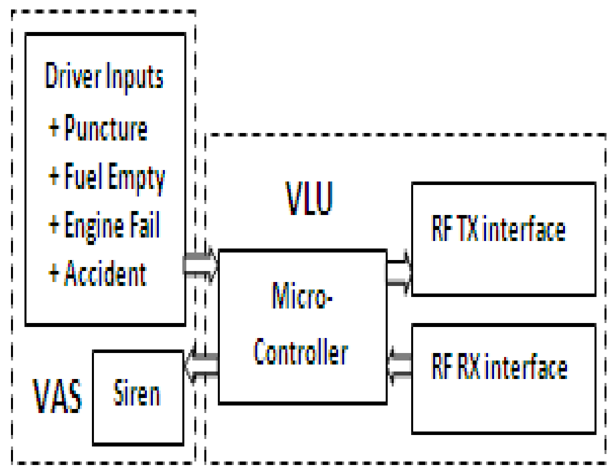

Fig. 1.Block Diagram of BOBS

III. BUS STATION MODULE (BSM)

BSM is to communicate with all arrival IPTS buseswith help of specialized communication controller using UART link. It is used for controls communication between all BOBS of same route, from low range RF link within same bus stop. BSM sends a polling/interrogation packet with a low range (150-200 meters) RF transmitter, and waits for reply from the IPTS buses. If any IPTS bus which has BOBS unit, is in the RF range, will reply with bus-id and other related information (like failure information). It mainly scans all bus's beacon frequencies near the bus-stop and reply form BOBS is buffered in the internal queue of BSM as multiple buses may send reply.

A. *Protocol implementation*

In developed system, one dynamic communication protocol implemented as shown in Figure 3 this protocol is able to communicate all ITPS modules [6] which are based on type of communication, to make the system more reliable. This

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protocol is dynamic in nature because size of packet changes based on type of communication and sent information. System responds according to type of communication and data field. Protocol field descriptions is depicted in Figure 2.

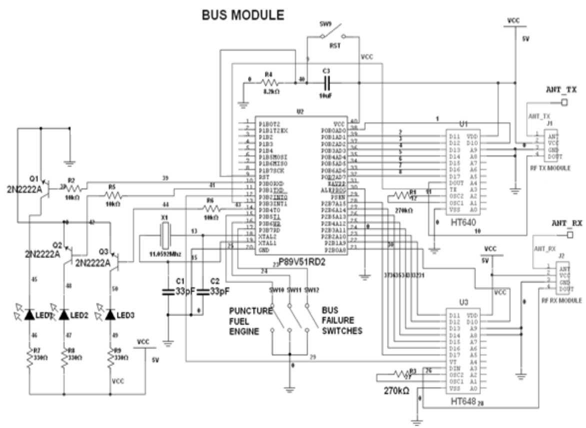

Fig. 2.Circuit Diagram of BOBS

***SF (Start Flag)*:**It is used in all data packet at the beginning, to indicate the start of some data packet to be sent. Based on communication between different modules, the start of frame can be of either type with unique address as shown in Table 1.

S F	Destination Address	Source Address	Data Field Byte 1 and Byte 2	E F

Fig. 3.Protocol Field Structure

Table1: Address based on communication type	
Communication	**Address**
BOBS□BCC	0x2B
BCC□BOBS	0x2C
BOBS□□BOBS	0x2D

Source or Destination Address: Based on the communication the source/address can either be a bus or stand. There will be specific addresses fixed for bus and the stand. This is necessary for the packets to reach the exact address, and the destination should know from whom it's receiving the data packet. In thisresearch, the addresses for the buses and bus stands are fixed as shown below examples in Table 2.

Table 2: BOBS and BSM specific addresses			
BOBS Specific Address		**BSM Specific Address**	
Broadcast to all buses	0x60	Broadcast to all bus stand	0x40
Bus-1	0x61	Bus Stand-1	0x41
Bus-2	0x62	Bus Stand-2	0x42

***Data Field*:** Byte 1, byte 2 data fields are used to carry multiple information like failed bus id, failure bus's problem id (0x91 for tyre puncture, 0x92 for fuel empty, 0x93 for engine failure, 0x94 for accident and 0x99 for unknown) and bus's pervious bus stand id.

EF (End of Frame): This frame is used in the data packet to indicate the end of information being sent from any source and destination. If the EF frame is not received by the destination within the specified time then the data packet will be sent again by the source. Address of EF is 0x21.

IV. Model Development

If bus fails in some route for any redundant reasons, that time driver has a provision for intimating to any nearest bus stop with failure reason. Whenever bus will fail with some reason then bus driver will press specific reason button from panic alert panel. Fault message packet with specific reason id will broadcast help packet with failure information from trans-receiver module and also trigger an alert siren or light in VAS. This packet will listen by any pass away on going bus's BOBS from same road and will carry this fault message packet, also send an acknowledge packet to failure bus. This bus will update it to next BSM with faulty reason, bus number and bus stop id where last time it detected to avoid in delay for help and update display of predicted bus arrival time for user notification at bus stop. This failure message can be used to inform adjacent bus stops for quick and appropriate action based on administration decision like sending aided vehicle for rescue. Failure bus will broadcast failure packet continuously until either it has not sent to three passed away buses or received aid by management. Due to sending help packet to three same way ongoing buses, will increase probability to reach failure information sooner to nearest BSM for update or help. After receiving third acknowledge from passed away bus, VAS will stop alert siren and light in failure bus. Figure 4 shows a BOBS unit working flow chart for failure packet send or receive mechanism in VLU. A running bus polls always for packet received from any unit (BOBS and BSM) of IPTS. If received packet is from another BOBS then received failure packet stores in VLU, also set "Bus Fail message" flag in source code, shown in Figure 4. After successful failure packet store, it sends an acknowledge packet to failure BOBS. If this packet is from BSM about polling at bus stand, BOBS replies an acknowledge packet to BSM with carrying bus failure information, if any (checks "Bus Fail message" flag is set or not in source code). In case if there is no packet received by BOBS, It checks if any specific failure reason button pressed from panic alert panel or not within the bus. If there is a failure, VLU will broadcast a help packet including bus id and problem id, along with that triggers alert signal in VAS. It will broadcast until receives 3 acknowledgement packets from pass away bus.

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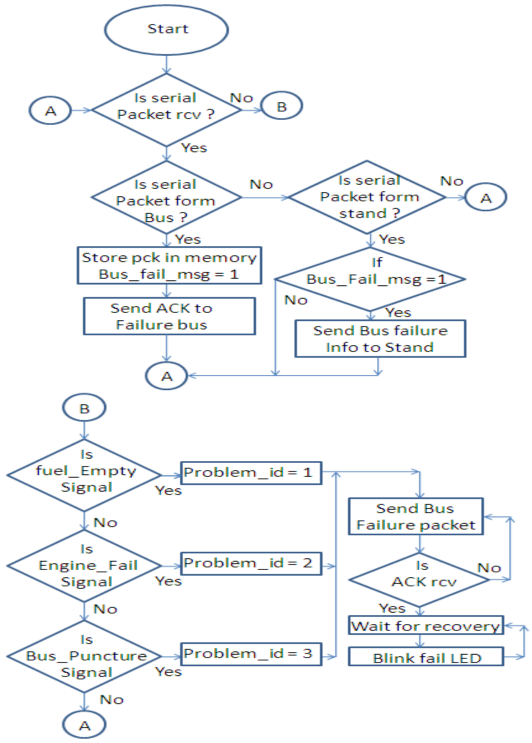

Fig. 4.Bus failure detection flow chart

Below are examples mentions about protocol structure and packet communication during bus failure scenarios:

Packet format: Message broadcast from failure BOBS: [SF][[FailBusid][ProblemId][EF]

Example: It is broadcast packet from bus-id 63; it has problem id-91 (Tyre Puncture).

2D	63	91	21

Fig. 5.Protocol for broadcast from failed BOBS

Packet format: Acknowledge from passing Bus to failure BOBS: [SF][[PassingBusid][EF]

Example: This is bus-id 30 which has carried failure message. Acknowledge to failure bus.

2D	30	21

Fig. 6.Protocol for Ack. from passing BOBS

Packet format: Bus brings a failure message along with original packet from another bus to inform next bus stand for help: [SF][DABSid][SABusid][FailBusid][ProblemId][EF]

Example: Bus id 60 has reached to bus stop id 43 and sending a packet which has information about bus id 61 failed with problem id 92 (Fuel Empty).

2B	43	60	61	92	21

Fig. 7.Protocol for polling reply packet by BOBS

V. EXPERIMENTAL RESULTS

The designed system is first verified via sending communication protocol packets among all modules which received messages successfully within time line. Failure bus detection verified where a failure bus (BUS1) received a failure signal from panic alert panel and started broadcasting signal with problem id and triggers VAS for alert. Another bus (BUS2) who crossed to BUS1 received that failure packet and sent acknowledgement to BUS1. Similar process repeated from BUS3 and BUS4 who crossed nearby to BUS1. After receiving 3 acknowledgments from 3 different buses, BUS1stops broadcasting signal and stops VAS for alerting. When any bus among BUS1, BUS2 or BUS3 reached to bus stand, it sent failure packet to BSM. BSM identifies failure bus details along with problem reason as shown in Figure 7, based on reason it takes appropriate action. Fig. 8 and 9 shows test bench setup of Bus Failure Detection Model.

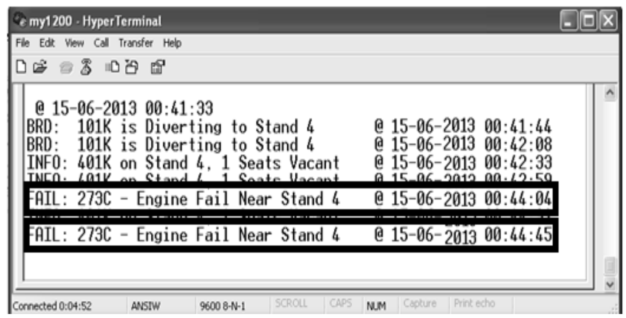

Fig. 8.Received Failure packet in BSM

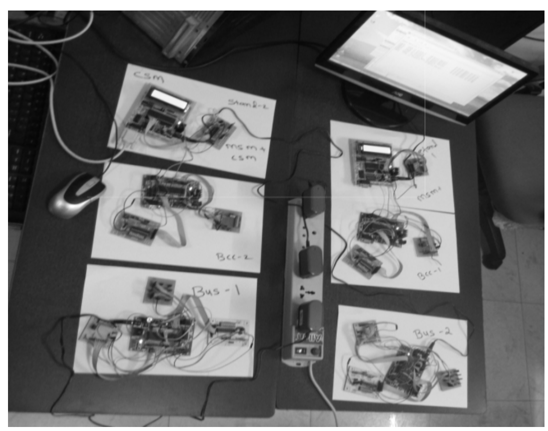

Fig. 9.Research test bench

CONCLUSION

THIS WORK IS CARRIED OUT FOR RAJASTHANSTATE TRANSPORATION FOR JAIPURDELHI ROUTE.

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