INTRODUCTION
Most successful enterprises today rely on Oracle databases to run their businesses. As such, the overall health of their businesses depends highly on the health of underlying Oracle Database. Recognizing these demands, Oracle has made the improved diagnosability of its products a prime focus area. This paper outlines Oracle’s future strategies and directions to make the database server more intelligent and self-diagnosing with the objective of significantly reducing the time to recover from errors and failures.

The information presented in this paper is forward looking and is only intended to inform and educate customers. No specific commitment can be made at this time regarding when, how, or whether any of the solution discussed here will be actually implemented.

KEY DIAGNOSABILITY CHALLENGES

Business Challenges
The Oracle Database today powers many of the most mission critical applications around the globe. Successful processing of common day to day business activities such as online purchase, airline reservations, credit card sales, ATM withdrawals, etc., critically depends on uninterrupted service from the Oracle Database underlying such applications. Consequently, the demands placed on the Oracle Database software to provide maximum availability, reliability and scalability has grown by phenomenal measure in the recent time. With so much at stake, the cost of failure is becoming increasingly prohibitive. Even a temporary outage of a critical application can jeopardize the viability of the entire business. Revenue and customers may be lost, penalties could be owed and, the resulting unfavorable publicity can have a disastrous affect on customer confidence and corporate stock valuation. According to an estimate by Gartner Group and Contingency Planning Group, Inc., the monetary value of losses resulting from a prolonged system outage could be over a whopping million an hour.

While the causes behind failures may be varied and it may not always be possible to preclude them, customers are increasingly looking up to their IT vendors help them minimize, if not completely eliminate, the outages caused by product defects. Product quality is, therefore, increasingly becoming a critical differentiating factor
among competing products. Consequently, vendors are investing unprecedented amount of development resources towards ensuring highest out-of-box product quality and making their product easily diagnosable to minimize business interruptions when unavoidable failures are encountered at the customer site.

Technical Challenges
For the technical personnel responsible for day-to-day IT operations, the challenges could be even more insurmountable. The complex architecture of modern applications, ultra large databases sizes, and complex workload variations make it very difficult to identify the component where, how, and when a failure originated, and collect the necessary diagnostic data to quickly identify the root cause. This not only leads to delay in problem resolution but also imposes an additional burden on already stretched administrative resources.

ORACLE RESPONDS TO THE CHALLENGE
Rising to these challenges, Oracle has made enhancing product quality and building automated diagnosability solutions in our products a key development focus area. A significant amount of development resources are being spent in renovating coding practices and testing procedures to ensure that

- Number of bugs introduced during software development is minimized, and
- Maximum number of bugs can be identified and fixed prior to software release so that customers can be assured of the highest quality product.

As a practical consideration, however, it is important to realize that even the most stringent of testing processes cannot simulate every unique customer environments. Consequently, in spite of Oracle's best efforts to deliver a completely bug free product, a small number of problems still being encountered at the customer site isn't completely avoidable. However, in order to ensure that the root cause of such problems is quickly identified and fixed with minimal business interruption, a new “Self-Healing Database” development initiative has been launched to equip the product with automatic problem diagnostic and resolution capabilities.

Highest Quality

Continuous Code Renovation
The Oracle Database kernel code has evolved over the years with a large number of new functionalities being added in every release to provide customers the best technology to deal with their business challenges. As the new features are introduced, some of the older features are deprecated/desupported. As a part of the continuous code renovation exercise, necessary cleanups are made to keep the code base crisp and easily maintainable. Cleanup of legacy code also ensures that the Oracle Database continues to provide customer with the best set of features and functionality without compromising on performance. In addition, the code
areas with a relatively larger number of issues reported are being closely examined to address any fundamental architectural issues.

The ongoing code renovation exercise will ensure a cleaner, more reliable, and easier to maintain code thereby minimizing the chances of bugs being introduced during software development. Additionally, it will also make the code easier to understand for developers and support analysts enabling them to fix problems quickly.

Quality Assurance Enhancements

Oracle follows some of the most stringent quality control practices in the industry to provide customers with the best quality product. A large number of tests are conducted throughout the development phase to ensure a comprehensive review of the product behavior in real world environments. As a part of Oracle’s commitment to continuously seek newer ways of making our product quality even better, we continue to invest heavily towards making our testing infrastructure even more comprehensive. Consequently, the number of tests conducted prior each new release has increased dramatically in the last few years. The latest release of Oracle Database software, Oracle Database 10g, was subjected to thrice as much testing as compared to Oracle 9i and 30 times as much when compared to Oracle 7.3. In addition, more and more tests are being automated to allow for more frequent and rigorous testing. A new set of test suites, called dynamic tests, has also been introduced to simulate unpredictable behavior in the real world.

To make the testing process more relevant to customers, a number of Oracle’s test procedure are based on real-world customer workload. A number of test beds have been established based on the workload and data provided by some of Oracle’s leading customers. These test beds have contributed immensely in dramatic quality gains seen in the latest releases of Oracle products.

Oracle Real Applications Cluster (RAC) is a key enabling technology for Enterprise Grid Computing. It enables the Oracle Database to deliver highest quality of service at the lowest possible cost. Considering the strategic importance of this technology to customers, Oracle plans to make significant investments in making its testing infrastructure fully RAC aware so that any RAC specific issues can be addressed.

However, no matter how through the testing procedures are, they cannot always guarantee to identify issues that may manifest when the product is deployed to service a real world application. Oracle, therefore, extensively deploys alpha and beta version of its product on internal systems to further bolster the product quality. Most of the Oracle’s internal systems were operational on pre-release versions of Oracle Database 10g for at least 6 months prior to its official availability.

To summarize, Oracle is committed to providing the customer the best technology and the highest quality products. Oracle accords customer satisfaction the highest
The planned self-healing solutions will enable proactive problem prevention, automatic diagnostics, and faster solution delivery.

priority and is taking all possible measure to ensure that customers get the most out their investment in Oracle technology.

The Self-Healing Database

The second aspect of Oracle’s diagnosability strategy is to build intelligent self-healing capabilities within the product so that problems encountered at the customer site can be resolved with no or little business impact. A core group of senior developers has been put together to spearhead the “Oracle Self-Healing Database” initiative. The group has been entrusted with the task of building sophisticated solutions that will enable the database to automatically detect problems and take the necessary corrective actions. In addition, a set of guidelines is being developed to ensure that all future development work includes diagnosability automation as a key objective. Although the initial focus of this group will be on the database, it is envisaged to be a cross-product initiative ultimately extending to entire Oracle technology stack.

The planned self-healing solutions will enable the Oracle Database to proactively identify potential problems and assist administrators in resolving them ahead of time so that failures can be avoided completely. On the other hand, when unavoidable failures do occur, it will automatically take steps to limit any potential damage and minimize any outage associated with the failure. Additionally, it will also capture all diagnostic data automatically and, optionally, send it back to Oracle to enable expeditious diagnosis and resolution. Once the problem solution has been developed, administrators will be able to easily apply any required patches with just a few mouse clicks, regardless of the number or sizes of the database they may responsible for.

Problem Prevention

As stated above, the first objective of the self-healing technology will be to prevent the problems from occurring. In order to achieve this, proactive checks will be performed to validate system health. During such validations, all components of the database will be inspected to determine if they are functioning properly. If existing or potential problem are detected, the database will automatically notify the administrator of its finding along with the recommended corrective steps. In addition, it will automatically trigger additional “drill down” checks to further narrow down the problem area. Affected database objects may also be “quarantined” to prevent further access and limit any potential damage.

Automatic Self-Diagnosis

Unified Storage of Diagnostic Information

A key requirement for automating problem diagnosis is the guaranteed availability of all necessary diagnostic data, preferably in a unified location. It is also important to ensure that logs from different components are written in a common format so that cross component correlations could be easily determined. In order to meet
these requirements, efforts are being made to unify the diagnostic data storage across different database components as well as across various Oracle products such as Database, Application Server, Collaboration Suite, etc. This will ensure that all pieces of information required to analyze a problem, such as alert logs, diagnostic dumps & traces, etc., are available at a single location relieving administrators from the time consuming task of manually compiling diagnostic information. In addition, all information stored the unified “Diagnostic Repository” will be conform to a standard format regardless of their origin enabling quick diagnosis of problems involving multiple database components, instances, or sessions. Finally, all the information required to analyze critical problems will be available even when the database is down to enable quick problem resolution and minimal application outage.

**Automatic Diagnostic Data Capture**

Another key requirement for successful problem diagnosis is that all required diagnostic data be collected at the first instance of the problem so that repeated failures can be avoided. The future releases of the Oracle Database will, therefore, have the intelligence to automatically trigger error specific diagnostic data capture whenever a problem is encountered. The automatic diagnostic data capture process will have the flexibility and adaptability to ensure that only the information relevant to the problem under consideration are captured, thereby helping reduce the volume data to be captured and shipped to Oracle support. The heuristics associated with determination of what information needs to be collected in response to a particular error may also be changed online via a “Live Update” mechanism. This will help minimize the downtime associated with applying diagnostic patches for those problems where the default diagnostic information is not adequate.

Quite often when a certain error condition occurs, an avalanche of the same error can be triggered across the processes or sessions running in the database. If not controlled, each of these errors can result in one or more trace files written until the error condition is corrected. Automatic Data Capture infrastructure will have a mechanism for limiting the number of repetitive dumping of trace information associated with a given problem. By matching problem characteristics, the system will be able to determine if sufficient diagnostic information have already been collected for a particular problem. Thereafter, any subsequent occurrences of the same problem will no longer trigger additional data capture, thereby reducing the amount of redundant information and eliminating the resulting wastage of disk space.

For problems that require a reproducible test case to be created and sent to Oracle Support for debugging purposes, the automatic diagnostic data capture infrastructure will provide a utility to collect and package all necessary diagnostic and test case information. This utility will provide administrators an invaluable tool that can be invoked to automatically generate test case information, thereby
liberating them from yet another complex and time consuming tasks. Such automation in the area of test case generation will also eliminate the chances of human mistakes, such as missing or incorrect information, and contribute significantly towards the goal minimizing the problem resolution time.

**Automatic Analysis**

Once the diagnostic data has been automatically captured, the self-healing Oracle Database will automatically analyze this information and develop a unique “identity” for the problem by studying its characteristics. The “problem identity” will allow the self-healing infrastructure to compare problems and determine if they share the same root cause. It will also be used to lookup the central problem repository at Oracle to determine if the problem is already known and whether any existing solutions or workaround exist. If a solution to the problem is found, administrators will be notified of the recommended corrective actions.

**Expeditious Problem Resolution**

As stated earlier, the overarching goal of the self-healing initiative is to minimize problem resolution time. All of the key technologies discussed so far, therefore, will contribute immensely towards significantly reducing the time required to diagnose a problem and develop a solution. The comprehensive nature of the automatically collected diagnostic data will either lead to solution availability right away – in case the problem is a known issue and a solution for the same already exits – or enable faster diagnosis by cutting down on the time spent in iterative collection of information.

Additionally, for cases invoking data damage, the Oracle Database will be able to automatically assess the extent of damage and recommend repair options taking into account down time vs. data loss trade offs. The recommend actions could include a wide variety of operation such as performing recovery using Recovery Manager (RMAN), recreating database objects such as indexes, patching a data block or isolating a corrupt Undo segment. The ready availability of the trade off information will enable customers to make an informed selection of the repair option they are most comfortable with. Once a given repair option is selected, an in-depth feasibility assessment of the selected options will be automatically done to make users aware of any undesirable consequences. Finally, users will be able to instruct the database to automatically implement a repair option once they have considered all possible implications. The Automatic Data Repair capabilities of the self-healing Oracle Database will provide customers a very powerful means to quickly recover from data loss scenario – a problem that can have disastrous business implications.

**Simplified Solution Delivery**

Oracle Enterprise Manager 10g provides administrators with powerful new patch management tools. The Critical Patch Advisory alerts users of critical patches
issued by Oracle and immediately identifies those systems across the enterprise that

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**Figure 1: Enterprise Manager Critical Patch Advisory**

The Patch Wizard facilitates the search, download and application of patches. Using the Patch Wizard patches can be searched either in the context of a specific target or, if desired, the administrator can query for a specific patch. Once the necessary patch is located, Enterprise Manager can be used to download and deploy it. Optionally, Enterprise Manager can execute an end-user provided script to install the patch. Each of these steps allows for quicker application of patches across the customer’s enterprise.

Using Enterprise Manager to find, download and deploy patches increases the efficiency with which administrators can work by automating mundane, repetitive, day-to-day maintenance tasks as much as possible. This allows administrators more time for proactive systems work.

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**Figure 2: Enterprise Manager Patch Management Wizard**
THE SELF-HEALING DATABASE AND YOU
The proposed self-healing functionalities of the Oracle Database will dramatically enhance application reliability. The proactive problem prevention will ensure that problems are fixed even before customer can notice them, thereby helping avoid unpleasant surprises. The automation introduced in different facet of diagnostic process will ensure faster problem resolution and help minimize business interruptions. In addition, precious administrative resources – hitherto utilized in manual problem diagnostic – will be freed for more productive use within the enterprise. A more fault tolerant and resilient Oracle Database will enable IT organizations to deliver even better quality of service to their end users and help their business become even more successful.

CONCLUSION
Oracle accords highest priority to addressing the pressing real-world challenges faced by customers. It is for this reason that the Oracle Database today offers the most sophisticated data management solution, equipped with many unique features and functionalities to meet the most exacting business demands. In addition, Oracle also fully understands the day-to-day operational challenges faced by IT managers and administrators. The new self-healing database initiative is designed to address the challenges of a globally competitive, “always-on”, economy where any software related failures could be prohibitively expensive and extremely damaging to business prospects. The new technologies being built as a part of this initiative will minimize such failures, reduce the outages caused when unavoidable failures are encountered, and provide business with an even more robust platform to run their mission critical applications.