LOCOMOTIVE RAIL POWER DISTRIBUTION SYSTEM (A REVIEW)

Pragati Deb[1], Isha Rajput[2], Aarti Aggarwal[3]

[1](Electrical & Electronics Deptt., ABES, Ghaziabad, U.P. (India)
[2] (Electrical & Electronics Deptt., ABES, Ghaziabad, U.P. (India)
[3] (Electronics and communication Deptt., ABES, Ghaziabad, U.P. (India)

ABSTRACT

Conventionally locomotives are connected in succession to add motive powers of the locomotives depending on the train length and power requirements. In this scheme the pulling force is not uniformly distributed throughout the length of the train which affects adversely hauling capacity , fuel efficiency, train safety , brake pipe pressure etc. It overall gives an inefficient and unsafe operation for longer trains. In a microprocessor based locomotive, a computer is located usually in the driver's cab which controls most of the locomotive operations. When the locomotives are joined together in succession, control signals are transferred from one locomotive to the adjacent locomotive via coupling between two connectors, those are located at the front and rear of the locomotives. Control signals are transferred to a connector from computer via a bus. It is a physical connection between locomotives. These two or more locomotives joined together are called multiple unit or multiple consist. First locomotive in the direction of motion of a train becomes the lead locomotive and other becomes simply consists. For example Indian Railways uses multiple unit operation of locomotives to add the motive powers of the locomotives but not Distributed Power. In this paper a concept of Distributed Power (DP) has been given to obtain an optimized performance of a train and an architecture to achieve DP has been proposed. This enables distribution of power along the train which enhances hauling capacity, fuel efficiency, more uniform and controlled coupling forces, and allows quicker brake pipe charging and efficient operation.

Keywords: Multiple Consists, Distributed Power (DP), Lead Locomotive, DP Computer, Locomotive Computer.

I. INTRODUCTION

Distributed power means the placing of additional locomotives at intermediate points in the middle of the train, remotely controlled from the lead locomotive. Distributed power thus describes the physical distribution throughout the length of a train of separate motive power groups. Such 'groups' may be single units or multiple consists. While locomotive consist refers to having one or more locomotives in succession, connected together so as to provide motoring and /or braking capability. The train can have more than one consist in its composition. Specifically, there can be a lead consist, and more than one remote consists. A system for establishing distributed power operations of the locomotive consist from a single location includes a communication network [3] providing communications to and from at least one distributed power system, and a

distributed power setup unit in communication with the distributed power system [1]. Without wireless communication network or a remotely controlled system , a train having locomotives that may operate in distributed power are set up manually, usually at a rail yard. Operators must physically enter each locomotive to enter data into the distributed power system aboard the locomotive to enable "linking" of the locomotives so that distributed power operations may commence. For example, suppose locomotives are included in a train where the locomotives may be facing different directions, meaning that some may be facing forward whereas others may be facing backward. The operator must physically enter each locomotive and select the direction the locomotive should motor. The operator must also initiate and attempt to complete the linking process prior to any unforeseen problems with equipment or systems in the train being detected. Train operators and owners may realize a financial savings and reduction in manpower from remotely setting up, linking and testing distributed power operations of a train. With a remotely controlled distributed power [3], railroads can optimize the distribution of power and braking control over the entire length of a train. A locomotive that has been fitted with Distributed Power (DP) equipment may be set up as either a Lead or Remote 'active' unit; the Lead unit being the controlling locomotive. Only one distributed power-equipped locomotive in any Lead or Remote consist (group) is active. Other locomotives coupled to this 'active' unit operate conventionally as multiple units [2]. There are two basic modes for over-the-road distributed power operation. Locomotive control can be *synchronous,* whereby control commands made by the engineer in the Lead unit are transmitted instantly via radio telemetry to - and are followed immediately by - all Remote units in the train, or *independent* whereby the engineer may set up and independently operate the Remote locomotives as a 'front' and a 'back' group [4]. The front group always includes the Lead locomotive, and all Remote locomotives in the front group follow the commands made by the engineer using the Lead locomotive controls. Which Remote locomotives are in the front or back groups are selectable by the engineer in real time. One DP train cannot affect another DP train and an individual DP - equipped locomotive not in a train cannot affect any DP train or other individual DP locomotive regardless of proximity. When operating in distributed power, an operator, usually located in the lead locomotive, can control operating functions of remote locomotives in the remote consists via a control system, such as a distributed power control element. Thus when operating in distributed power, the operator can command each locomotive consist to operate at a different notch power level (or one consist could be in motoring and other could be in braking), or each individual locomotive in the locomotive consist operates at the same notch power. Wireless System provides a RF link between the Lead and Remote Locomotive(s) [1].The Lead Locomotive gains Wireless Control over the consist.

II. PROPOSED SCHEME AND ARCHITECTURE

Embodiments of the scheme are directed towards a system, method, and a computer software code for remotely establishing distributed power operations of a train [3]. A system for establishing distributed power operations of a locomotive consist from a single location in a locomotive consist that has a lead locomotive and/or a remote locomotive with a distributed power system on each locomotive in the locomotive consist is considered. The system includes a communication network. The distributed power setup unit has minimum a processor, display, and/or an input device to allow a user to establish distributed power operations. The method is for autonomously establishing distributed power operations of a locomotive consist from a single location where the locomotive

consists has a lead locomotive and/or a remote locomotive with a distributed power system on each locomotive [2]. It includes receiving data remotely from a distributed power system on a locomotive specific to the locomotive, and involves sending data remotely to the distributed power system on the locomotive pertaining to distributed power settings to configure the locomotive for distributed power operations. A computer software code is to be used. The computer software code is for autonomously establishing distributed power operations of the locomotive consist from a single location that has a processor. The locomotive consist has a lead locomotive and/or a remote locomotive with a distributed power system on each locomotive and a processor connected to each distributed power system. The computer software code includes a computer software module for receiving data remotely from a distributed power system on a locomotive specific to the locomotive; A computer software module is to be used for sending data remotely to the processor connected to the distributed power system on the locomotive pertaining to distributed power settings to configure the locomotive for distributed power operations. It also includes a computer software module for confirming the locomotive is configured for distributed power operations. A data collection, data management and wireless transmission system, provides railroads with locomotive data. Fig.1 shows DP architecture and functional diagram.
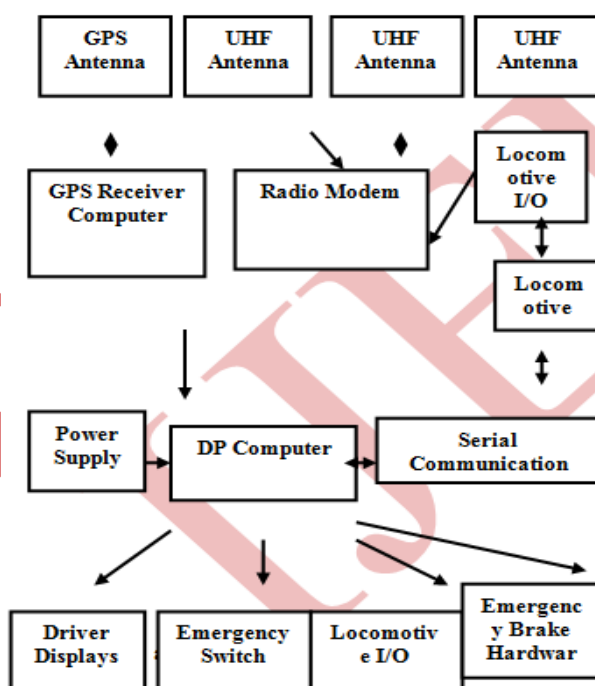

Fig1: DP Architecture and Functional Diagram

III. DISCUSSION

Conventionally locomotives have microprocessor based control on their operations; thereby locomotives are fitted with a computer which controls operations of different locomotive systems. It receives various inputs via sensors and sends signals to control locomotive operations. When two locomotives are coupled together in succession then one locomotive works as a lead locomotive and control signals are transferred via a physical connector between the locomotives. But this is a multiple unit operation [5] not a distributed power. In a distributed power operation same connector signals are to be transmitted to different multiple units via a

wireless system and these multiple units work together in coordination. DP computer is connected to Lead Locomotive Computer as add on via a serial communication link. It accesses all important features from Locomotive Computer and transmits them via radio modem and UHF antenna to other multiple units where they have similar system. A GPS antenna gives location of the locomotive. Four antennas are to be used one GPS and three UHFs. Three UHF antennas have one transmitter and two receivers to have strong reception. All these communicate with DP Computer which is energised by a power supply. And this DP Computer communicates bidirectional with Locomotive Computer via a serial communication physical link. Two driver displays are used to view input and output signals and facilitate locomotive operations. Locomotive I/O signals and emergency brake control signals to be transmitted to other multiple units via wireless communication system. Every locomotive in distributed power is to be fitted with such system. There is a serial communication between locomotive computer and DP computer under a protocol say CAN bus for better speed. Motoring, Braking and other locomotive operations should be in coordination with the lead locomotive otherwise coupling forces between may lead to train partitioning or an accident. A Software is needed to control operations between DP Computer and Locomotive Computer. Usually locomotives have microprocessors of different make they need to share their architecture and information to communicate with wireless system or a common platform is required for software and microprocessors.

IV. CONCLUSION

An architecture for distributed power application in locomotives using a wireless system for train optimization has been proposed and implementation of given architecture should establish an automatic distributed power system via a wireless communication network and railroads can optimize the distribution of power and braking control over the entire length of a train.Train operators and owners may realize a financial savings and reduction in manpower from remotely setting up, linking and testing distributed power operations of a train. A data collection, data management and wireless transmission system, provide railroads with locomotive data well beyond the capabilities of a traditional system.

REFERENCES

[1] A. T. Chronopoulos, J. Sarangapani, S. Ponipireddy, "Distributed Power Control in Wireless Communication Systems", at the IEEE International Conference on Computer Communications and Networks (ICCCN 2002), Oct. 2002, pp 493-496.

[2] Lustig, David. (September 2010). "Freight Train, Unbounded: Distributed power: It's a bigger deal than you think". Trains Magazine (Kalmbach) 70 (9).

[3] Method, system, and computer software code for automated establishment of a distributed power train, US 8280566 B2, Robert James Foy, James Glen Corry

[4] Railroad vehicles, IEEE Transactions on Vehicular technology, 2011, 60, 2,406–420.

[5] S.Lu, S. Hillmansen, and C.Roberts, "A power-management strategy for multiple-unit.