

The Grid as Management Backplane

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Next-generation management software must facilitate automated and business-driven management, for systems with increasing scale, heterogeneity and federation challenges. Existing management software is not designed for this. We argue that it is necessary for management software to adopt a clean, standardized, service-centric software architecture. In particular, we make the case that the Grid, accompanied by suitable management extensions, is the appropriate backplane for management software.

Management Software To Date

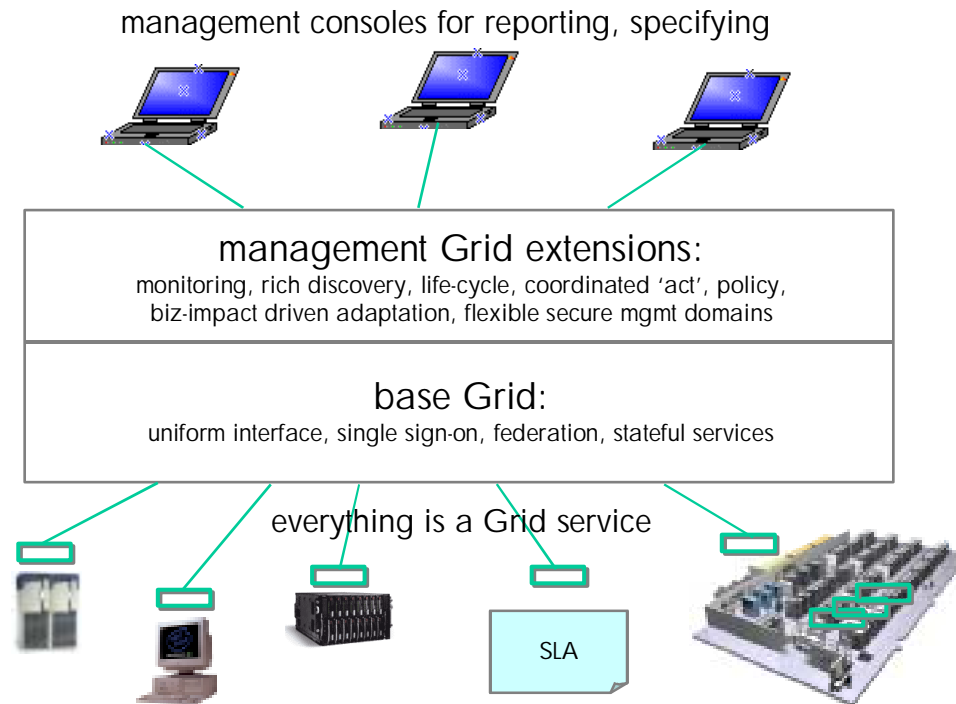
Management software refers to any distributed software application that assists IT operators and administrators in their respective jobs. Such software has traditionally emphasized instrumentation and monitoring, supported by standardized technologies such as SNMP, CIM, WBEM and product suites such as HP OpenView, CA, IBM Tivoli. Certainly, traditional management software has proven its value, but future Internet-based systems and services will demand richer functionality from management software, resulting in technology challenges that cannot be met by above standards and products.

IT decisions in the enterprise are no longer dictated by the necessity to keep up with Moore's Law in CPU and storage—as an example, consider desktop PCs, which for many employees are simply 'good enough' and no longer require continuous replacement. As a consequence, IT decision makers are able to explore new and different avenues to improve total cost of ownership and return on IT investment. This increases the demand for effective management software, and changes the requirements posed on it. In particular, since operator and support cost is a major element of total cost of ownership, next-generation management software must offer more and more *automation*. Furthermore, IT control (automated or not) must be more and more understood in terms of *business impact*, requiring advanced tools to correlate management actions with their consequences in terms of business metrics.

To compound these increasingly challenging requirements, the systems for which they are posed are becoming increasingly complex. The *scale* at which enterprise computing operates becomes all encompassing: devices and sensors are getting smaller and smaller, data centers and data sets larger and larger, and everything gets networked together to form an interconnected infrastructure of planetary scale. *Heterogeneity* is a given within each enterprise, and is not yet diminishing, and IT solutions that involve *federation* (that is, hook multiple parties together) become increas-

ingly prevalent. We refer to [1] for a sample scenario outlining the complexity we deal with, and an inventory of components required for its management.

To recap the above challenges in a single sentence, we require *automated and business-driven management, for systems with increasing scale, heterogeneity and federation challenges*. None of the existing management software standards or products is designed to deal with this.



Management Software Tomorrow

To respond to the above challenges, we argue that management software must evolve into a richer type of distributed application, with the Grid as its backplane. With Grid, we mean the 'services grid' [2] as advocated through the Global Grid Forum [3], in particular its standards for Open Grid Services Architecture and Infrastructure.

The above figure positions the management backplane relative to existing management software. At the top the legacy management consoles are shown, at the bottom devices are shown that need to be controlled; these devices may have legacy data collection agents (SNMP, CIM). Instead of traditional direct connections from agents to consoles, we 'wedge' the Grid backplane in between. The backplane maintains Grid services for anything worth managing, and manipulates the managed elements through its associated Grid service—in the figure, PCs, storage, SLAs and data centers are controlled in this way. To achieve the desired flexibility, we leverage

the base Grid infrastructure services, and to increase functionality we develop Grid service extensions for management purposes (represented in the figure by the two layers of the 'stack')¹.

When evaluating the proposed management backplane, the crucial question is if it fulfills the requirements listed above—that is, does the backplane support automated and business-driven management, for systems with increasing scale, heterogeneity and federation challenges? We argue that for the following reasons the Grid is the answer to these challenges.

- a. **Rich interfaces.** To automate management, one needs control interfaces for devices, and one needs to coordinate control actions across multiple devices. For example, to stop an application when server performance degrades and to restart the application on a different server, one needs start and stop commands and need to coordinate between servers and applications, as well as across the start and stop actions. SNMP and other management protocols are simply too much focused on reporting, and have too few extensibility features to be suitable for such tasks. The Grid, being web services based, is easily and naturally extensible with richer interfaces for adaptation and control.
- b. **Uniform, abstraction and virtualization interfaces.** There are several strong software engineering arguments behind introducing the layers of indirection of the management backplane. First, the *uniform representation* of devices by Grid services hides device (and data collection agent) heterogeneity from client software. It also allows distinct management tasks (such as provisioning and runtime SLA assurance) to be unified through the same Grid services. In addition, Grid management extensions can be introduced to provide interfaces at any desired *higher level of abstraction*, such that the interfaces are most natural for the developer of management software. Finally, the Grid management extensions provide a natural place to introduce *virtualization*, that is, a place where the decision is made which resources implement a client request and where the bindings between resources and requests are maintained, without exposing this to the client software (think of virtual LANs or virtual machines).
- c. **Leverage web services.** It can not be stressed enough that the Grid is nothing more (or less) than a web services platform (hence our desire to talk about the services grid, to distinguish it from traditional resource and data grids [2]). Since service grid interfaces are web service extensions, one can make use of any other desired web service technology, such as WS Inspection, WS Security, WS Coordination, WS Policy or WS Transaction. Note that these web service standards target federated environments, which can be exploited by management applications in two ways: one can conveniently manage across federated envi-

¹ We previously discussed the integration of management and Grid functionalities in [4], while architectures similar to the management backplane, but based on web services without Grid extensions, were proposed in [5] and [6].

ronments, and one can create management applications that are federated themselves. Also note that web services create a natural connection with business impact of management actions, since business impact is often determined by the functioning of web services that drive an enterprise. See our discussion of web services management network, which deals with management of business services, providing an architecture that is fully compatible with the Grid-based management backplane [5].

- d. **Leverage Grid.** The Grid adds features to web services that make it especially useful for management. In particular, it introduces an elegant way to deal with state information, through the service data concept. Since management is nothing else than reporting and manipulating status of devices, it forms an obvious application for the Grid. The Grid also adds features such as single sign-on and the creation of virtual organizations, which may be exploited by management applications to manage dynamically changing environments or dynamically adapt management domains.
- e. **Standards.** Scale, heterogeneity and federation make it impossible for single vendors or technologies to provide the complete solution. No proprietary solution can be expected to offer close to all the required features, nor can it be expected to deal with all heterogeneity and federation issues. Standardization is therefore a must, and judged by its working groups (which deal with topics such as resource reservation and service agreements), the Global Grid Forum is the natural place to standardize service-oriented management technologies.

For all above reasons, the Grid-based management backplane is necessary and appropriate for building future management applications. The management backplane helps to automate operator tasks in business-driven fashion, and is able to deal with increasingly challenging issues around scale, heterogeneity and federation of enterprise IT.

References

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