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PERFORMANCE ANALYSIS OF A GRID MONITORING SYSTEM - AUTOPILOT

[1]Rakesh Bhatnagar, [2]Dr. Jayesh Patel

ABSTRACT

Monitoring is critical for providing robust, high performance Grid environment. Without monitoring mechanisms, it will be impossible to determine the status or health of environment. And so it will be difficult to use it effectively & efficiently. Monitoring data can be used for performance analysis, performance diagnosis, performance tuning, fault detection and scheduling.

Due to the complexity and dynamics of grid, an improved monitoring system is needed which should have features like Grid Monitoring Architecture compliance, Scalability, Resource Performance Analysis and Forecasting, Directory service for events subscription & notification etc. In this paper, we have reviewed the grid monitoring system – 'Autopilot'. 'Autopilot' is an infrastructure for real time adaptive control of parallel & distributive computing resources. The objective of 'Autopilot' is to create an environment which provides distributed applications with real time adaptive control so that they can automatically select & configure resource management features based on request patterns and observed system performance.

This paper discusses the various performance parameters and criteria of the grid monitoring system – 'Autopilot' and provides some useful information as far as Grid Monitoring Architecture is concerned.

Keywords: Grid Monitoring Architecture, producer, sensor, actuator, consumer.

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1. INTRODUCTION

A complex globally distributed system that involves large sets of diverse and geographically distributed components that can be used for a number of applications, is called a Grid environment [1]. These components include all the software and hardware services and resources needed by the applications.

The problem with the GRID environment is its diversity of these components and their large number of users. These can make them vulnerable to faults, failure and excessive loads. Hence, some suitable mechanisms are needed to monitor the components, and their use, which can hopefully detect conditions that may lead to bottlenecks, faults and failures. Grid monitoring is a critical facet for providing a robust, reliable and efficient environment [2].

The goal of grid monitoring is to measure and publish the state of resources at a particular point in time. To be effective, monitoring must be end-to-end, meaning that all components in an environment must be monitored. This includes software (ex. Applications, services, processes and operating systems), host hardware (ex. CPUs, disks, memory and sensors) and network components like routers, switches, bandwidth and latency.

Monitoring data is needed to understand performance, identify problems and to tune a system for better overall performance. Fault detections and recovery mechanisms need the monitoring data to help determine if parts of an environment are not functioning correctly, or whether to start a component or redirect service request elsewhere. A service that can forecast performance might use monitoring data as input for a prediction model which in turn be used by a scheduler to determine which components to use.

2. NEED - GRID MONITORING ARCHITECTURE (GMA)

Grid Monitoring Architecture (GMA) [2] consists of three types of components -

- A directory service which supports the publication and discovery of producers, consumers and events.
- Producers that are the sensors that produce performance data
- Consumers that access and use performance data.

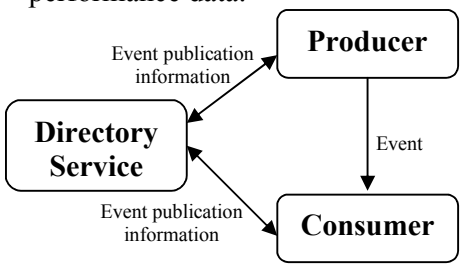

Figure 1: GMA [2][6]

GMA Directory Service [6] –
It provides information about producers or consumers that accept requests. When producers and consumers publish their existence in a directory service, they typically specify the event types they produce or consume. In addition, they may publish static values for some event data elements, further restricting the range of data that they will produce or consume. This publication information allows other producers and consumers to discover the types of events that are currently available, the characteristics of that data, and the sources or sinks that will produce or accept each type of data. The directory service is not responsible for storage of event data, only information about which event instances can be provided. Functions supported by the directory service can be summarized as -

- Authorize a search
- Authorize a modification
- Add
- Update
- Remove
- Search

A Grid Monitoring System can have one central Directory Service or multiple services.

Producers [6] -
It is a software component that sends monitoring data i.e. event to a consumer. Following are the steps of producer -

- Locate event
- Locate consumer
- Register
- Accept query
- Accept subscribe and unsubscribe
- Initiate query
- Initiate subscribe and unsubscribe

Producers are used to provide access control to the event, allowing dissimilar access to different class of users. Since a Grid can consist of multiple organizations that control the components being monitored, there may be different access policies, varying frequencies of measurement and ranges of performance detail for consumer who is inside or can be outside the organization owning a component. Some sites may allow internal access to real time event streams, while providing only summary data outside a site. The producers would enforce these types of policy decisions. This mechanism is important for monitoring clusters where they may be extensive internal monitoring but only little monitoring data accessible to the grid.

Consumers [6]-
Any program that receives monitoring data i.e. event from a producer can be a consumer. Following are the steps of consumer -

- Locate events
- Locate producers
- Initiate a query
- Initiate a subscription & unsubscribe
- Register
- Accept query
- Accept subscribe and unsubscribe

Real time consumers collect monitoring data in real time. A real time consumer potentially subscribes to multiple events of interest, and receives one or more streams of event data. In this way, data from many sources can be aggregated for real time performance analysis.

Overview consumers collect events from various sources and use the combined information to make some decision that could not be made on the basis of data from only one producer.

Job monitoring consumers can be used to trigger an action based on an event from a job, for example to restart a job.

3. RELATED LITERATURE - AUTOPILOT

'Autopilot' is an infrastructure for real time adaptive control of parallel & distributive computing resources [5]. The objective of 'Autopilot' is to create an environment which provides distributed applications with real time adaptive control so that they can automatically select & configure resource management features based on request patterns and observed system performance.

To achieve this, Autopilot provides components to facilitate the collection and distribution of host, service and network performance information. Autopilot was developed by Pablo Research Group [4], University of Illinois and is used in number of projects like GrADS –

Grid Application Development Software Project.

General Architecture -AUTOPILOT

Autopilot's infrastructure is based on the GMA and uses the Globus Toolkit to perform wide area communication between its components. Following figure shows a general architecture of Autopilot.

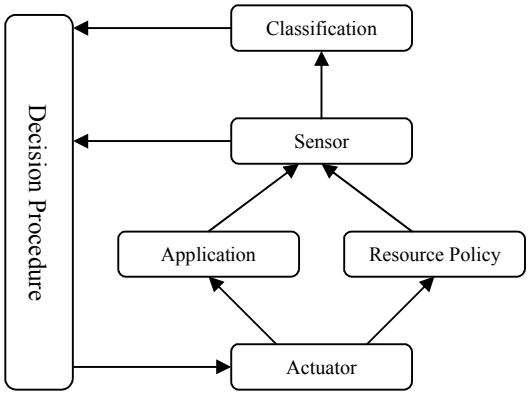

Figure 2: Architecture of Autopilot [5]

Its monitoring components [6] are -

- The Sensor - that corresponds to a GMA producer. Sensors are installed on monitored hosts to capture application and system performance information. Sensors can be configured to perform data buffering, local data reduction before transmission, and to change the frequency at which information is communicated to remote clients. Upon start-up, sensors register with the Autopilot Manager (AM).
- The Actuators - that corresponds to GMA producers and provides mechanisms for steering remote application behaviour and controlling sensor operation. Upon start-up, actuators register with the Autopilot Manager (AM).
- The Autopilot Manager – that performs the duties of a GMA registry. It supports registration requests by remote sensors and actuators, and provides a mechanism for clients to locate resource information.

An Autopilot client behaves like it is a GMA consumer. It locates sensors and actuators by searching the AM for registered keywords. For each producer found, a Globus URI is returned so that the consumer can connect to producers directly. Once connected, the client can instruct sensors to extract performance information, or actuators to modify the behaviour of remote applications.

The Autopilot Performance Daemon (APD) provides mechanism to retrieve and record system performance information from remote hosts. The APD consists of collectors and recorders. Collectors execute on the machines being monitored and retrieve local resource information. Recorders receive resource information from collectors for output or storage.

4. PERFORMANCE CRITERIA

Following performance parameters and criteria are reviewed:

Scalability and Fault Tolerance

The Autopilot Manager (AM) binds together multiple concurrent clients and producers, and provides seamless mechanism for locating and retrieving resource information from remote sensors. Hence, AM is the key component for ensuring scalability and fault tolerance of the system. However, while multiple AMs can exist within the monitored environment, there is currently no support for communication between multiple AMs. So if an AM fails, the sensor registration that it holds will be unavailable. Sensors can potentially register with multiple AMs and clients can query those

AMs. However, mechanisms are not provided to locate available AMs. Due to lack of communication between managers, it is not possible to create hierarchies of managers, wherein each manager contains information from sensors that report directly to it.

Monitoring and Extensibility

The APD periodically captures network and operating system information from the computers on which they execute. For consistency in heterogeneous networks, only a common subset of host monitoring information is available. Host information includes processor utilization, disk activity, context switches, system interrupts, memory utilization, paging activity and network latencies.

Developers could extend the scope of monitoring information by inserting sensors into existing source code that is used to perform local monitoring functions. These sensors can be configured to return specifies resource information. Autopilot does not provide a query interface for sensors. Clients retrieve information that has been previously configured for collection.

Data Requests and Presentation

Sensors periodically gather information and cache it locally regardless of client request. Client requests are fulfilled from the sensor's cache. Historical data is collected by the APM's collectors and made available to clients. Sensors are capable of filtering and reducing the information returned to clients by using customized functions in the sensors. Aggregated records can also be used to combine information related to a given host. Mechanisms to support homogeneous view of information from heterogeneous resources are not provided by Autopilot. VIRTUE an immersive environment that accepts real time performance data from Autopilot interacts with sensors and actuators using SDDF (Self Defining Data Format) and provides graphical features to view and control Autopilot components.

Searching and Standards

Autopilot uses Globus Toolkit 2 to perform wide area communications and follow the GMA. The data format used is SDDF which is non-standard.

Security

Autopilot does not support security support and assumes that applications will use Globus security mechanisms.

Software Implementation

Autopilot is actively supported and releases under Pablo Project Software License Agreement. Autopilot is freely available without fee for education, research and non profit purposes.

Software portability is limited to unix based platforms.

5. CONCLUSION

Monitoring is critical for a robust, effective and efficient grid environment. Monitoring data can be used to tune an environment's performance, detect faults and schedule jobs. The three fundamental components in a monitoring system are sensors (producers), clients (consumers) and directory services. A good monitoring system should potentially have a good scalable GMA like architecture and support variety of sensors and for analysis to

provide a number of different vies of monitored resources.

Autopilot is one grid monitoring system that uses Globus platform and provides graphical features to view and control Autopilot components.

Autopilot supports following features-

- Scalability
- Monitoring of computer
- Searching of information
- Filtering of data
- Open Source License

Autopilot does not support following features-

- Monitoring of services and network
- Homogeneous data
- Run time extensibility
- Open standards
- Security

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