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As network-centric operations become ubiquitous, the need to enforce resource usage policies through control and allocation of collections of computing and network resources must be addressed. Researchers and technology developers have produced resource management middleware (RMM). RMM addresses this need by providing mechanisms for (1) describing resources and resource usage policies, (2) monitoring resource status and utilization, (3) controlling how resources are allocated to users and processes, and (4) reasoning about effective ways to allocate resources. Previous work in RMM can be found in numerous projects, including the following: DeSiDeRaTa [1], DQM [2], Globus [3], HiPer-D [4], Q-RAM [5], and Quo [6].

A typical resource management system begins by characterizing the resources to be managed. Then the properties, resource needs, and performance requirements of the software systems are characterized. The characterizations of resources and software systems may be performed statically, as in [1], or dynamically, as in [2]. Given the characterizations, RMM finds and enacts an initial (feasible) allocation of resources to software systems. Once the application systems are operational, RMM monitors resource status, resource utilization, and software system resource needs. When the monitoring data indicate a system’s performance must be improved, a reallocation is planned and enacted.

This presentation will focus on the characterization of the resources and software systems. While there are several approaches to this problem (see [7] for an overview), no standard specification approach has been defined. An approach for specification will be presented, with the intention of providing a starting point for a standardization effort.

The presenters will show a specification approach that has emerged from the DARPA Adaptive, Reflective Middleware Systems (ARMS) program, which is producing multi-layer resource management middleware (MLRM). The specification approach supports a multi-layer system and resource hierarchy involving three layers1: (1) the mission and system wide layer for coarse level global allocation, (2) the collections layer (resource pools and application strings2) for fine-

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1 The network resource allocation is handled both across and within the MLRM layers using a bandwidth broker technology as described in a companion paper [8].
2 Abstractly, an application string represents a software aggregation supporting one operational capability; essentially, it captures the notion of an end-to-end task within a mission.
grained allocation within/using a subset of resources, and (3) the individual units layer (nodes, components, and applications) for allocation at an individual resource level. At the mission layer, the focus is on managing the operational capabilities required to support the mission over the entire available infrastructure. Multiple distinct operational capabilities are typically required for each mission. At the collections layer, aggregations of hardware and software resources are managed interoperably as an integrated group to meet specific operational capabilities. At the individual units layer, resources and applications/components are managed to achieve various performance and quality of service (QoS) levels. The hierarchical software system is overlaid with multidimensional QoS requirements, which include the dimensions of real-time, fault tolerance, and security. In addition the authors will discuss tools that support the specification approach, and will discuss common problems when developing a specification approach.

The Object Management Group (OMG) has a number of QoS initiatives in various stages of development. These include UML Profile for QoS, QoS for CORBA Component Model (CCM), Data Distribution Services (DDS) for Real-time. Within the Command, Control, Communications, Computers, Intelligence (C4I) Domain Task Force (DTF), the Application Management Services RFP is currently being developed. The authors will discuss these initiatives, and how these relate to the MLRM effort and to the U.S. Navy FORCEnet and Open Architecture efforts.

References


