A Cloud-Integrated, Multilayered, AgentBased Cyber-Physical System Architecture

Abstract:

Since the 1940s, the IT industry has undergone many changes in terms of computing and communications technologies and the control platforms and infrastructures that support them—from mainframe computers to PCs, from LANs to the Internet, and the shift toward the cloud computing era that exists today.1 This evolution, along with across-the-board increases in computing power, has paved the way for the development of state-of-the art intelligent and autonomous systems, called cyber-physical systems (CPSs), that utilize cyber and physical components. CPSs are an integration of monitoring, communication, and computation operations; they capture physical data using embedded systems and sensor networks, and respond to the environment using actuators and software components. Such systems generate and consume huge amounts of data. Thus, their complexity poses a significant challenge, as architectures must support integrating various heterogeneous components, overseeing distributed computations and network control, and efficiently managing large data collections. Other CPS aspects require further research as well, such as the development of dependability and verification/ validation mechanisms to guarantee the quality of service (QoS) of both software and hardware components. Cloud computing, defined by NIST as "a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources that can be rapidly provisioned and released with minimal management effort or service provider interaction,"2 can help address some of the problems posed by CPSs.

Introduction:

The cloud-integrated CPS is not a new concept. These kinds of systems exist in many domains on a large scale, including transportation, healthcare, environmental monitoring, critical infrastructure support (such as smart grids and water management systems), manufacturing, and public services

. Jiafu Wan and his colleagues developed a cloud-based multilayered architecture for context-aware vehicular CPSs (VCPSs) that consists of three layers: vehicle, location, and cloud.

This division is based on the hierarchical spatial regions encountered in this class of systems. The layers provide context-aware services for mobile vehicles, drivers, passengers, and relevant traffic authorities. Two major components of VCPSs are vehicular social networks and context-aware vehicular security. The proposed context-aware approach allows the system to dynamically adapt to a driver's situation based on specific circumstances. The authors demonstrate its use with a parking system case study, in which the goal is to reduce parking difficulties and improve QoS. The most significant drawback of this and all VCPSs is that they require the establishment of a supporting vehicular infrastructure as well as changes to related legislation. The scarcity of resources on mobile platforms is also a limiting factor