INTRODUCTION
A reliable and secure server infrastructure is essential for every cloud computing or data center environment. This challenge is multifaceted as organizations contend with leaner budgets, limited resources, and increased network complexity. The ability to reduce the cost of maintaining servers around the globe, and in a distributed environment, is becoming a necessity. Various management solutions that address these needs are available; however, many of them are system-vendor dependent, require a working operating system, and/or consume significant levels of energy to ensure managed servers are accessible at all times. These solutions are also proprietary and unique, and include costly customization for each cloud computing or data center environment. This results in an increased total cost of ownership (TCO) and a lack of efficiency and consistency when managing these server systems.

Background
Over the last decade, remote server management has matured to offer a set of resources that facilitate system administration tasks by minimizing labor and lowering TCO.

Such capabilities enable basic remote manageability of server systems (such as hardware/software inventory, alerting, software installation and updates, and so forth), but are limited to working within the operating system. These tools also lack the robust security requirements that are needed in cloud computing and data center environments.

Cloud and data center infrastructure design, stability, as well as remote management and control now require an elevated level of system flexibility to fulfill these increasingly demanding responsibilities.

This technical brief highlights Broadcom® TruManage™ technology for servers and specifies how it addresses prevalent system administration community concerns. This technology enables remote and secure manageability regardless of the state of the system or operating system, while maintaining high energy efficiency and government agency compliance.

TruManage Technology Benefits
- Reduces data center and cloud infrastructure side visits
- Lowers Total Cost of Ownership (TCO)
- Optimizes server deployment
- Scalable Out-Of-Band (OOB) management architecture
- Enables efficient platform provisioning
- Interoperable with mainstream manageability tools
- Standards based
- Low cost and low power
- Single-chip integration of network and management controllers
- Highly reliable
**TruManage Technology Fundamentals**

Broadcom's TruManage technology is built on a scalable Ethernet controller architecture that combines highly optimized hardware, firmware, and software to enable extremely low-power and cost-effective management functionality for in-band, out-of-band, and out-of-service environments.

The figure below illustrates the incorporation of TruManage technology into the Broadcom NetXtreme® GbE NIC with integrated management controller, and how it is typically implemented in a server platform.

Broadcom centralized TruManage is a management technology solution that includes an integrated management controller which is efficient in terms of power and software integration compared to proprietary server management technologies relying on a discrete Baseboard Management Controller (BMC). Ethernet controllers with TruManage technology integrate an on-chip applications processor and memory to provide a single-chip solution for network connectivity and platform manageability at all times, enabling the proliferation of advanced server manageability.

**Practical Application**

Broadcom’s centralized architecture enables a secure and reliable solution that is less susceptible to system component failures. When the AC power cable is plugged in (and without requiring a boot cycle), a remote management console can start managing the platform regardless of its state. Network connectivity, along with manageability protocols, is available without the support of the system’s operating system. When TruManage technology is enabled, all firmware and software stacks run exclusively on the controller (for example, Real-Time-Operating-System, network stack, and IPMI 2.0/DCMI 1.5 and SMASH 2.0/WS-Management stacks including HTTP/HTTPS and TCP/IP protocol stacks) and without the need to share any of the system components, such as the system memory and chipset or processor, which increases the reliability and maximizes availability.

Contrary to Broadcom’s centralized solution, some proprietary server manageability methodologies rely on a discrete Baseboard Management Controller (BMC) with external memory or a chipset resident management controller with system memory (management firmware operates in system memory) and a continuous power source to support platform components. This is true even when the system is in a sleep state. As a result, server manageability solutions are less reliable and less power-efficient, leading to an increased TCO for cloud and data center infrastructure.
**TruManage™ Technology Highlights**

**Asset Management:** TruManage technology enables comprehensive asset tracking of hardware and software inventory including detailed information about the processor(s)/cache(s), system memory, chassis, fan(s), power supplies, and driver/firmware versions. OOB asset inventory is necessary for remotely managing, diagnosing, and repairing the system independent of OS and system power state (on/off/sleep). Advanced logging and reporting provides an easy and effective mechanism for system managers to monitor the system and be alerted to any change in the system components.

**Power Control:** Systems with TruManage technology can be powered on, shut down, reset, or put in a sleep mode securely from a remote console or web browser. A system administrator can perform a system shutdown or reset operation gracefully or ungracefully. The power control feature is essential during the remote diagnosis and repair of a system that fails to boot or run the OS.

**Boot Control:** This allows the boot configurations of the system to be visible and modifiable by a system administrator using the TruManage technology. Both persistent and one-time boot configurations can be supported. The system administrator can use different boot source settings for different boot configurations. The remote boot control feature is useful for reimaging and/or repairing the system. For example, when an OS becomes unresponsive on a system, the system administrator can remotely reboot to a diagnostics environment to detect and analyze OS problems, successfully reimage the system with a new OS image, and reboot the system with the new OS.

**User Account Management:** This allows the system to efficiently and securely manage distinct platform management tasks assigned to various system administrators. TruManage technology enables assigned system administrators to be associated with different roles. Each role can be configured to perform different OOB management functions. Supported roles can be dynamically configured. TruManage supports the following aspects of account management:

- Creating and deleting an account.
- Changing the enabled state of an account.
- Modifying the user name, organization name, and password of an account.
- Associating an account (identity) with specific roles tied to specific privileges.
**Text Console Redirection:** The ability to remotely monitor and administer a system without a local keyboard, mouse, and video monitor is important for handling a scenario where the system fails to boot or the OS fails to load. Text console redirection is a feature that allows for the text console I/O to be redirected to a remote management console. If the system administrator needs to check or change the BIOS setting on a remote system, the text console redirection feature allows the BIOS menu screen (or any text console) to be redirected to the system administrator's console. With the local keyboard being locked, the administrator can reconfigure and reboot the system remotely.

**USB Redirection:** This feature provides the ability to remotely boot a system when the local disk is corrupted or the system fails to boot. USB redirection allows a system administrator to boot from a remote ISO image using an HTTP-based protocol. The USB-redirected device appears as a virtual read-only mass-storage class USB device to the system firmware (BIOS) and OS. The redirection of the control/data to/from the virtual USB device is handled transparently using an HTTP-based redirection protocol. This feature enables remote booting, provisioning, reimaging, and diagnostics while leveraging the existing USB plug-n-play capabilities, as shown in the figure below. This eliminates infrastructure-side visits and extends the system manager's accessibility to remote platforms.

**Firmware Update:** The ability to update OOB management firmware using either in-band or an OOB environment allows a management console or an administrator to push fixes to the management firmware as well as update the firmware with new features.

**BIOS Management:** This allows remote configuration and control of the system BIOS using the TruManage technology. The BIOS attributes and settings are visible to the remote management client, and BIOS attribute changes can be made programatically. The TruManage management firmware acts as a cache of BIOS settings and attributes. This feature enables an administrator to roll out BIOS settings changes (e.g., enable TPM) programatically across multiple systems with TruManage technology.

**Opaque Management Data:** The Opaque Management Data feature provides persistent nonvolatile memory space where the users or applications can store information such as software version numbers, asset tag, system ID, logs, and software inventory. IT technicians (administrators) can use a remote management console or a local software agent to upload the information in this memory to assist in software-asset inventories, application, OS migrations, and problem resolution. This helps minimize the reliance on local software agents to store and retrieve data to help prevent accidental data loss. TruManage technology provides the access to Opaque Management Data in both the OOB and In-band environments.

**Event Logging:** This feature provides alert indication related information as a log file. This log can be read and cleared. It allows an administrator to have visibility into the events that have happened inside the system. The event logging feature enhances the ability to monitor and diagnose a system.
TruManage Technology

ADVANCED SERVER MANAGEABILITY THROUGHOUT THE CLOUD AND DATA CENTER

TruManage Technology Benefits

Open-standard technology offers increased choice, reduced cost for training and deployment, and improved interoperability in a heterogeneous IT management infrastructure. Broadcom TruManage technology is built on the Distributed Management Task Force (DMTF). TruManage supports the System Management Architecture for Server Hardware (SMASH) Standard that is a suite of specifications that takes full advantage of DMTF’s Web Services for Management (WS-Management) protocol and Common Information Model (CIM). TruManage also supports Intelligent Platform Management Interface (IPMI) 2.0 and Data Center Management Interface (DCMI) 1.5 specifications. In addition, TruManage supports the Management Component Transport Protocol (MCTP), Platform Level Data Model (PLDM), System Management BIOS (SMBIOS), Network Controller Sideband Interface (NC-SI), and IPMI 2.0/DCMI 1.5 specifications, which enables a common intercommunication architecture for the TruManage firmware to communicate with other platform management subsystem components, including BIOS, chipset, environmental controllers, network controllers, and sensor devices.

Management consoles that support DMTF standards and/or IPMI/DCMI specifications can manage any platform with TruManage technology, regardless of the chipset, processor, or OEM vendor. With this flexibility, system managers will not have to worry about what tools to use to manage a specific platform, or what state the platform is in (sleep or functional). Broadcom is a board member and significant contributor to the DMTF organization.

Proven and Low-Risk Solution: TruManage technology provides the best fit for any server platform architecture as it leverages already proven and deployed standards-based mechanisms for internal communications with platform management subsystem components. The TruManage solution has been adopted by major ODMs and OEMs in a number of server platforms. The table below shows a number of major management software products and tools that leverage TruManage technology supported standards: SMASH 2.0, CIM, IPMI 2.0, DCMI 1.5, and WS-Management.

Management Software Products

<table>
<thead>
<tr>
<th>Vendor</th>
<th>Management Software Product or Tool Names</th>
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<tbody>
<tr>
<td>AMD</td>
<td>System Center Configuration Manager (SCCM) Plug-in Console SDK including CLI</td>
</tr>
<tr>
<td>Broadcom</td>
<td>Broadcom Advanced Control Suite 4 (BACS4) and TruManage Software Development Kit (SDK)</td>
</tr>
<tr>
<td>Microsoft</td>
<td>PowerShell, SCCM, Windows Remote Management (WinRM)</td>
</tr>
<tr>
<td>Open Source Software</td>
<td>OpenWSMAN, FreeIPMI, and IPMItool</td>
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A Comprehensive Set of Software and Tools: Broadcom tools simplify the provisioning/configuration aspects of TruManage as well as maintain consistency and coordination between OS-present and OS-absent environments on the system. In order to enable a complete TruManage-based solution, Broadcom provides a comprehensive set of software tools, including: TruManage Software Development Kit (SDK), Broadcom WMI/CIM providers, Broadcom Advanced Control Suite 4 (BACS4), Broadcom Management Agent, Broadcom Management Configuration and Control (BMCC) Utility, and Scripts.
Rich and Competitive Features: TruManage provides a rich set of features that are use case driven. TruManage features benefit the end users and simplify the deployment of OOB management solutions. The ecosystem including BIOS, environmental controller, chipset, software tools, enterprise infrastructure, and management clients/consoles is already in place to realize the full benefits of these features. TruManage technology is the only proven/stable implementation that supports advanced OOB management features like graceful power control, programmatic BIOS management, and USB redirection for server systems. TruManage technology supports both In-Band and Out-Of-Band update of management firmware that allows system administrators to deploy platforms with different OOB management capabilities and support dynamic upgrade/downgrade of the management firmware in the field. TruManage supports multiple (In-Band, Out-Of-band, and Out-Of-Box) provisioning methods to address different system life cycles and environments.

Power-Efficient: The ability to fully diagnose and repair systems remotely (bare-metal or with a crashed OS) should not be at the expense of increased power consumption. By integrating platform manageability on the LAN controller, Broadcom enables full capability for both network connectivity and platform manageability while drawing minimal power. With TruManage technology, a green server can still be fully managed and compliant with EnergyStar™ and other government agencies in the United States, Europe, and globally. The networking subsystem consumes less than 0.2W when the system is in a sleep state. Broadcom is a participating member in the Green Grid industry consortium.

Easy-Access Web Interface: In small business environments where a full management console tool is cost and resource prohibitive, TruManage technology offers the ability to manage any platform on the network using any web browser. A web server runs on the controller hardware and provides a full set of capabilities (power control, asset management, user account management, and so forth) to securely manage, diagnose, and repair systems remotely. This enables direct communication with the remote server, regardless of its state.
**Conclusion**

Small and large cloud and data center infrastructure managers are continuously under pressure to increase the efficiency and reliability of their infrastructure while maintaining lower cost of ownership. Therefore, it is critical for enterprises to have the ability to manage platforms remotely without sending support personnel on-site, while being both vendor-agnostic and energy-efficient.

Broadcom, via its TruManage technology, offers an innovative solution to address system managers’ needs without the tradeoffs inherent in competing proprietary technologies. TruManage technology enables a reliable, secure, energy efficient, and vendor-agnostic solution that can be deployed on servers of any form factor including rack-mounted servers, blade servers, and micro-servers, in both cloud and data center environments. Broadcom TruManage technology is available from major ODM and OEM vendors.