Viewpoint paper

Embrace the new era of data center and cloud services

HP Data Center of the Future

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Introduction: IT facilities are undergoing a fundamental shift

Heightened business and government mandates, growing demands from an always-connected global audience, new levels of IT infrastructure complexity, an explosion in the growth of data, and the evolution of the cloud have forever changed the traditional relationship between the enterprise and the data center.

As enterprises expect more from their IT—delivering to ever-higher service-level agreements (SLAs) and driving stronger business results—those expectations must be achieved with less money, by less staff, and in less time. It comes down to meeting the customer challenges: speeding innovation, enhancing agility, and improving financial management.

Innovations such as virtualization, mobility, thin clients, convergence, standardization, and consolidation have provided the data center with greater capabilities. But they've also added greater implementation, management, and strategic challenges. As a result, executives need to think in new ways about their IT to make massive quantities of information more meaningful, actionable, and aligned to the business—and doing it in real time.

Essentially, the data center needs to move at the speed of business as opposed to the speed of its IT—and it has to deliver the right information at the right time in the right format to make the right business decisions. Indeed, the "I" in IT is now far more important to an enterprise's success than the "T."

If the data center is not optimized to meet business demands, then the enterprise is not maximizing its investment. In fact, it is costing more every day, and whatever competitive advantage an organization may have had rapidly dwindles—along with its ability to efficiently serve its customers and/or citizens.

As a result, forward-looking enterprises are looking more and more to hybrid cloud data center environments—and to outsourcing at least part of their deployment, implementation, and management to third-party vendors that specialize in data center and cloud services. These services include the people, processes, and technology needed to keep servers, storage, network, applications, and other key infrastructure running efficiently—giving the enterprise reliable and secure access to information.

The key is to enable the infrastructure to make the information available to applications to drive services and make business decisions: Infrastructure Anywhere + Applications Anywhere + Information Anywhere = Services Anywhere.

Today's competitive enterprises—and its data centers—are dynamic, meaning that they need to provide seamless, secure, context-aware experiences. In a dynamic enterprise, everything and everybody is connected, and the enterprise is expected to fully engage—not just transact—with all of its stakeholders. The next-generation data center will increase an enterprise's agility. At the same time, it will create additional burdens related to security, management, and automation because technology will be sourced from multiple places.

The data center of the future requires a robust, high-density, hybrid infrastructure with seamless, integrated, and pervasive security, based on these developments:

- Cloud computing has fundamentally shifted the role of IT.
- The accumulation of, and dependency on, so-called Big Data has created the need for real-time predictive analytics.
- Automation has to drive optimization across the value chain.

This paper will further examine trends affecting the data center while focusing on a converged cloud infrastructure, how these trends are driving a new era in data center services, and the increasing role that data center services are playing in helping enterprises modernize, improve utilization, and future-proof themselves to promote success for years to come.

Rapid pace of change creating rapid transformation of the data center

Managing a data center was much easier years ago when there was a lot less digital data in the world. Growth was manageable, workloads were predictable, and access was limited—all of which could be accommodated in an era when walled-off, independent silos and hardware were dedicated to single business processes and isolated functions. This created islands of information, but the solution—to simply buy more space and capacity when either or both ran out—remained practical.

With the amount of cumulative digital archive capacity growing exponentially, the traditional data center can no longer be considered an effective tool for productivity and growth—especially with the dramatic increase in mobility needs. Consider this:

- By 2013, downloads in mobile applications are expected to surpass 21.6 billion.
- By 2014, 130 million enterprise users will work in a mobile cloud.
- By 2020, approximately 5 billion people will be operating 50 billion wirelessly connected devices, and approximately 2 trillion devices will be used—and interconnected—on a daily basis.

This monumental shift jeopardizes the standard "formula" governing IT, which went something like this: Technology changes approximately every three years, but the lifetime of a typical data center facility is roughly 15 to 20 years. If seven technology refreshes on average are conducted over a 20-year span, then how much of an impact will the ongoing changes have on a typical facility infrastructure? The answer would be too great to measure against today's infrastructures, which are burdened by the following:

- They're over-provisioned, making them cost-inefficient.
- IT and facilities align too slowly.
- Data centers are built to specific—and the highest-possible—tier levels to cover all levels of availability, and applications and hardware are typically allocated specifically to their tiers.

In fact, mechanical and electrical infrastructure costs will account for approximately 75 percent of the cost of next-generation data centers. Unquestionably, new, innovative strategies are called for, beginning with the idea that IT must integrate fully and seamlessly with business processes—and be able to accommodate change and optimize the IT investment. Indeed, the data center of the future must be as dynamic as the enterprise it supports, providing seamless, secure, context-aware experiences in an always-connected world. A dynamic enterprise may be defined this way:

- It focuses on engaging with its users and/or citizens, not merely transacting with them.
- Everything is connected.
- It provides real-time, predictive analytics.
- It relies on automation to optimize the value chain.
- It is fortified by seamless, integrated, pervasive security technologies and policies.

Major trends affecting the data center

HP believes the ongoing alignment of business/government and IT is headed toward the instantly available, everything-is-connected enterprise—one in which services are requested and delivered anywhere at any time. This always-on connected enterprise is a dynamic one that includes employees, citizens, board members, and executives, and often business partners and suppliers.

Enterprises extend their reach upstream—beyond adjacent links in the supply chain—and downstream—beyond immediate channel partners to find opportunities for growth. The degree to which the enterprise interacts with the external entities that compose its business ecosystem demands radical changes in the way data centers are conceived and deployed.

The steady demand for more and more IT services is only increasing the pressure to get the data center under control. It demands an approach to IT that calls for organizations to create new products and services that harness, manage, and arm enterprises and governments to more efficiently access this onslaught of data.

The data center of the future will be built on the principles of a converged, cloud-based infrastructure that delivers a systematic approach to accelerate time to business value for IT organizations. It accelerates the provisioning of IT services and applications by integrating servers, storage, networking, security, power, cooling, and facilities into shared pools of interoperable resources—all managed through a common management platform. As these new data centers will augment the existing ones, the result will lead to the ability to deliver any workload—anywhere, anytime—to achieve better business results through a hybrid delivery model.

In the cloud data center, infrastructure, applications, and information go hand in hand, optimizing the environment to generate the optimal user experience. A cloud data center is different from a traditional data center because it is:

- Built to perform different workloads
- Designed to achieve the highest levels of business continuity
- Built to a different scale
- Not constrained by the same physical limitations

The reality is that no organization can instantly and completely move to cloud computing. No single cloud type, solution, or delivery approach can possibly satisfy all enterprise or government requirements. Executives need to consider what works for their organizations now and what will work best in the future as part of a hybrid delivery approach that combines traditional IT, private cloud, managed cloud, public cloud, and in-house solutions as part of an integrated seamless solution stack.

How thinking about data centers is changing

To deliver on the promise of delivering services anywhere/anytime, organizations can no longer solely be a builder of internal infrastructure and services. They will also need to broker or consume third-party/external services. The key will be to understand the unique requirements—such as availability, cost, performance, and industry and federal regulations—of each service in the organization's portfolio.

They must also address SLAs in the most efficient and cost-effective way. And at all times, they must comply with internal and external policies and regulations. This can be accomplished by creating the right mix of on-premise and off-premise services that leverage the best of traditional IT, private, managed, and public cloud—a hybrid delivery environment.

"Most of us IT professionals see cloud as the next phase in the evolution of IT; however, most customers will run a hybrid environment consisting of traditional dedicated solutions, private enterprise-wide cloud, managed virtual-private cloud, and public cloud. Data centers remain a strategic asset for hosting, integrating, and managing these hybrid environments. Enterprises with the best environments, tools, and skills will be able to adapt fastest."

Chris Moyer, Chief Technology Officer, HP Fellow

Several changes in infrastructure approach will be required to support this dynamic enterprise, including:

- **Embracing variable assets as opposed to those that are fixed.** The physical "ownership" of a technology may no longer be appropriate for the simple reason that the cost of fixed assets can't be recovered as quickly and easily as in the past. That means enterprises need to identify those critical assets that align specifically with the business and shift them from "capital" to "expenses" on a pay-per-use basis.
- **Speed of business.** Because technology innovations are being introduced faster and more frequently than ever, enterprises need to embrace dynamic resources that can accommodate innovation and service creation to advance their competitive edge.
- **Speed of operation.** Legacy systems simply aren't capable of delivering the type of instant information or type of real-time, interactive customer engagement needed to drive the speed of business. This is coupled with security (across information, applications, infrastructure, and delivery models), end-to-end management, and automation.
- **Automation.** Economics and innovations have drastically changed the role that humans play in IT. Automated systems, overseen by people as minimally as possible, are now able to handle exceedingly complex tasks and manage critical data without interruption. Human resources will always be vital to a successful operation, but the move to automation will continue to increase business productivity and service roll-out. In combination with this, the increasing abilities of machines to learn from data and trends in almost instantaneous fashion will be leveraged more and more by enterprises—and by the people making decisions based on that information.
- **Developing real-time, predictive analytics.** Business success is becoming a matter of anticipating and influencing user/customer decisions. Knowing what consumers like and why they behave as they do enables the possibility of influencing their decisions at the moment they make them—which is radically different from the previous model of simply analyzing the past to understand current market trends. Whereas post-purchase analysis will remain important, successful enterprises will be combining centralized business intelligence with real-time, predictive analytics. In essence, we are moving from the traditional transaction-based systems toward a system of engagement in which transactions are replaced by interactions.

Note that "being green" is not included here. Environmental considerations are now considered part of the foundational components of a next-generation, hybrid-cloud data center, and green solutions are embedded in almost everything that solutions providers such as HP design, manage, and operate. But it's equally important to note that the cost of energy is a major factor in the day-to-day operational costs of a data center—especially in a power-dense cloud data center. For that reason, the data center's location needs to be considered, taking into account energy availability and costs, Internet access, and government rules and regulations.

Next-generation data center considerations

With data becoming more and more important, data center strategy, location, and network connectivity become increasingly critical components of the overall IT strategy. Globalization has increased the risks that contemporary enterprises face in terms of working with infrastructure, tools, and processes across time zones, cultures, and political differences.

Extended workforces, roles, information and information frequency, data sources, and security are among the critical issues to consider in developing the data center of the future. This includes the need to combine strong security and governance to allow for full visibility for data at rest and data in transit. For example, some countries require financial institutions to keep and process client financial data inside the country where it originates—leading firms to operate in-country data centers for the task.

Enterprises also need to consider these factors at the beginning of their data center modernization:

- Remote and mobile workforces are evolving from a typical employer-employee relationship to new models.
- Outsourcing, off-shoring, best-shoring, crowd-sourcing, and even reverse auctions are being used with increasing frequency. Many enterprises are finding that outsourcing noncore tasks may be more cost-effective, and suppliers are requiring previously confidential sales projections and production information.
- Internet customers need immediate access to prices, stock levels, and delivery dates.
- Utility companies are changing from checking meters once a month to dynamically manage electricity demand by implementing smart meters, which entails continuous interaction with their customers.
- Customers are researching and ordering products and services from any location at any time and from a wide range of devices.
- New data sources such as sensors and devices with embedded intelligence are generating exabytes of information that needs to be processed, analyzed, and made actionable.

This brings up the challenges of enriching security while simultaneously achieving transparency and governance. Few imperatives are more vital than securing critical information. But a services-oriented world in which suppliers and customers are constantly changing requires the ability to perform lightning-fast—and accurate—changes. Just as the extended enterprise segues into the dynamic enterprise, the security and privacy measures that support it must be dynamic. Likewise, managing all interactions with a growing number of entities in the face of constant change creates greater pressures to achieve transparency and maintain appropriate governance.

Further, these new data centers must provide availability for redundant connections to the Internet and have the ability to access power (and water) directly from more than one local utility or sources. They must have the ability to be powered by diesel generators (which means they require access to diesel), and to be maintained by extremely large cooling systems.

Thinking logically about the next-generation data center

Conceiving, creating, and implementing a data center of the future that incorporates cloud innovations obviously requires a new way of thinking about how the data center needs to perform for the enterprise. At the same time, there is a gradual, but important, increased focus on not only infrastructure and applications but also on information.

Because the enterprise must be able to deliver always-on services, the thinking needs to change in terms of scalability, lifecycle management, the use of portals, platform instantiation, remediation through automated closed-loop management, automatic scaling, multicloud platform support, and extreme automation.

- **Scalability.** In a traditional data center, delivering new services meant deploying more servers, more operating environments, more storage capabilities, and more administrators across multiple data centers. The result? Increased costs, underused assets, integration headaches, and an inability to react quickly to changing business needs. A services-oriented data center, conversely, is virtualized—one that is controlled by software and not focused on technology or location. The services can be reconfigured automatically and dynamically when any element fails or the workload dictates a change. It will also be able to add or subtract resources depending on demand, and respond to errors and failures—automatically managing itself. The main difference is that in a traditional IT environment, scalability is performed vertically by adding more processors in a physical server or by deploying larger servers. In the cloud, scalability is achieved via more—probably smaller—servers, and by enabling horizontal growth.
- **Lifecycle management.** End-to-end service lifecycle management in the cloud requires a far greater level of maturity, particularly in the area of automation. The next-generation cloud data center will allow for full-service lifecycle management on demand, including allocation, provisioning, deployment, configuration, change, and monitoring. To achieve their business objectives, organizations will require end-to-end visibility and use the cloud and software as a service (SaaS) to achieve it. Service lifecycle management will be automated through a set of well-defined yet flexible cooperating services that are responsible for defining the depth of control. Additionally, if the services are to provide value, then the SLAs also need to be end to end, not just within the data center.

- **Portals.** Service providers will need to offer disparate portals for end users and IT administrators. User-friendly user portals enable customers—in a self-serve model—to order services and/or storage (such as business files and important documents for business users, and family photographs and music files for consumers), and as a platform for a bundled set of applications. IT administrators, on the other hand, will require management portals that provide higher levels of functionality and the ability to manage and operate the environment.
- P**latform instantiation.** In the cloud, IT service delivery will be automated, standardized, configured on demand, and designed with a flexible approach that defines the depth of control—rather than built to order. The complexity of instantiating and managing these services will be pushed into declarative service models that characterize the structural, functional, nonfunctional, and runtime dimensions of the services.
- **Remediation.** The cloud data center will require a runtime engine that provides a generic automated capability for provisioning, scheduling, managing and allocating resources, and handling closed-loop management, pool management, and repair. There will also be a need for a plug-and-play integration layer to other management technologies and service provider solutions, in support of a hybrid cloud environment.
- **Auto-scaling.** The ability to scale in and out of instances based on set policies is another critical aspect to consider. For example, scaling in a private cloud uses internal resources to increase the footprint of an application in response to a workload increase. As the load increases, a decision needs to be made—either manual or automated—to scale out the application, which would result in the deployment of new servers and reconfiguration of the application components such as load balancers. The speed and reliability of this scale-out is essential, requiring a sophisticated level of automation—such as a platform enabling the systematic capture and management of the scaling of the applications. Similarly, scaling out to a public cloud can also be accomplished as the demand on an application increases. In this case, a virtual private cloud needs to be established in order to ensure that the parts of the application that are deployed on the public cloud can connect to the private cloud to access the data.
- **Multicloud platform support.** Another important consideration is the necessity of being able to integrate seamlessly with commercial, public cloud providers such as HP Cloud Services, Amazon, and Rackspace. The architecture needs to be easily extensible to accommodate new providers as they enter the market, and the location of the data center, as discussed earlier, needs to be considered, due to latency based on application requirements.
- **Extreme automation.** This is another requirement of the cloud data center, because any change to the environment needs to be tracked automatically since the billing is based on pay-per-use. For example, a change to the underlying hardware environment needs to be tracked and reported to the billing engine to allow for changes in the billing components.

Everything as a service and the cloud

Enterprises face an ever-increasing need to bring products and services to market faster and to meet the increasing demands from consumers, citizens, and governments. Cloud computing promotes better ways to source, deliver, and govern highly flexible, scalable business-driven services.

This transition entails a shift of focus from technology to services. So organizations must move beyond the data center and “up the stack” to include applications and business processes to achieve greater value from their IT. This implies, naturally, that the infrastructure components need to be managed and operated even better and more efficiently, because they form the foundation for the more value-added areas of applications and business processes.

That’s where the cloud and everything as a service (XaaS) come in. The cloud enables the access and use of low-cost, easy-to-use, and flexible hardware and software components via Internet technologies. Through the cloud, everything will be delivered as a service, from computing power to storage to business processes to personal interactions. Applications run the business, so there needs to be a seamlessly integrated, end-to-end view of all the infrastructure’s applications, infrastructure, services, and management capabilities.

The business benefits of cloud computing and XaaS include low cost, ease of use, and flexibility. This will enable organizations to:

- Respond automatically to consumer or constituent needs
- Scale assets automatically, either up or down
- Minimize unused assets and maximize utilization
- Serve multiple needs for multiple users
- Take advantage of different pricing models, such as pay as you go, free, or advertising-supported
- Achieve anytime/anywhere service access
- Reduce time to launch new services
- Deploy standardized environments, further promoting infrastructure agility and speed
- Increase the focus on self-service models, enabling users to allocate and access resources via self-serve portals in a user-friendly manner

Adjusting and developing applications for the cloud

Relatively speaking, only a few applications exist in the cloud today (for this discussion's sake, "a few" refers to a small percentage of all applications in existence today). There are many technology, business-model, and sociological barriers that need to be addressed before all application domains can move to the cloud—but that number continues to accelerate and expand. Tremendous economic value can be unlocked when application domains reach the appropriate economies of scale.

The ideal cloud application is one that makes use of the cloud's software architecture, often by eliminating the need to install and run the application on the user's computer. This alleviates the burden of software maintenance, ongoing operation, and support. Successful cloud applications include peer-to-peer examples such as BitTorrent, web applications such as Facebook, SaaS offerings such as Google Apps and Salesforce, and software-plus services such as Microsoft Business Process Online Services.

The main differences in cloud application architecture from traditional IT include:

- Multitenancy: The ability to support multiple enterprises from a single instance
- Extreme scaling: The ability to scale across the data center as well as globally to accommodate massive numbers of intermittent users
- Management and security: These need to be role-based and federated
- Integrated design: For the purposes of achieving optimal efficiency, leverage, and scale
- Self-service orientation: Designed for low-touch, low-commitment interaction

The benefits of moving and leveraging cloud applications include:

- Shifting from fixed capital costs to variable costs
- Rapid procurement and instantiation
- Standardized delivery models
- The flexibility to scale up, down, and out
- Shifting from an internal focus on technology to an external, client focus on service

Development and security considerations

For development purposes, applications for the cloud need to be adjusted to scale horizontally across automatically deployed virtual servers. Applications that are built from the ground up need to be cloud-ready and cloud-enabled. Developers should take into account several security, availability, and performance considerations when adjusting or building applications for cloud.

From a security perspective, there is a movement toward an integrated security approach as opposed to the bolt-on security implementations of the past. Besides adopting and implementing standard security practices—such as overwriting sensitive memory storage upon exit and ensuring that sensitive data is not packaged in Virtual Machine Images—cloud security practices should include enforcing identity management and separation of roles, and adopting ISO 177799, SAS 70, and PCI DSS practices.

Some of the key components of application development include the need to include replication capability (in conjunction with the infrastructure capability), load balancing, and clustering needs. And when it comes to performance, developers need to consider the impact of network latency and bandwidth on application performance. Furthermore, the development process needs to take into account the application scalability needs and allow for performance and stress testing.

The custom-developed application into a managed environment such as test, model office, and production should be automatically provisioned and deployed. This includes custom application, middleware, database, operating systems, and infrastructure components. There should also be a change control mechanism for workflow and governance across the lifecycle. Developers need to ensure that a standard set of services, tools, and processes are incorporated—and the developer view should be expanded to allow for viewing other roles.

Why a hybrid cloud computing environment is an imperative

Focusing on always-on service delivery is no longer "good to have"—it's essential. And in a hybrid delivery environment that promises greater control and flexibility, enterprises and governments should examine such offerings as cloud types and services based on functionality and fit, and deploy those that deliver the desired business outcomes. These considerations must be applied throughout the traditional IT, cloud, and even in-house solutions that an enterprise deploys.

As the data center evolves and organizations continue to merge private, public, and managed cloud environments into their traditional architectures, many enterprises will be challenged by disparate architectures, different management and security platforms, inconsistent development environments, and, as a result, increased complexity. The future state—a converged cloud infrastructure—will offer a hybrid delivery model consisting of:

- Converged infrastructure, converged management and security, and converged information
- Hybrid delivery, spanning traditional IT, private, managed, and public cloud, and supporting infrastructure, applications, and information
- Open extensible architecture, enabling service flexibility and portability that is heterogeneous (hypervisor, deployment, development, and infrastructure) and designed with partners in mind

Gartner, the IT research and advisory company, says "hybrid cloud computing is an imperative[1]," and recommends that enterprises: 1) build and consume the right mix of services based on service requirements; 2) leverage the best aspects of their current environment; and 3) manage and secure a hybrid environment to maximize its value and minimize risk. Gartner further suggests that a hybrid environment will entail tight integration among all environments at the data, process, management, and security layers. Eventually, a hybrid environment will likely evolve into a single cloud consisting of several cloud platforms that enterprises will selectively use as business requirements dictate.

HP agrees that an organization's objectives, maturity, and risk profile (among many other factors) will dictate how it develops a hybrid cloud delivery model—and that its journey may not be a linear one.

Beginning the journey to a hybrid cloud environment

Many enterprises building their own on-premise environments as they prepare to move to the cloud will begin by standardizing, consolidating, virtualizing, and automating their environments. Standardization and consolidation reduces footprint, energy consumption, and cost while providing an easier way to move workloads across platforms. Virtualization creates enhanced efficiency, and automation significantly reduces manual effort, errors, and cost.

Some organizations will begin by building their own private cloud environment to improve operational efficiency, reduce time to provision, and enhance agility to meet business demands more efficiently. This will also create the foundation to develop richer, on-premise services such as platform as a service (PaaS) or SaaS while simultaneously putting in place the means to secure a true hybrid environment.

Other starting points include cloud development and testing, application transformation, or incorporating SaaS applications. Cloud development and testing focuses on reducing time to provision a development and testing environment to minimize manual errors with automation. Leveraging a dynamic, flexible, self-service infrastructure—both on premises and off—will also accelerate application testing. With application transformation, organizations will develop new applications or modernize existing ones for scalability and flexibility so they can run optimally in the cloud. SaaS applications will replace selected legacy applications via a third-party provider.

About HP Converged Cloud

HP Converged Cloud is the industry's first hybrid delivery approach and portfolio. It is based on a common architecture that spans traditional IT, private, managed, and public clouds, and is built on industry-leading HP solutions. These include:

- Converged Infrastructure (as a service), encompassing servers, storage, and network
- Converged Management and Security, encompassing monitoring, security, and automation
- Converged Information, encompassing structure and unstructured information

Engineered for the enterprise, HP Converged Cloud extends the power of the cloud across infrastructure, applications, and information and provides customers with:

- Choice through an open, standards-based approach supporting multiple hypervisors, operating systems, development environments, heterogeneous infrastructure, and an extensible partner ecosystem
- Confidence through a management and security offering that spans information, applications, and infrastructure
- Consistency through a single common architecture, portability across models, and one consumption experience

More information on HP Converged Cloud is available at **hp.com/go/cloud/**

[1] "Five Cloud Computing Trends That Will Affect Your Cloud Strategy Through 2015," February 10, 2012, by David W. Cearley and David Mitchell Smith

Conclusion

A seismic shift affecting information technology is changing the way enterprises are thinking about their data centers. This can be simply stated and understood by the idea that the "I" has eclipsed the "T" in terms of importance to business success. Executives need to instantly make exponentially growing amounts of information actionable and aligned to their business needs. To do this, they need their data centers to become as dynamic as their always-on enterprises. They need to work faster, anticipate and accommodate changing volumes and demands, and adjust quickly to meet new opportunities.

The data center of the future—a robust, high-density, secure, hybrid infrastructure—will be able to achieve these imperatives. It is based on the following premises: 1) real-time, predictive analytics culled from increasing volumes of Big Data will drive business success; 2) the continuing evolution of cloud computing will drive those real-time analytics and decisions; and 3) automation has to drive this data center transformation. To achieve these "must-have" changes, enterprises of all sizes are increasingly embracing third-party data center services to promote continued enterprise success.

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Dr. René J. Aerdts, an HP fellow, is the chief technologist and leader of the Service Provider Cloud Services organization and is part of the Office of the CTO for HP Enterprise Services. He directs a team of architects to drive the enterprise strategy for cloud services for service providers, leveraging technology to improve business outcomes by increasing speed and agility, driving down cost, and improving quality. The title of HP fellow is awarded to the corporation's most innovative thought leaders in recognition of their exceptional achievements. As an HP fellow, Dr. Aerdts helps develop enterprise-wide initiatives that shape the HP future.

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