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An E-Maintenance IoT Sensor Node Designed for Fleets of Diverse Heavy-Duty Vehicles

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Abstract : E-maintenance is a relatively new concept, generally referring to maintenance management by monitoring assets over the Internet. One of the key links in the chain of an e-maintenance system is data acquisition and transmission. Specifically for the case of a fleet of heavy-duty vehicles, where the main challenge is the diversity of the vehicles and vehicle-embedded self-diagnostic/reporting technologies, the design of the data acquisition and transmission unit is a demanding task. This clear if one takes into account that a heavy-vehicles fleet assortment may range from vehicles with only a limited number of analog sensors monitored by dashboard light indicators and gauges to vehicles with plethora of sensors monitored by a vehicle computer producing digital reporting. The present work proposes an adaptable internet of things (IoT) sensor node that is capable of addressing this challenge. The proposed sensor node architecture is based on the increasingly popular single-board computer – expansion boards approach. In the proposed solution, the expansion boards undertake the tasks of position identification by means of a global navigation satellite system (GNSS), cellular connectivity by means of 3G/long-term evolution (LTE) modem, connectivity to on-board diagnostics (OBD), and connectivity to analog and digital sensors by means of a novel design of expansion board. Specifically, the later provides eight analog plus three digital sensor channels, as well as one on-board temperature / relative humidity sensor. The specific device offers a number of adaptability features based on appropriate zero-ohm resistor placement and appropriate value selection for limited number of passive components. For example, although in the standard configuration four voltage analog channels with constant voltage sources for the power supply of the corresponding sensors are available, up to two of these voltage channels can be converted to provide power to the connected sensors by means of corresponding constant current source circuits, whereas all parameters of analog sensor power supply and matching circuits are fully configurable offering the advantage of covering a wide variety of industrial sensors. Note that a key feature of the proposed sensor node, ensuring the reliable operation of the connected sensors, is the appropriate supply of external power to the connected sensors and their proper matching to the IoT sensor node. In standard mode, the IoT sensor node communicates to the data center through 3G/LTE, transmitting all digital/digitized sensor data, IoT device identity, and position. Moreover, the proposed IoT sensor node offers WiFi connectivity to mobile devices (smartphones, tablets) equipped with an appropriate application for the manual registration of vehicle- and driver-specific information, and these data are also forwarded to the data center. All control and communication tasks of the IoT sensor node are performed by dedicated firmware. It is programmed with a high-level language (Python) on top of a modern operating system (Linux).
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