Middleware for Service Composition in Cyber Physical System

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Abstract—**Cyber Physical Systems, faces many inherent challenges due to the tight coupling between cyber and physical world, heterogeneity at various scales, unreliable networking, close integration of computation and physical process, complexity at multiple temporal as well as spatial scale and highly dynamic operating conditions. Various core research challenges present in CPS are namely resource management, service composition, protocol standardization, achieving quality of service. Service composition means to combine more than one services when individual service is not sufficient as per the demand. While doing service composition, we may require the correct and timely provisioning of the resources because in the context of CPS, resources and services are equally important. Our work focuses on service composition and resource provisioning simultaneously. In this work, we design the middleware for Service Composition and Resource provisioning.**

Keywords—*Cyber Physical Systems, Resource Provisioning, Service Composition, Middleware*

I. INTRODUCTION

The term Cyber Physical Systems was first coined in by Gill in 2006 and gained much attention from academia as well as industry as it is very potential due to capability to depict the interaction between cyber and physical space. The application domain of CPS are mission critical areas such as transportation, health care, energy, defence, homeland security, smart grid, water distribution and many more. Each domain is becoming smarter day by day, as smartness in adopted in every service and every device. This gives rise to need of considering resources along with services. To coordinate the variety of services and numerous resources present , middleware seems to be the best approach. Sufficient discussion is done on core challenges of Service composition and Resource Provisioning in the context of CPS [1][2]. Middleware provides aims to hide the technological details. Many researchers have proposed variety of middleware in CPS with different perspective which is sometimes limited to theoretical framework discussions or sometimes limited to a particular domain or sometimes incapable to handle the primary challenges of CPS itself. The paper is organised as follows. Section II gives overview of related literature in the CPS domain. Section III gives on overview of challenges in middleware. Section IV talks about our middleware design followed by conclusions.

II. LITERATURE REVIEW

Middleware[3] is the software that acts like a {glue, intermediary, broker, middle man, interpreter, abstraction provider, consolidator, integrator, facilitator, or connector} between one or more applications and other application(s) or between one or more applications and the underlying infrastructure including the platforms and operating systems used. Main functionality/ features of middleware can be summarised as follows.

In the domain of CPS , many researchers have adopted middleware approach focusing on any particular aspects or a particular application or a particular QoS attributes. The prominent work is discussed here.

Bourcier[4] have implemented a middleware to enable the management of software deployment and the dynamic reconfiguration of these CPS systems. It has considered Component Based Systems and the model at runtime paradigm as the basis for the design of CPS.

Kiril[5] have proposed a middleware approach and demonstrated that service-oriented computing approach which improves portability without loss of performance. An extremely light-weight and flexible method for local and remote service interaction is proposed.

Dabholkar [6] presented an approach to systematically specialize general-purpose middleware used to host CPS. Their approach is based on the principles of Feature-Oriented Software Development (FOSD),

Calyo[7] have talked about CPS requirement of new computing and networking technologies and they have analyzed the applicability of different middleware technologies as data distribution means for CPS.

Ismael[8] have focused on applications requirement such as autonomy, fault tolerance, energy efficiency and configurability issues. Their work described the design principles of CPS which needs cooperation.