Executive Summary

Customers expect PCs to be reliable, powerful, and quiet. However, in an effort to deliver more power, the industry has tended to sacrifice reliability and environmental serenity. Essentially, as processors get faster, they generate more heat, and that heat lowers reliability, shortens system life, and calls for an ever larger number of high-speed fans that make more noise.

Gateway's BTX systems address requirements for reliability, high performance, and quieter operation by incorporating new industry-standard and Gateway-specific technologies.

- The BTX system architecture is the result of an industrywide effort to redesign the motherboard to improve airflow and heat dissipation for PCs using Intel processors. BTX succeeds ATX, an industry standard for the last eight years.

- While holding to the BTX standard, Gateway has added patented fan control technology and unique chassis designs to differentiate its systems from those assembled by other PC manufacturers.

Independent testing of Gateway's BTX systems found a reduction of up to 10 Celsius degrees (18 Fahrenheit degrees) when compared with ATX systems using the same processors, graphics boards, and hard disk drives. Using the industry-standard Arrhenius Acceleration Reaction Rate Model and industry reliability data, engineers at Accolade Engineering Solutions estimated up to an 82% improvement in reliability for (critical subsystems measured) Gateway's BTX systems.

IDC applauds Gateway's leadership in bringing BTX systems to market. The transition from the ATX architecture to the BTX architecture is necessary and underway. Gateway's approach, which combines the standard BTX architecture with Gateway innovation, is a model for the industry. Gateway's experience with BTX will be an important asset for addressing emerging markets for digital home products where quietness is of great concern.
**Introduction**

PC owners increasingly want quieter and more reliable personal computers without sacrificing the system’s performance. With each passing year, faster processors and more powerful graphics accelerators consume greater power and hence produce more heat that must be dissipated. The trend toward smaller semiconductor die size creates more intense hot spots, not only across the surface of the processors themselves, but also on the system circuit boards, as smaller components are placed closer together. These hot spots further exacerbate the thermal challenge.

With each advance in technology, under the current system architecture, more fans operating at higher speeds are necessary to dissipate the increasing heat. However, adding more high-speed fans increases PC manufacturing costs, creates higher levels of irritating noise for the end user, and introduces increased vulnerability to failures. A design change is needed if customers are to have quiet, reliable, high-performance PCs. Just in time, the BTX system architecture has arrived to address the need for that design change.

**BTX System Architecture**

The Balanced Technology Extended (BTX) initiative is an industry-wide effort led by Intel and influenced by Gateway and other system suppliers. The BTX system architecture addresses the goal of moving a tremendous amount of air over a redesigned motherboard, thereby improving heat dissipation and decreasing heat-related system failures to make BTX systems more reliable.

Among its other benefits, BTX brings noise abatement to the PC. Due to improved airflow, only two large fans are needed to circulate air, and those fans, while running at lower speeds, can push more air through the chassis and over the components. As a result, PCs with BTX motherboards are quieter than PCs with ATX motherboards.

The BTX motherboard provides a foundation for new system-level architectures. A BTX system architecture comprises the motherboard and power supply, the fan and air duct design, and the computer’s case design.

**ATX Architecture**

BTX is the successor to ATX, an eight-year-old PC motherboard design, and BTX will eventually replace ATX over the coming years. The ATX design was derived from the first PCs that used Intel processors. Intel published the current ATX standard in 1995. The goal of ATX was to increase standardization for PC manufacturers and improve the opportunities for OEMs to exploit economies of scale and to focus their efforts on product differentiation beyond the motherboard.

Over the years, the amount of heat produced by processors and other components has increased. To combat the heat, ATX motherboards have included small, high-speed fans dedicated to dissipating heat from the processor and from other sources, such as high-performance graphics cards. For single-processor PCs, as many as five fans may be required to cool the computer: one each for the processor, graphics processor, and power supply, and two (intake and exhaust) for the chassis.
The venerable ATX architecture has been a mainstay for the PC industry because it standardized component placement and integration, which enabled OEMs to focus on value-add functionality. The industry-standard ATX motherboard also influenced form factors and cabinet design.

**Gateway's BTX System Architecture: Features and Benefits**

Gateway's BTX System Architecture is a set of specifications for the desktop PC chassis that substantially improves heat dissipation. Figure 1 shows a side view of a Gateway BTX chassis. The front intake fan sends cool air directly into a thermal module, or duct, which ensures that fresh air arrives first to cool the PC's processor, both over and under the motherboard. Air partially warmed in the processor area and additional fresh air drawn in from the front inlet grill join together to cool the processor's chipset, memory, hard disk drive, and video processors. A rear exhaust fan eliminates warm air from the chassis. A third fan cools the PC's power supply, which is not a part of the BTX motherboard but is a part of the BTX chassis design.

**FIGURE 1**

*Air Flow in the Gateway BTX Chassis*
To estimate PC failure rates, Accolade Engineering Solutions conducted experiments with two PCs, one with an ATX architecture and the other with a BTX architecture. Both were configured with the same processor (Intel 3.0GHz P4), video card (ATI X800), memory (2x256M PC3200 DDR), and hard disk (80GB).

The test PCs were placed in a test chamber with sensors monitoring the temperature of the hard disc drive, memory, and ambient air near the hard disk drive. Measures were obtained for two conditions. A Max I/O workload was run and measures were recorded. Then, Max I/O and 3D Mark workloads were run and measures were taken a second time.

AES engineers found temperature differences between the ATX and BTX architectures ranging from 4–10°C, depending on the measurement point and the workload. The largest difference, for example, was the temperature of the HDD case when the PC was running the Max I/O workload. The ATX machine's HDD temperature was 42.5°C (113°F) while the BTX machine's HDD temperature was 32.5°C (90.5°F). As expected, the BTX architecture was cooler than the ATX architecture under all experimental conditions.

AES then used the Arrhenius Acceleration Reaction Rate Model to estimate the improvement in mean time to failure (MTTF). The original Arrhenius model described the expected acceleration of chemical reactions with temperature increases. The model is used more generally to estimate the acceleration of component and system failures. The acceleration factors for HDD and Memory are 1.82 and 1.67, respectively. AES cites similar findings when temperature is reduced from 40 degrees centigrade (104°F) to 30°C (86°F) in studies conducted by a hard drive manufacturer and a fan manufacturer. Thus, AES engineers conclude that the BTX design improves reliability by up to 82% for fans and as much as 64% for hard disk drives.

Gateway's BTX systems incorporate a patent-pending two-step control system to make certain that the PC's cooling fans are running properly. During system boot-up, Gateway systems test that the fans are capable of running at full RPM within the time specified by the fan manufacturer. If fan performance is outside specifications, then the PC user is warned; if the fan fails to rotate, then the system boot halts and the user is informed that a repair is needed before the PC can be operated.

In addition to improving heat dissipation, the BTX architecture better organizes components on the motherboard. For example, routing of information from the processor to the I/O chips has been streamlined, and all I/O components are lined up at the rear of the motherboard where connectors can be mounted. The strength of the motherboard is improved in the BTX design, which has a support and retention module designed to protect the processor area from mechanical shock.
The BTX architecture specifies three sizes of motherboard. The full-size BTX model contains up to seven slots and requires a chassis of 20 liters or more. The mid-size BTX model, which is called micro BTX, supports four slots and can be manufactured in a chassis as small as 10 liters. Intel provides a reference design for a 12.9-liter slim tower desktop PC using the micro BTX model. The smallest BTX model, called pico BTX, has a single slot and can be contained in a chassis smaller than 10 liters. Intel provides a 6.9-liter reference design using the pico BTX model.

While the overall capacity and physical size of the BTX models vary, the core technology remains the same. Namely, all BTX models require airflow from front to back, have uniform thermal modules, and contain the same support and retention module for increased resilience to mechanical shock.

**Expected Improvements in System Reliability**

Gateway commissioned an independent testing laboratory, Accolade Engineering Solutions (AES), to evaluate the potential effect of the BTX architecture on overall system reliability. AES estimated up to an 82% improvement for BTX failure rates over comparably configured ATX systems for the subsystems measured due to better thermal dissipation.

**Gateway's BTX Initiative**

Gateway's 700GR Desktop PC was released in August of 2004 and is the first PC with a BTX architecture to reach the market. Aimed at PC power users and digital media customers, the 700GR is equipped with an Intel Pentium 4 processor, uses the Intel 915G chipset (supporting HyperThreading, PCI Express, and High-Definition Audio), an ATI RADEON X300SE PC Express 128MB graphics card, and 8X DVD+/-RW multiformat drive supporting dual-layer DVD.

Gateway is committed to the BTX architecture, and customers should expect to see BTX offerings moving downward from the top of Gateway's product line.

**Major Benefits of Gateway's BTX System Architecture**

According to Gateway, its systems that use the BTX architecture support the following value propositions:

- **Improved reliability due to more effective heat dissipation.** As noted, by providing improved airflow through the PC and across the motherboard, the BTX design expels heat more efficiently, which will improve system reliability and extend the life of the PC.

- **Improved acoustics.** Research at Intel indicates that the larger, slower, and quieter fans will result in a BTX system that is 5dBA quieter than a comparable ATX system. While subjective judgment of sound levels varies, most listeners report that when a sound level decreases by 10dBA, the sound is half as loud.
**Improved system design.** The BTX architecture rearranges motherboard components and chassis design to improve routing of data and power, to provide adequate space for legacy and future I/O and graphics subsystems, and to cluster I/O functionality at the rear to ease connectivity.

**Volume economics for all form factors.** BTX brings a new standard motherboard to full-size and smaller form factors that required custom motherboards in the past. With standardization, Gateway can leverage common components and subsystems (i.e., the motherboard and power supply) to reduce the cost of PCs.

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**IDC Analysis**

**Situation Analysis**

A transition is occurring in a relatively slow-moving niche in the PC ecosystem. As evidenced by the successful eight-year lifespan of the ATX motherboard design, moving to a new design is a rare event. While the industry will move to the BTX standard, the shift will be slow and incremental.

**Opportunities**

Gateway's release of a BTX-based PC gives the company an early start in two complementary ways: First, Gateway will begin designing and manufacturing BTX machines and begin the learning curve that will lead to lower costs. Second, Gateway will offer customers Gateway-brand BTX PCs and will begin building an affinity for Gateway and BTX with some customers.

Early experience building quieter PCs may be quite useful to Gateway in frontier areas such as the digital home products. For example, in order to be clients, servers, and control points in the home environment, PCs must be located in many parts of the home. For locations such as a living room or the classroom, these PCs will need to be quieter than today's ATX technology allows.

**Challenges**

Evolution to the BTX motherboard standard will occur over years. Gateway faces the challenge of timing its offerings to match market demand, which may be limited in the near term. First-to-market leadership may result in modest sales over the first years of the BTX offering as PC owners slowly become aware of the BTX technology and its benefits.

Gateway's early move to market BTX-based PCs may lead to low-volume sales and thus impair the company's attempt to gain the economies of scale when manufacturing motherboards and obtaining BTX components. It will be important for Gateway to maintain the sales of its traditional lines of PCs that use the ATX motherboard until demand for BTX PCs grows.
**Conclusion**

IDC believes that the transition from ATX to BTX motherboard design is a step ahead for the PC industry. By taking a leadership role, Gateway is positioning itself as a forward-looking company capable of leading-edge PC designs. From a branding perspective, Gateway's reputation should be enhanced by its first-to-market BTX PC systems.

Inertia is a strong force in large industries and will slow the move from ATX to BTX motherboard designs. IDC expects to see other suppliers testing the market for BTX systems. In three-to-five years' time, BTX will establish itself as a significant segment of the PC desktop market. Furthermore, the BTX form factor will have a compelling effect on chassis design, which will change the look of the PC dramatically.

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