Cloud Computing For Financial Markets

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January 2009

Enterprise IT is in the midst of an evolution in the way the applications, information, content, compute, storage, and network is deployed and consumed. As things stand today, costs are out of control and it is difficult to relate growth to cost in the datacenter; the complexity is becoming unmanageable and there is poor alignment between the business and its supporting technology.

The move is toward an efficient, reliable, and tailored operating platform, called a cloud. A cloud distinguishes the service delivery of IT. It respects the relationship between lines of business and their collaborating applications. The migration toward this dynamic and real time service oriented infrastructure is based upon business demand and allocated infrastructure supply to that demand as needed / when needed, just like a utility.

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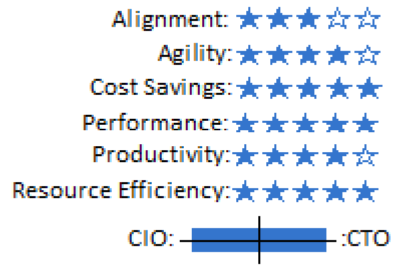
Executive Summary

Like most new IT operating models, Cloud Computing is making a big splash in the news headlines. The most promising aspect of Cloud Computing is that it's an evolution in technology, which unleashes a revolution in business operations. For organizations that have already been leveraging dynamic and virtualization technologies, the changes aren't dramatic; for those who have been watching from the sidelines, this is an ideal time to begin.



The key design consideration of Cloud Computing is the abstraction of underlying applications, information, content and resources. Physical resources are housed in massively scalable, yet tailored resource pools configured for dynamic provisioning of virtualized resources in real time and on demand. This abstraction makes the underlying resources easier to manage, which provides the basis for more effective management of the applications themselves. The entire Cloud Operating environment is more agile, reliable and efficient: and because it is abstracted, the environment can evolve as new technologies emerge, minimizing the negative impact that infrastructure changes normally cause. A cloud of computing resources can exist inside or outside a corporation's datacenter, which is important for companies that wish to consider migrating important but non-strategic services to an application service provider, while getting Service Levels that meet or exceed what would have been provided from internally supported platforms at manageable costs.

Business Drivers / Strategy

- **Simplify the Delivery of IT:** The processes and complexity of deploying infrastructure and applications often takes weeks or months, which directly impacts the profitability of the business.
- **User Experience:** The business has been promised improved user experiences that have not materialized, which leads to missed revenue and productivity opportunities.
- **Agility:** Beyond reducing the time to deliver of supply more quickly, the business needs to dynamically scale up / down in real time to have resources where / when needed.
- **Environment Efficiency:** Even with the recent attention to consolidation programs, large portions of the IT infrastructure is still poorly utilized, which directly affects the profitability of the business.

Key KPI Improvements

- **Time to Market:** up to 50+% reduction
- **Total Cost of Ownership:** up to 60+% less in Capital and Operating Expense
- **Performance:** up to 50+% improvement
- **Datacenter Productivity:** up to 70% reduction in packaging, deploying, and changing applications and infrastructure

Execution Strategy

- **Virtual and Dynamic:** Allocate low overhead virtual resources from physical ones dynamically and in real time.
- **Reduce Resource Costs:** Once deployed into a cloud infrastructure, the resources can be internal or external to the organization depending on what is most cost effective.
- **Robustness and Performance:** Since the resources are virtual and dynamically allocated, replacing failed or scaling up resources as needed becomes significantly easier.

Key Technologies

- Cisco Nexus 2000 / 5000 / 7000
- Cisco ACE
- Cisco ACE XML Gateway
- Cisco Enterprise Policy Manager
- Cisco Unified Communications Manager
- Cisco Ecosystem Partner: DataSynapse Dynamic Application Service Management (DASM)
- Cisco Ecosystem Partner: VMWare ESX & VDI
- Cisco Ecosystem Partner: Scalent VOS
- Solid State Disk

Cloud Computing Overview

Cloud Computing is the new "next big thing" and many view it as a revolutionary, disruptive innovation. However, when considering the use of grids and the notion of IT Utility, it is clearly a natural evolution of the digital supply chain. The concepts of cloud computing—networked infrastructure resources, available for a price and accessible via a standard interface—are quite similar to the preceding ones, with the primary differentiator being these resources are now supplied from outside the enterprise firewall.

Although today cloud computing is widely regarded as a consumer or small business platform, it will play an increasingly important role in the datacenter of the future, particularly as resource demands continue to grow for applications such real-time collaboration. Enterprises that opt to drive the efficiency of their internal IT Utility to higher levels will purposely constrict the capacity available internally, perhaps shifting from engineering the utility capacity to meet 99% of average peak capacity demands to 95%. At some point workload demand will exceed available capacity and a choice will have to be made: throttle or suspend lower priority workloads, or look to supplemental capacity outside of the enterprise to meet that demand. Whether that demand spike occurs due to an outage, an unforeseen demand surge, or simply because the utility operators wish to drive higher efficiencies, cloud computing is ideally suited to meet that demand. In fact, as the technologies underpinning cloud computing mature, progressive organizations may wish to permanently shift a percentage of infrastructure capacity to the cloud, and eventually migrate most if not all of it. Assuming enterprise security concerns are addressed, such decisions will be made wholly via an economic lens rather than technology.

Does this trend mean the Next Generation Datacenter will evolve on its own, and there's little for an IT executive to do? Absolutely not! The lessons in resource sharing from grids, and the business skills and control systems for dynamic application service management in an IT Utility, are essential to exploiting the benefits of cloud computing. Enterprises that master these skills early will have a distinct advantage in time to market, efficiency and resiliency that will go directly to their bottom line, while improving scale, productivity and collaboration.

Enterprise Cloud Design

The basic cloud is comprised of pooled resources (compute, network and disk) which are dynamically provisioned to meet the demands requested of it. Heavy use of real time and on demand virtualization technologies is leveraged to facilitate the rapid deployment of resources to meet the demand. There are generally three primary services that are provided by the cloud infrastructure, though they are each interrelated.

- **Infrastructure as a Service (IaaS)**—Raw compute, network and disk resources on demand. Often virtualization technologies are leveraged to facilitate the real-time reconfiguration of environments.
- **Platform as a Service (PaaS)**—A complete computing platform available on demand for the design, development, testing, deployment and hosting of applications. This includes everything provided by IaaS plus the development environment, application run-time, middleware, caching services, security services, integration services, etc.
- **Software as a Service (SaaS)**—A server-based version of software application or content channel that a remote thin client can connect to and operate with. Management of the software is centrally controlled and preferably is managed as virtual instances available on demand and typically built upon a PaaS.

A cloud can be operated by your organization (internal) or a third party (external). There are various tradeoffs to creating internal or buying external cloud resources. See Table 1—Cloud Decision Model for details.

Table 1—Cloud Decision Model

Many critical decisions must be made about investments that change conventional datacenter service provisioning. Deciding on the level of service (platform, software or infrastructure) will affect the level of investment in infrastructure and personnel. The strategic importance of an application, combined with its performance parameters, will dictate whether it is better to outsource an application externally or keep it internal.

Problem	PaaS	IaaS	SaaS	Ensemble	Internal Cloud	External Cloud
Need extra CPU and memory for spikes of trading during a volatile market for a few hours at a time to run high-risk analytics		From an extended pool to minimize security and data transfer issues		Numerical Processing Ensemble	Prefer to use internal cloud providing quick (within minutes) resource allocation.	
Need extended platform resources available to print end-of-month statements due to increasing volume. Don't want to invest in more infrastructure, and current datacenter sharing schemes cannot guarantee service window times.	Provides a tailored footprint for the kind on month-end processing required, including sufficient disk, CPU, memory and bandwidth. Would need encryption for large bulk data transfers.			Numerical Processing Ensemble with heavy emphasis on large data movements.		Operations can be run remotely by the renter. If more resources are needed to meet time windows, this would be covered under the SLA in terms of incremental cost to supply above and beyond.
Manage costs for GL and Oracle financials internally.	Create an internal PaaS that can generate allocated charge backs for resource used in apportioning costs to process all feeds from federated LOB.			Information Integration Ensemble combined with Numerical Processing Ensemble	Used as a transparency measure to get LOBs to streamline their input. Too often GLs must process hundreds of input feeds every night. Internal PaaS lets IT treat the processing of GL, etc. as a business.	
Stop building internal support staff to house Taleo, HR, timesheets, etc.			Get a tight contract for SLA so that these become externally provided SaaS.	Complex Transaction Ensemble	Must resolve Issues of security, possibly two-factor authentication	
Reduce investment s in point solutions for common services such as Date/Holiday service position service.			This should be crested with contracts in mind.		This makes sense to do internally to minimize delay.	

Use Case Examples

The following four use cases are commonly found in organizations that are significantly challenged by traditional solutions. An analysis of the challenges with each use cases is provided, followed by how they benefit from the availability of cloud infrastructure

- **The Desktop Experience—Revenue Generating:** The centralization of compute processes away from the desktop and onto the cloud to improve the trader's experience and simplify management.
- **The Desktop Experience—Client Facing:** The replacement of thick client technologies with thin client / SaaS solutions to improve cost and simplify management.
- **Decision Support Infrastructure:** Transformation of fixed and discrete grids to a more efficient and effective grid utility.
- **Application Delivery:** Transformation of fixed and discrete application resources into a more flexible SaaS solution.
- **Work Shift Adjustment:** Transformation of a fixed infrastructure into a time-of-day and/or business-event-driven dynamic cloud infrastructure.
- **Disaster Recovery Infrastructure:** Transformation of idle DR resources into a PoC, performance testing, UAT and development environment utility, with faster recovery time in the case of a disaster; use of multiple clouds to minimize DR resources.

Each use case has a brief description of the challenges faced by a specific aspect of a financial institution characterized as a 'Day in the Life'. This is followed by a description of requirements that necessary to meet the need, and a section of the problems and consequences of not meeting need that typically manifest themselves when traditional approaches are applied. These descriptions are provided to elucidate on subsequent diagrams.

The diagrams depict a high-level view of the environment discussed and are tagged with problem areas and followed up with a solution diagram. Each diagram has areas of interest tagged with numbers, which are related between the diagrams (problem in red and solution in green).

Cisco has developed a family of products and partnerships that solve the many challenges faced when deploying and operating a cloud environment. These use cases are meant to highlight the general approaches and how a Cisco oriented cloud infrastructure can be leveraged to enable the environment and simplify the architecture.

The Desktop Experience—Revenue Generation Use Case (High Performance Trader Desktop)

Day in the Life of a Trader

A trader in financial services must make critical decisions quickly because the market moves at sub-second speed. The trader must process enormous volumes of information and make judgments expeditiously in order to stay ahead of the market. If a trader is not kept informed in a timely manner, then the firm could miss an opportunity, or take a considerable loss.

Requirements to Fulfill the Trader's Need

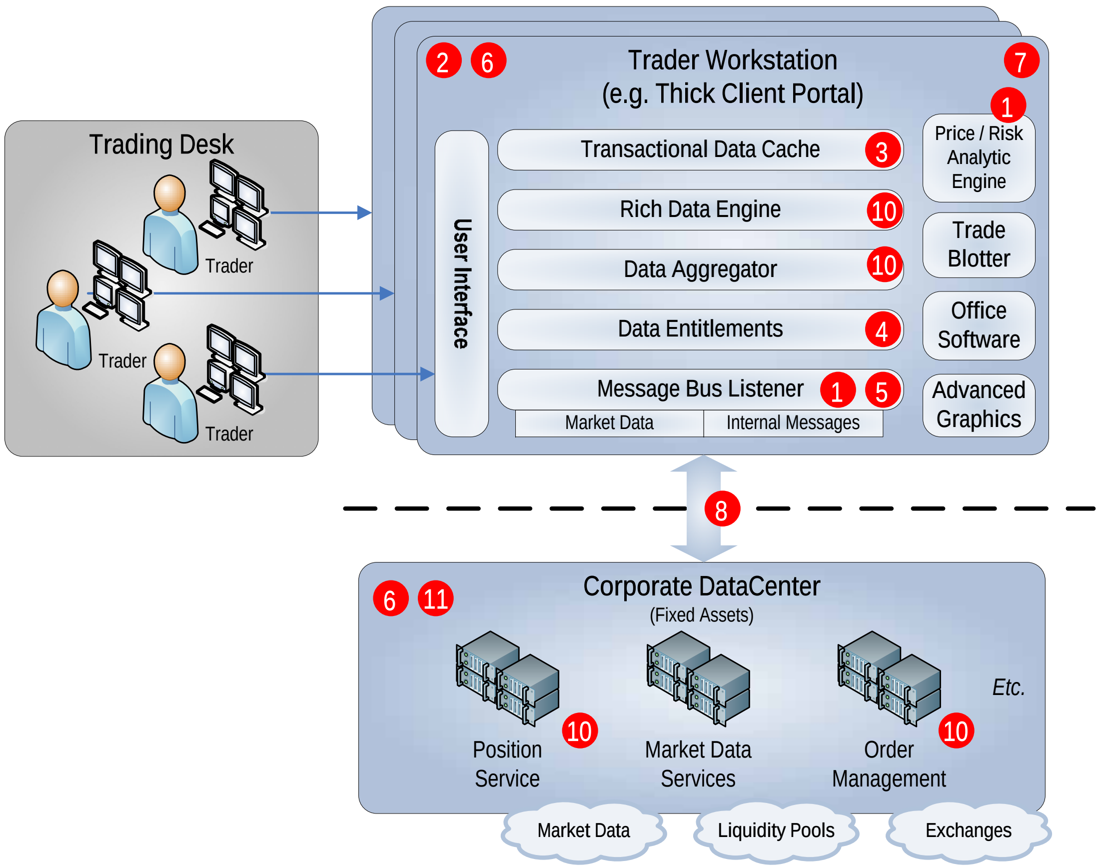
A trader needs information from the markets delivered in a timely manner; incoming message rates could be over 1,000 messages per second from multiple markets. A trader needs to run models that accept the influx of real-time messages, while calculating strategies on the fly. A trader also needs sophisticated visualization tools that will make it easy to see predefined alerts and trends that can be acted upon. A trader needs streaming news sent to the desktop so that information remains current. If a trader is unable to make a decision due to lack of information, unreliable operations of the models, or slow alerting, it could cost the firm millions of dollars; a trader's desktop and its entire supporting infrastructure must be ultra-reliable.

Problems and Consequences in Meeting that Need

Trader desktops are one of the most extreme examples of users that demand large "personal" infrastructures that can be tailored to an individual's taste. The consequences are:

- **An Overwhelmed Desktop Affects User Experience:** These workstation platforms must process large volumes with low latency, (under 40 ms per transaction), can handle 1,000's of inputs per second, render real-time graphics, run real-time alerts, keep a large cache of highly volatile data, and must be ultra reliable as downtime can be measured in millions of dollars lost per hour. The trend for some time has been to expand the workstation to meet the demands of the individual trader. This is costly, and ultimately does not solve the problem as the pace and complexity of growth outraces workstation capacity.
- **Desktop Workstation Sprawl:** Increased cost and operational complexity; some solutions place multiple workstations for a trader. This adds cost, increases complexity and causes reliability problems. It can over tax the network as it serves multiple workstations per user.
- **Collaboration:** Traditional applications treat collaboration as an afterthought, if at all; however, this is a source of major product and service differentiation. Missed business opportunities or clunky interfaces are the result.
- **Operational Complexity Decreases Reliability:** Each trader tends to have their own configuration, and the degree of dedicated personnel and other support costs assigned to a trading desk causes costs to be out of control. Problem determination is harder, making it harder to maintain reliability.
- **Agility Suffers:** New features are hard to rollout; the whole purpose of giving traders large workstations is to maximize agility, but the fast moving market pressures that force sprawl also make the trader platform less stable, impeding the migration of application changes. In the end, the primary drivers of agility and performance cannot be met successfully.

Revenue Generation
High Performance Trader Desktop



Problem Areas:

1. Workstation Performance: Peak market data traffic competes for CPU and I/O resources with longer running analytic calculations. Scale by increasing desktop capacity; adding CPUs to separate processing promotes uncontrolled growth.

2. Time to Market: Deployment of new functionality must be rolled out rapidly to the Traders. Each trader has their own configuration; hundreds of individual changes required for upgrades; inhibits agility, causes operational instability.

3. User Experience: Large amount of cache required for large influx of market data, streaming data, the data is very volatile. Non-optimized infrastructure causes frequent cache updates and garbage collection pauses, disk utilization runs high.

4. Security: Access to resources must be secured. Exposure to organization is high from market data providers.. Security and permission measures are often ad-hoc, and manually checked only periodically.

5. Workstation Scaling: Market Data rates are constantly increasing. Processing and network load stress individual trader workstations, forcing upgrades.

6. Shared Infrastructure: Infrastructure should been shared for common services. Caching and analytic engines are deployed per workstation and datacenter resources are fixed causing sprawl, escalating costs and operational complexity.

7. Collaboration: Interactive collaboration is needed between users to share information. Traditional applications typically lack collaboration features, such as IM and sharing a view.

8. QoS: Market data messages, such as trades and orders must be top priority. All network traffic has equal importance; trades and orders compete for bandwidth.

9. Load Spikes: There are spikes 2x-3x baseline peak that infrequently occur. Invest in additional and costly infrastructure or allow QoS to suffer.

10. Performance: Client facing Java applications must perform consistently. Java applications suffer from garbage collection pauses and JVM memory limits, which can greatly affect reputation.

11. Physical Connectivity: Density of Servers continues to increase. Each server has multiple connections to the network and SAN, which raises costs, lowers reliability, and makes maintenance more difficult.

Figure 1 - Traditional Trader Desktop

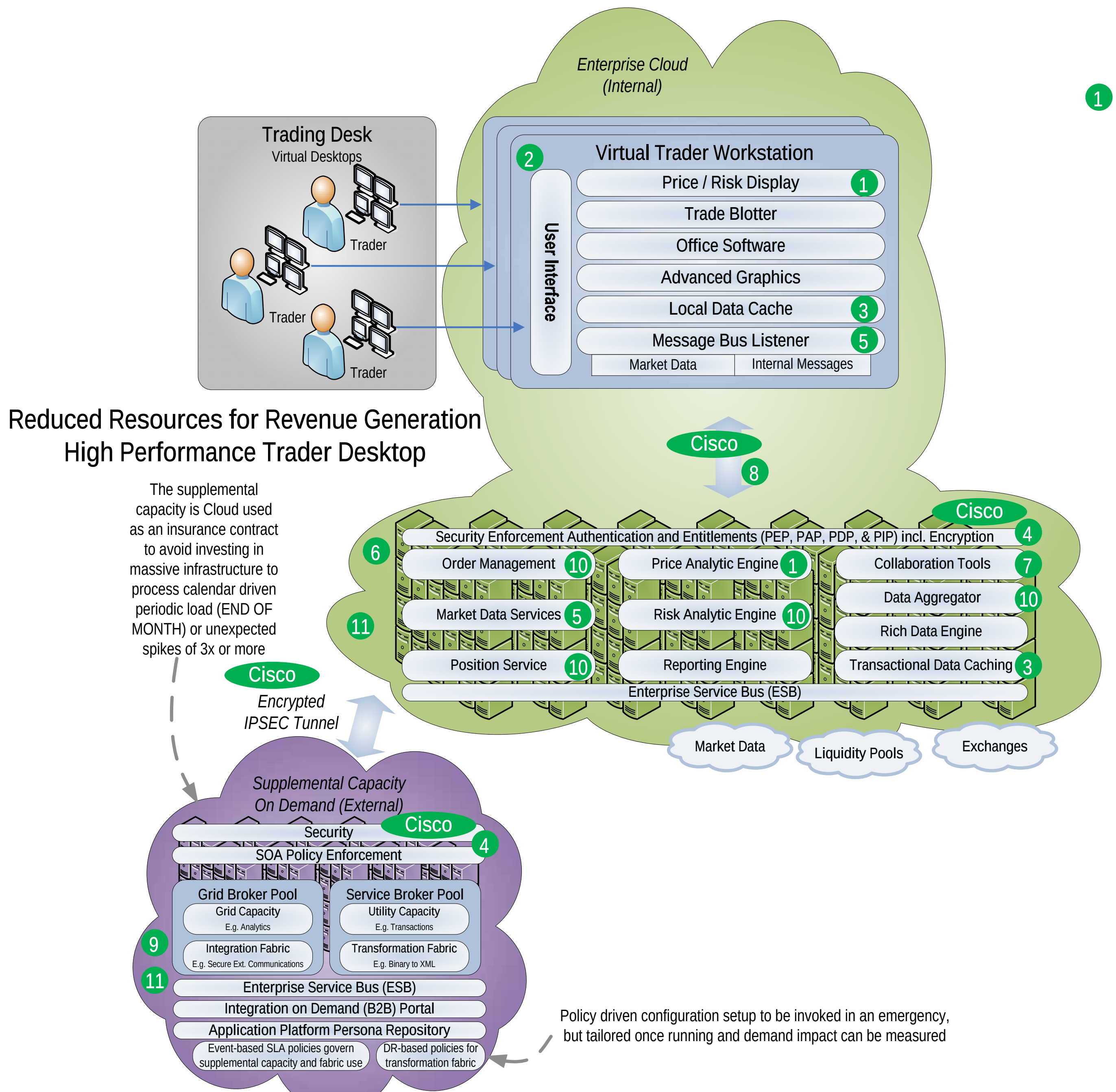


Figure 2 - Cisco's solution for Trader Desktop

Solutions:

1 3 Performance: Local caching requirements reduced as most volatile persistence is processed and held by the Cloud, which has tailored caching engines that streamline processing. Increased market data activity is processed by the cloud as it transparently adds resources to meet demand.

2 Time to Market: Deployment of new functionality must be rolled out rapidly to the Traders. Enterprise cloud provides consistent service builds for common functions; upgrades occur seamlessly.

4 Security: Access to resources must be secured. Cisco Policy Manager and Policy Enforcement Points; ensures WIRE SPEED fine grained auth disallowing invalid requests before they waste resources.
Business Policy Driven: (Client and Trader Entitlements)

- Policy Enforcement Points (PEPs)
- Policy Administration Points (PAPs)
- Policy Decision Points (PDPs)

5 Workstation Scaling: Market data rates are constantly increasing. CPU intensive processing demand, volatile data management and disk management stress removed from Trader Server Platform, reducing the need to add resources per trader continuously.

6 Shared Infrastructure: Infrastructure should been shared for common services. Trading desks share infrastructure, such as caching or analytics engines; reduce datacenter sprawl, simplified cabling and escalating costs.

7 Collaboration: Interactive collaboration is needed between users to share information. Application integration with Cisco Unified Communication Manager.

8 QoS: Market data messages, such as trades and orders must be top priority. Network traffic for trades and orders transaction types are prioritized by Cisco's QoS Policy Manager.

9 Load Spikes: There are spikes 2x-3x baseline peak that infrequently occur. Dynamically tap supplemental third party cloud capacity to meet spikes.

10 Performance: Client facing Java applications must perform consistently. Supplement Java processing with a network attached JVM processor (Azul) which eliminates garbage collection pauses, accelerates inter-communications with <40ms response time and supplies 864 JVM cores / 768GB memory.

11 Physical Connectivity: Density of servers continues to increase. Cisco Unified I/O combines network and SAN connectivity into a single converged network adapter connected to a Cisco Nexus switch to run FCoE. Quality and Performance over FCoE is enabled via Cisco's Priority Flow Control (PFC) providing a lower cost environment with higher availability that is easier to maintain..

The Desktop Experience—Client Facing Use Case
(Client Account Manager—CAM—Desktop in a Retail Brokerage)

Day in the Life of a CAM

Retail brokerages are the face of financial enterprise and represent the opportunity to provide differentiated services to clients and foster client loyalty and retention. Retail brokerages strive to provide a comprehensive set of services to clients and expect the services to be easily navigated to instill confidence in the client. During heavy market activity it is essential that a Client Account Manager (CAM) be able to counsel a client by utilizing timely market data.

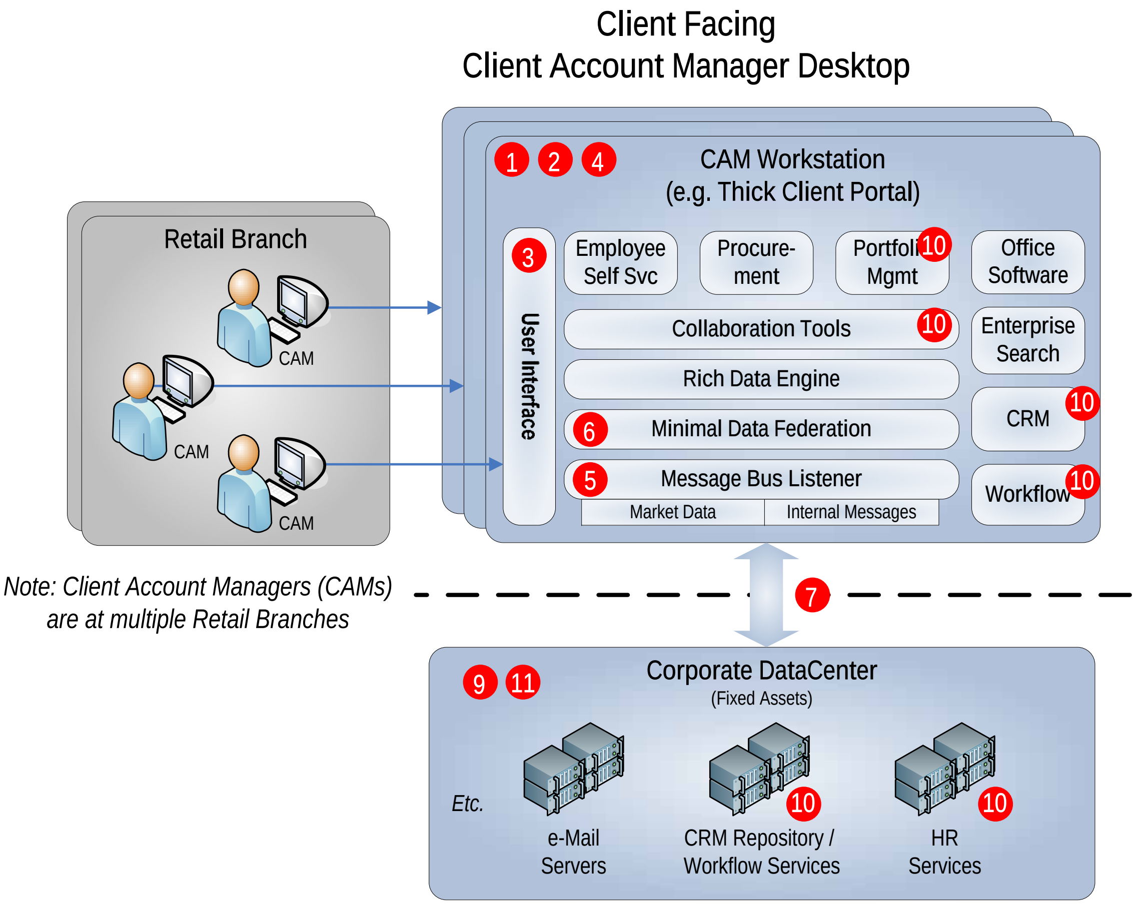
Requirements to Fulfill CAM's Need

CAMs should be able to obtain streaming data and be informed of trends, use PDAs to keep current when visiting a client, and be able to procure a complete view of all accounts a client has (e.g., family members, IRA, regular investment, loans). CAMs need to be able to run what-if scenarios for clients and quickly make presentations including projections and trends. CAMs need easy access to client preferences, as it is a priority to ensure recommendations are in line with the client's objectives.

Problems and Consequences in Meeting that Need

The typical IT answer to a retail branch's needs is to rollout suites of applications to robust workstations that communicate with a branch server which keeps a subset of data local to that branch. That branch server then communicates with a central hub back at a robust datacenter. The consequences are:

- **Slow Application Updates:** Application update rollouts are time consuming, often taking over a year and are compounded by the problem that making changes to these systems remotely is error prone. As the applications evolve and add more features, the remote, less populated branches are left behind, rarely receiving updates in a timely fashion.
- **User Experience:** Access is cumbersome as delays become more prominent because the branch server and the infrastructure are rarely updated.
- **Collaboration:** Traditional applications treat collaboration as an afterthought, if at all; however, this is a source of major product and service differentiation. Missed business opportunities or clunky interfaces are the result.
- **Out of Date Resources:** Over a period of a year, the once robust workstations become legacy, making it difficult to provide a consistent branded user experience, which is critical for the business image.



Problem Areas:

1. Collaboration: Interactive collaboration is needed between users to share information. Traditional applications typically lack collaboration features, such as IM and sharing a view.
2. Time to Market: Deployment of new functionality must be rolled out rapidly to the CAM users. Each CAM has their own configuration; thousands of individual workstations must get changes required for upgrades; inhibits agility; many upgrade opportunities are shunned for fear of operational instability.
3. User Experience: High performance interfaces are desired. Underlying technology platform is only upgraded every 3 to 5 years.
4. User Experience: Collaboration tool compete with other processing that require timely response. Stressed CPU and network resources on the workstation cause inconsistent user experience at market peaks.
5. Performance: Conflicts exist between large content movement and the need to have interactive web processing. Stressed CPU and network resources on the workstation cause inconsistent user experience.
6. Security: Access to resources must be secured. Exposure to organization is high from fragmented data storage policies.
7. QoS: Optimized use of bandwidth given the geographic constraints that affect service quality. Inconsistent network bandwidth to regional offices and unprioritized/uncompressed data sources.
8. Support: The resources must be easy to maintain. The number of configurations at the remote site requires that there be staff on hand to repair and maintain the systems.
9. Shared Infrastructure: Infrastructure should been shared for common services. Caching and analytic engines are deployed per workstation causing sprawl, escalating costs and operational complexity.
10. Performance: Client facing Java applications must perform consistently. Java applications suffer from garbage collection pauses and JVM memory limits, which can greatly affect reputation.
11. Physical Connectivity: Density of Servers continues to increase. Each server has multiple connections to the network and SAN, which raises costs, lowers reliability, and makes maintenance more difficult.

Figure 3 - Traditional Client Account Manager Desktop

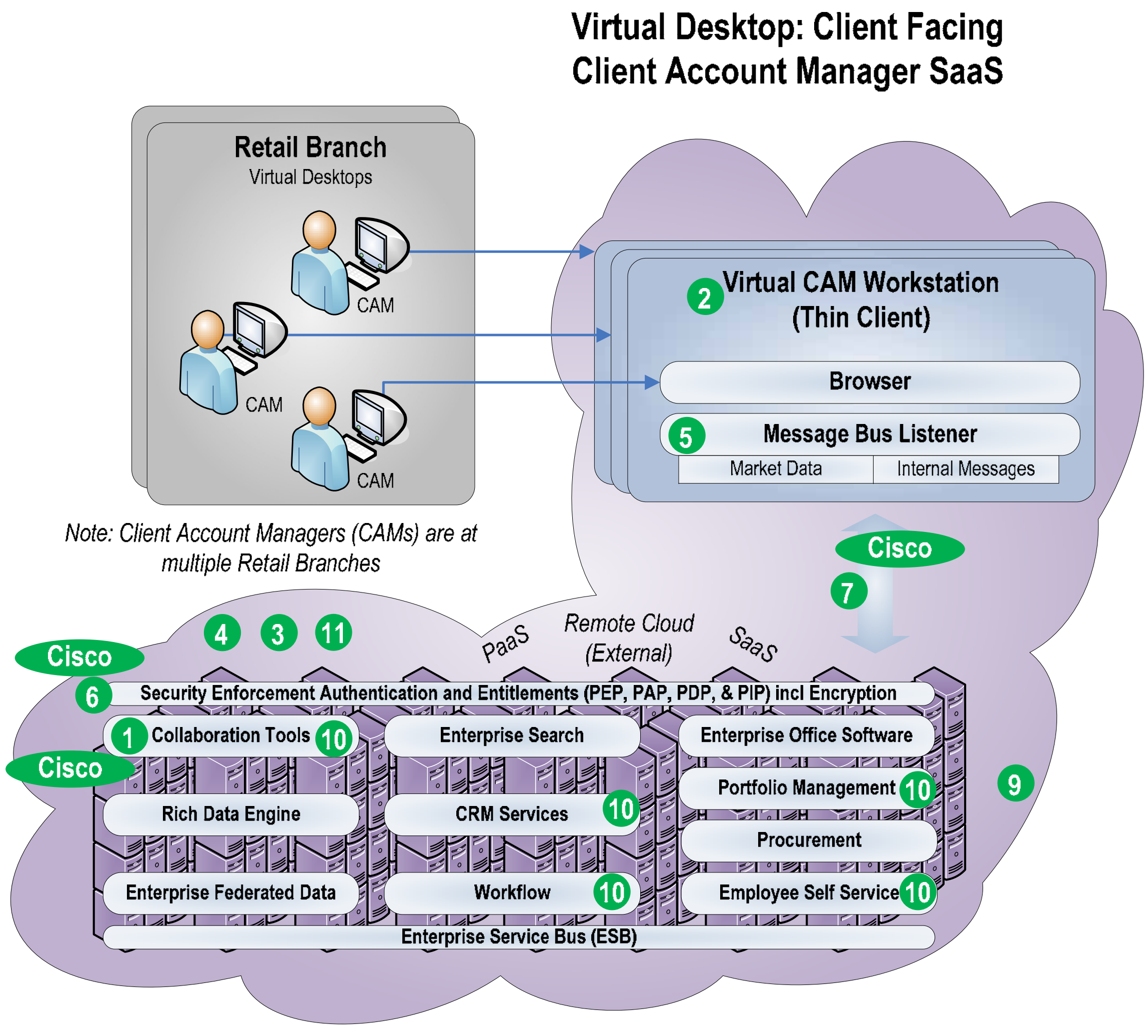


Figure 4 - Cisco's solution for Client Account Manager SaaS

Solutions:

1 **Collaboration:** Interactive collaboration is needed between users to share information. Application integration with Cisco Unified Communication Manager.

2 **Time to Market:** Deployment of new functionality must be rolled out rapidly to the CAM users. New features and changes are not hampered by workstation limitations; changes are rolled out everywhere at once; Web 2.0 infrastructure provides thick client responsiveness via a thin client.

3 4 5 **Performance:** Local caching requirements reduced as most volatile persistence is processed and held by the Cloud which has tailored caching engines that streamline processing. Increased market data activity is processed by the cloud as it transparently adds resources to meet demand.

6 **Security:** Access to resources must be secured. Cisco Policy Manager and Policy Enforcement Points; ensures WIRE SPEED fine grained auth disallowing invalid requests before they waste resources.
Business Policy Driven: (Client and Trader Entitlements)
- Policy Enforcement Points (PEPs)
- Policy Administration Points (PAPs)
- Policy Decision Points (PDPs)

7 **QoS:** Optimized use of bandwidth given the geographic constraints that affect service quality. Cisco QoS Policy Manager assigns priority by message type based on business rules and time schedules; Cisco CSA compresses remote traffic optimizing limited WAN bandwidth.

8 **Support:** The resources must be easy to maintain. Thin configurations at the remote site enables a standard builds that can be maintained remotely.

9 **Shared Infrastructure:** Infrastructure should been shared for common services. Trading desks share infrastructure, such as caching or analytics engines; reduce datacenter sprawl, simplified cabling, and escalating costs.

10 **Performance:** Client facing Java applications must perform consistently. Supplement Java processing with a network attached JVM processor (Azul) which eliminates garbage collection pauses, accelerates inter-communications with <40ms response time and supplies 864 JVM cores / 768GB memory.

11 **Physical Connectivity:** Density of servers continues to increase. Cisco Unified I/O combines network and SAN connectivity into a single converged network adapter connected to a Cisco Nexus switch to run FCoE. Quality and Performance over FCoE is enabled via Cisco's Priority Flow Control (PFC) providing a lower cost environment with higher availability that is easier to maintain..

Decision Support Infrastructure Use Case

Day in the Life of Decision Support Systems

Decision support systems in financial services are critical to the viable operation of the institution as they provide layered sets of information for executives, traders, and compliance and risk officers so that they can perform timely actions to seize opportunities, defray risk and plan for the future. These systems must aggregate data from many sources and run models in order to provide information in a variety of formats and degrees of detail. Timeliness and accuracy are critical for all stakeholders. Decision support systems include various risk analytics, liquidity ratio calculators, general ledger, treasury projections, trading scenarios, asset allocation models and pricing applications. Some analytics must run during the day, others can only run at the end of the day after all trading is done; still others must incorporate a global view, and thus have multiple runs during any given day.

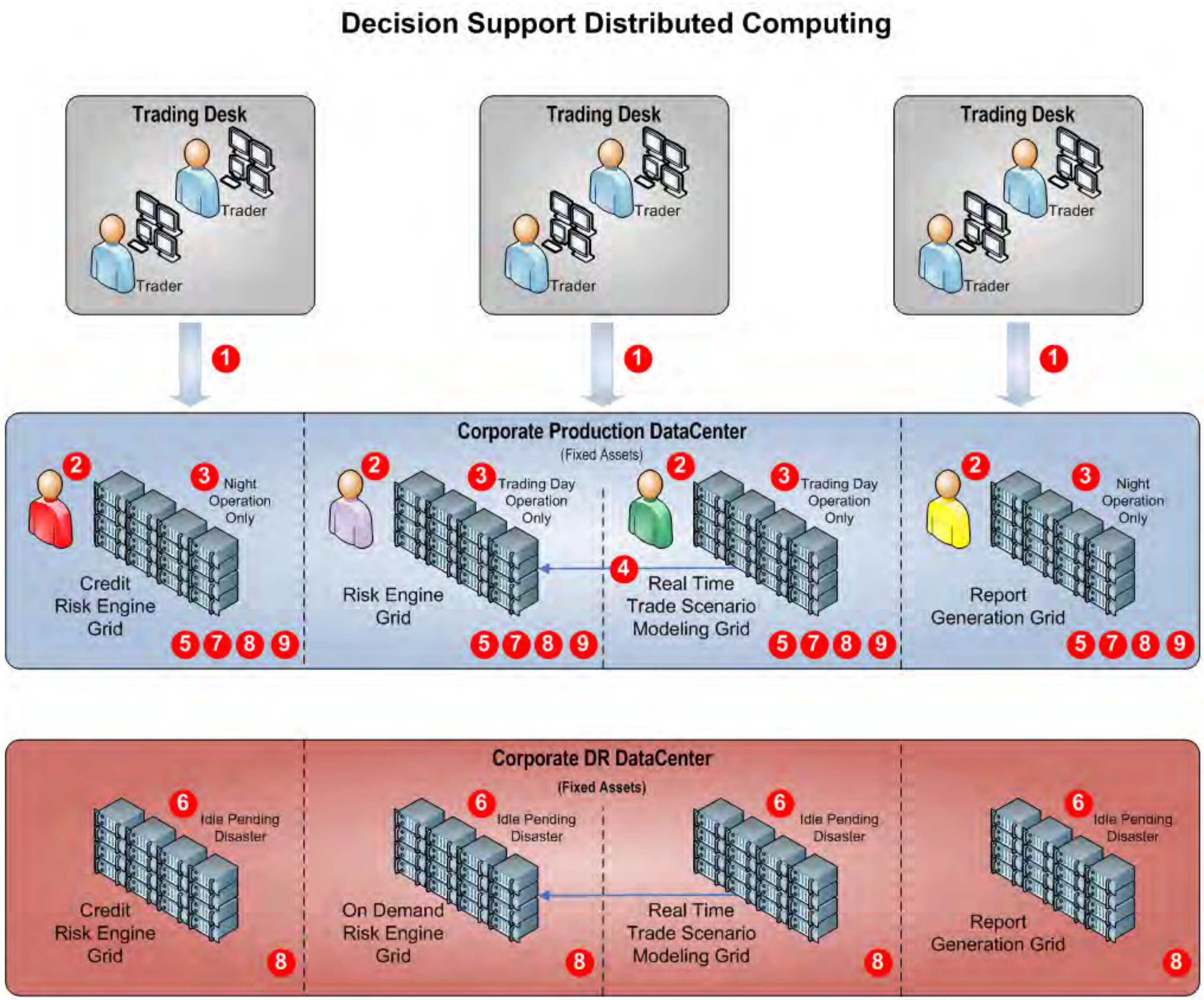
Requirements to Fulfill Decision Support Systems' Needs

Decision support systems must aggregate many large data sets (10 GB or greater) in multiple data formats. There is usually a tight operational time frame (2–6 hours at night) to process all of this information for one application. There are typically hundreds of decision support applications that run in a given night across an enterprise. Data must be transformed, processed, integrated and summary information produced in that short time frame. During daytime runs there are choices a service requestor can make about maximum time to calculate, number of iterations for accuracy, etc. Daytime analytics often must accept incoming data at rates in excess of 1,000 messages per second. These decision support systems often produce results in multiple formats with multiple destination points.

Problems and Consequences in Meeting that Need

The typical IT trend in grid computing has been to build project grids. Project grids have reached staggering numbers where a single project requires 2,000+ nodes to run risk analytics, or other intensive processing. These grids cannot be used for other types of processing because their configuration prevents reuse. In most cases the grids were designed with a single project in mind. These grids were not designed to be utilized by a variety of applications based on policy, to meet incoming demand or to be invoked based on an event.

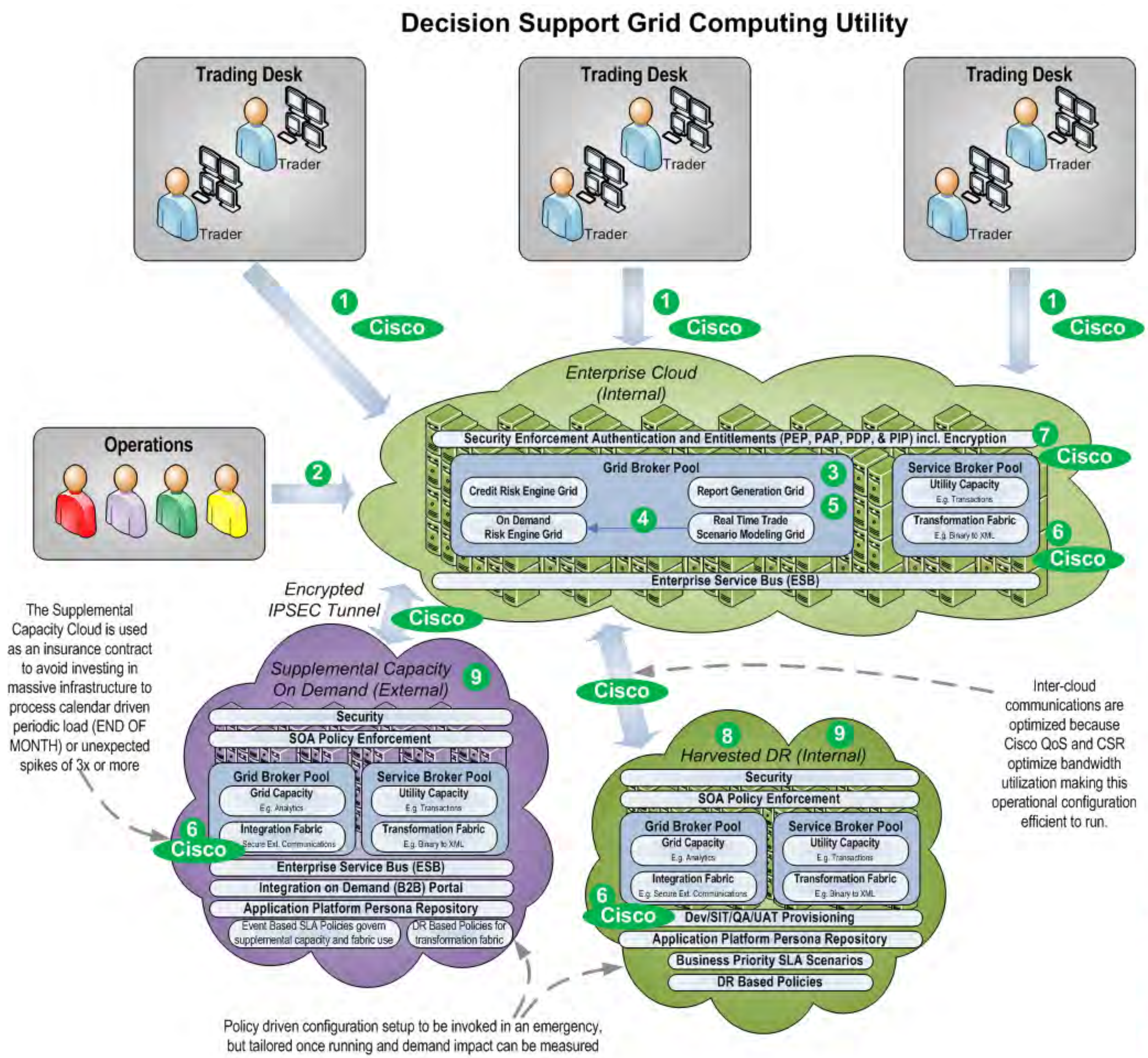
- **Datacenter Sprawl:** Inefficient use of heavily invested resources is a massive waste and drives up the cost of network, server, power, cooling and storage and devours precious datacenter space; all the while, more resources need to be bought because at peak usage individual grids run into performance problems.
- **Network Utilization:** The proliferation of project grids leads to excess bandwidth utilization, and the stress on datacenter floor space causes inefficient use of the network that project grids need so much of.
- **Growth Driver:** The current regulatory environment will drive the need for better risk metrics and continue to force individual grids to grow, even as the apparent utilization of resources continues to dwindle below 25%.
- **Lack of Business Alignment:** The grids do not expand proportionately with revenue, creating an alignment mismatch that starves agility.
- **Support Costs:** The skill set for grid maintenance is hard to find, driving support costs up.
- **Idle Capacity:** Grids are frequently set aside for disaster recovery, but lay dormant waiting to be utilized.



Problem Areas:

1. **Network:** High speed network traffic is required to meet demand as trading desks invoke multiple risk engines. Network congestion occurs due to large transfers of data from the trader workstation.
2. **Personnel:** Large grids require large staffs. Skills for similar problems are not easily shared because each application running in a dedicated grid has a unique configuration in common causes, which causes wasted opportunities to cross train and save money.
3. **Time of Day:** Many operations are only needed at certain parts of the day. The dedicated grids make it *not* possible to share infrastructure because each grid is uniquely configured to run on a specific set of servers.
4. **Performance:** Many resources collaborate during the various calculations. Efficiencies had by proximity of collaborating applications and related data are not guaranteed because fast growth has caused significant sprawl.
5. **Utilization:** There are hundreds to thousands of nodes in the grids. Each dedicated grid is sized to it's peak processing; when not running at a peak, the capacity lays dormant.
6. **DR Capacity:** A mirror of resources are allocated in case disaster strikes the Production DataCenter. Since DR resources are not dynamically allocated they sit idle pending a disaster.
7. **Security:** Access to resources must be secured. Security and permission measures are often ad-hoc, and manually checked only periodically.
8. **Physical:** There are hundreds to thousands of nodes in the grids. Extensive space and complexity for large cabling installations, compounded by rapid growth needs makes a spaghetti mess.
9. **Load Spikes:** There are spikes 2x-3x baseline peak that infrequently occur. Invest in additional and costly infrastructure or allow QoS to suffer.

Figure 5 - Traditional Decision Support Distributed Computing



Solutions:

1. **Network:** High speed network traffic is required to meet demand as trading desks invoke multiple risk engines. Network is utilization is reduced as data and services move into the datacenter.
2. **Personnel:** Large grids require large staffs. Skill for similar problems are easily shared because each application runs on grids dynamically allocated from pools of resources, which improves opportunities to cross train and save money.
3. **Time of Day:** Many operations are only needed at certain parts of the day. Each grid is dynamically allocated and right sized to the demand in real time, which makes it possible to share infrastructure as desired.
4. **Performance:** Many resources collaborate during the various calculations. Efficiencies had by proximity of collaborating applications are possible, as resources are easily localized due to the dynamic operation of the grids and distributed memory (Coherence) / disk (IBRIX) caching to optimize IO.
5. **Utilization:** There are hundreds to thousands of nodes in the grids. Each dynamically allocated grid is sized to it's current processing demand; unused capacity is available for other tasks.
6. **Physical:** There are hundreds to thousands of nodes in the grids. The Cisco Nexus switches combines network and SAN physical access, reducing complexity, connections, and hardware per server.
7. **Security:** Access to resources must be secured. Cisco Policy Manager and Policy Enforcement Points; Ensures WIRE SPEED fine grained auth disallowing invalid requests before they waste resources. Business Policy Driven:
   - Policy Enforcement Points (PEPs)
   - Policy Administration Points (PAPs)
   - Policy Decision Points (PDPs)
8. **DR Capacity:** A mirror of resources are allocated in case disaster strikes the Production DataCenter. Since DR resources are dynamically allocated they can be tasked with other work while not needed for a disaster and quickly brought to bear when there is.
9. **Load Spikes:** There are spikes 2x-3x baseline peak that infrequently occur. Dynamically tap supplemental 3rd party or DR cloud capacity to meet spikes.

Figure 6 - Cisco's solution for a Decision Support Grid Computing Utility

Application Delivery Use Case

Day in the Life of the Typical Employee in a Retail Brokerage Branch

The retail branch employee depends heavily on the branch workstation, as it supports the user experience for the corporation's clients while keeping employees in touch with the larger organization. Employees in branches perform many client-facing duties including arranging client advisory meetings, running seminars, running special statements, performing projections and initiating new accounts Retail branches are the representative of the larger corporation and thus enact the brand; therefore, it is critical that IT supports the branch in these efforts. Keeping employees informed of changes is critical in a larger corporation and thus employee self service is a vital part of ensuring consistency of process while capping costs for employee benefits.

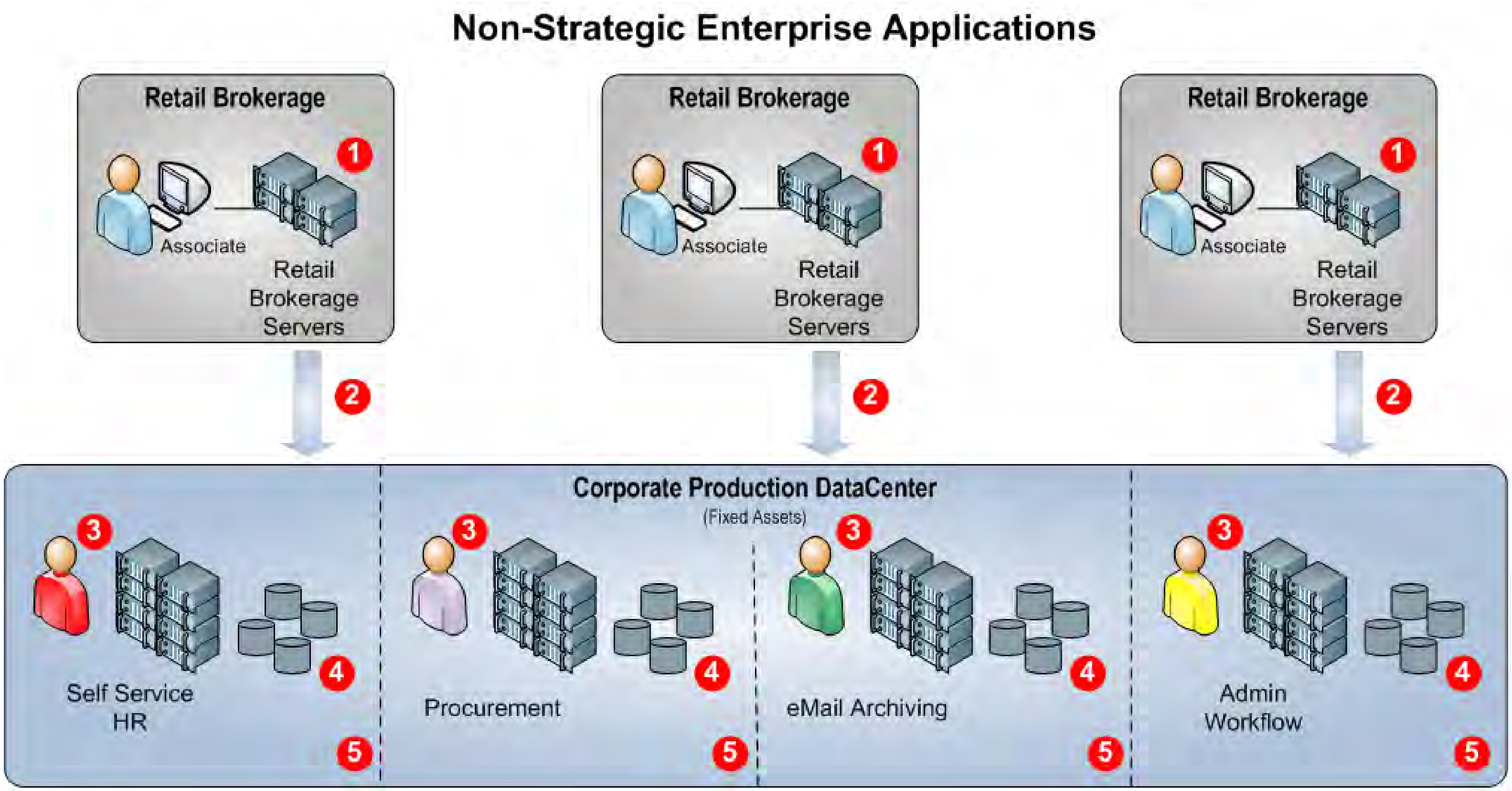
Requirements to Fulfill the Retail Branch's Needs

Retail branch personnel will need to support the CAMs in their efforts to provide differentiated service to clients, and thus must have some of the robust applications that CAMs do. In addition all employees need a suite a applications that the enterprise makes available to take care of procurement, general administrative duties, employee HR self service applications, compliance and reporting applications etc.

Problems and Consequences in Meeting that Need

The enterprise needs to provide a large array of applications that while important (e.g. HR self service, time sheets, on-line education) are not strategic to the firm's revenue generating goals. The traditional approach to providing these applications is to dedicate staff and resources to these applications in the enterprise datacenters. These applications must provide high levels of reliable service, and thus become significant investments in infrastructure, software and support personnel, even though they are not tied directly to revenue. There are problems that persist as a result of this traditional arrangement:

- **Administrative and HR Applications take Significant Resources:** Many important applications that must run reliably are not strategic to the business; they must run reliably with service performance levels of many client facing applications. There could be hundreds of applications that an enterprise will need to run for administrative or HR purposes. The cost of retooling the application platforms to meet demand as the company grows is rarely related to revenue growth. These applications are rarely built to share base infrastructure, so a company is forced to dedicate servers for each application.
- **Unstructured Data Archiving:** Branch desktops and branch servers often serve as local repositories for unstructured data. These platforms become overwhelmed with data that is generated.
- **Managing Patches and Software Updates:** Desktops with full applications need to have frequent updates to keep up with changes. Coordinating this take significant resources and is error prone.
- **Datacenter Sprawl:** If archiving for e-Mail and unstructured data is pushed to the datacenters for all branch activity, then the datacenter is stressed to manage the significant amount of data that grows at 40% per year in most large enterprises.
- **Collaboration Tools Investments:** Large enterprises will rely on video conferencing, webinar and other forms of collaboration more heavily as cost pressures in financial services mount. Managing this is not the core business of most enterprises and takes significant datacenter and infrastructure resources to run correctly. If they are not run correctly they will not be used.



Problem Areas:

1. **Time to Market:** Patches and Updates need to be rapidly deployed to the Retail Brokerages. Since the servers are remote, patches and updates are harder to execute and are prone to errors.
2. **Network:** Network bandwidth is limited to slow connection speeds at Retail Brokerages. Bandwidth is strained due to large amounts of data sent to servers.
3. **Personnel:** Operational support of the servers. Skills each type of technology employed by these non-strategic applications require large investments.
4. **Storage:** Enterprise storage is used to keep unstructured data. Growth rates of 40% per year takes up precious datacenter space.
5. **Security:** Access to resources must be secured. Exposure to organization is high from fragmented Data Storage Policies.

Figure 7 - Traditional Non-Strategic Enterprise Applications

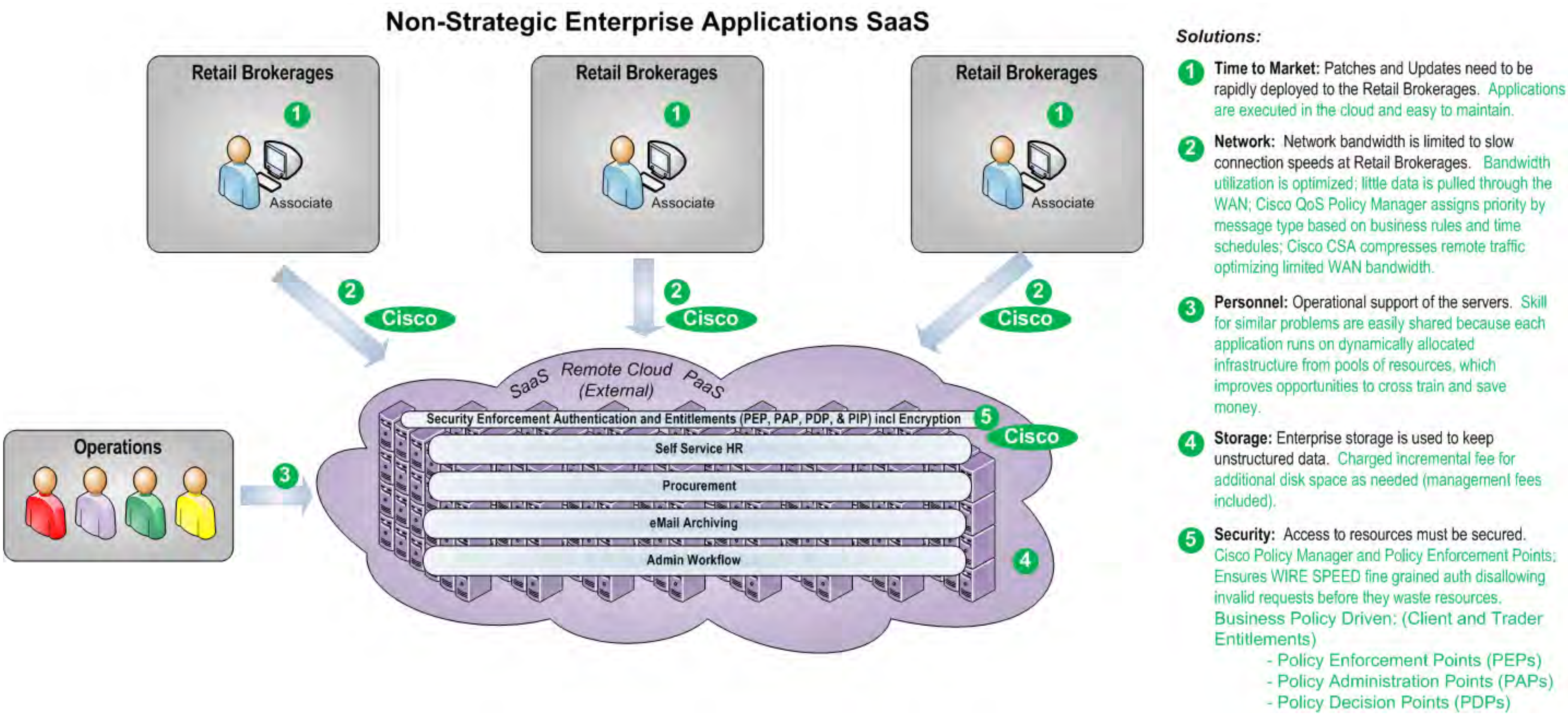


Figure 8 - Cisco's Solution for Non-Strategic Enterprise Applications SaaS

Work Shift Adjustment Use Case

Day in the Life of the Application Suites in an Enterprise

As has been highlighted throughout the previous use cases, financial services institutions rely on many different classes of applications and must comply with strict regulations in addition to considerable market pressure. These myriad suites of applications are critical to the operation of the institution, and each has unique operating characteristics that have typically led them to be constructed on dedicated platforms in order to optimize performance according to their unique operational qualities.

During the day applications run that provide the support for trading, sales, client account management, research, on-line client access and on demand risk. At night the organization changes focus to batch processes that calculate risk across the institution on many different levels (e.g., credit, market, and client) along with applications that run settlement and clearing operations. Compliance, audit, inventory, asset allocation, ledger updates, liquidity calculations and a suite of critical reporting functions (e.g., regulatory, client, management, etc.) are also required.

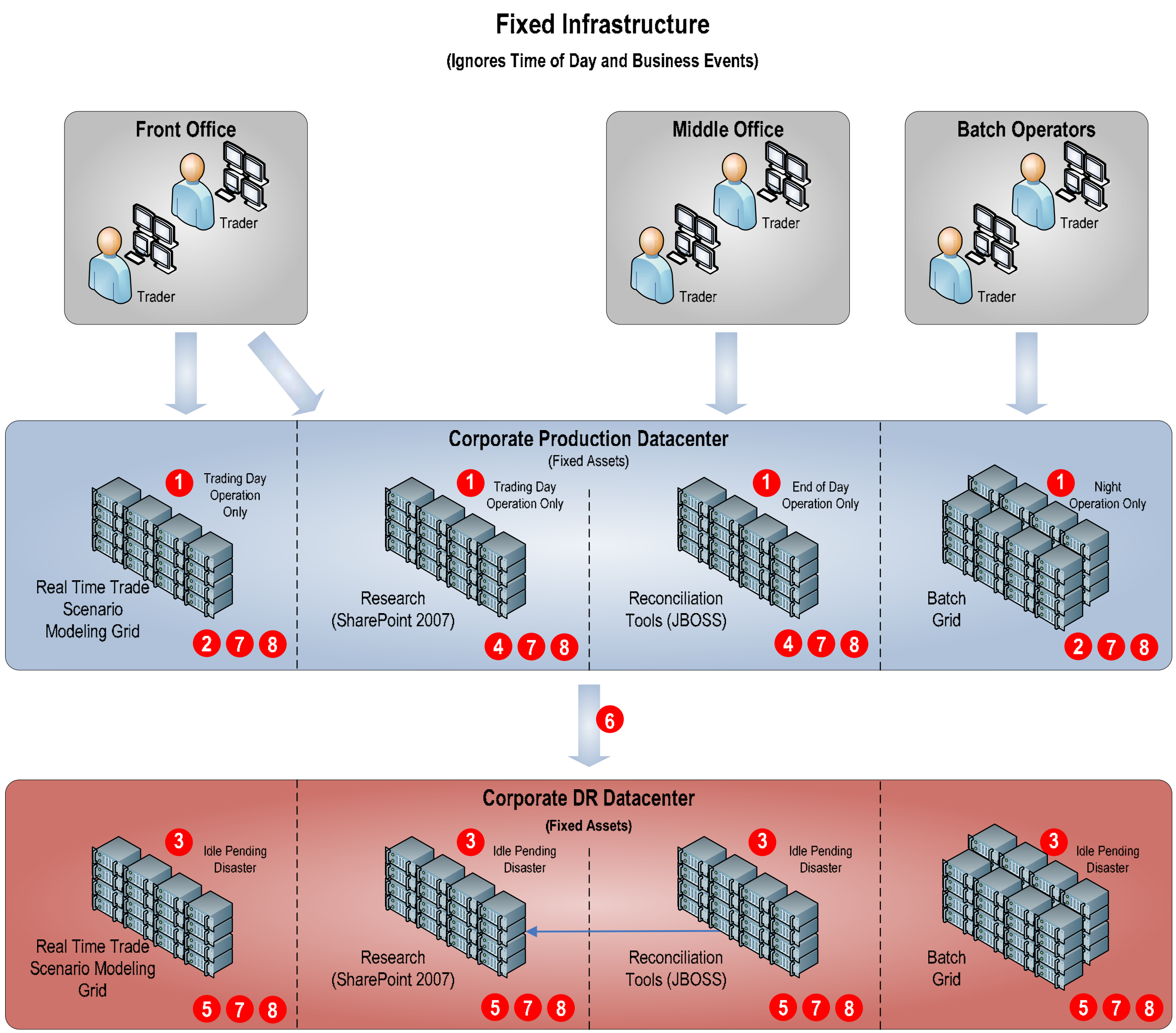
Requirements to Fulfill Decision Support System's Needs

The trading environment obviously requires high performance operating platforms, but functions that support risk, reporting and other back office operations also do. Collaboration tools have significantly reduced workflow processing, but at the cost of massive unstructured data proliferation and use of rich media which requires significant network bandwidth. Daytime operational requirements of low latency and tight response time are replaced at night by the need to perform massive calculations on gigabyte data sets that require high bandwidth. These calculations must be performed in very tight operational timeframes (2–6 hours) and are continually challenged with increased market volume. The need to finish end-of-day processes in one continent balanced with the active market on another. Real-time demand outpaces supply, which causes an extreme IT response.

Problems and Consequences in Meeting that Need

The typical response to meeting the different classes of demand for these critical applications has been to build dedicated applications per platform—to guarantee operational stability and performance. But that intent is rarely achieved because the demand continues to increase, while nightly timeframes shrink. The result is an ad hoc 2x–3x over-provisioning strategy for each platform that creates instability and wastes resources, but none of the dedicated platforms can be repurposed at off hours to off-load work from the current shift.

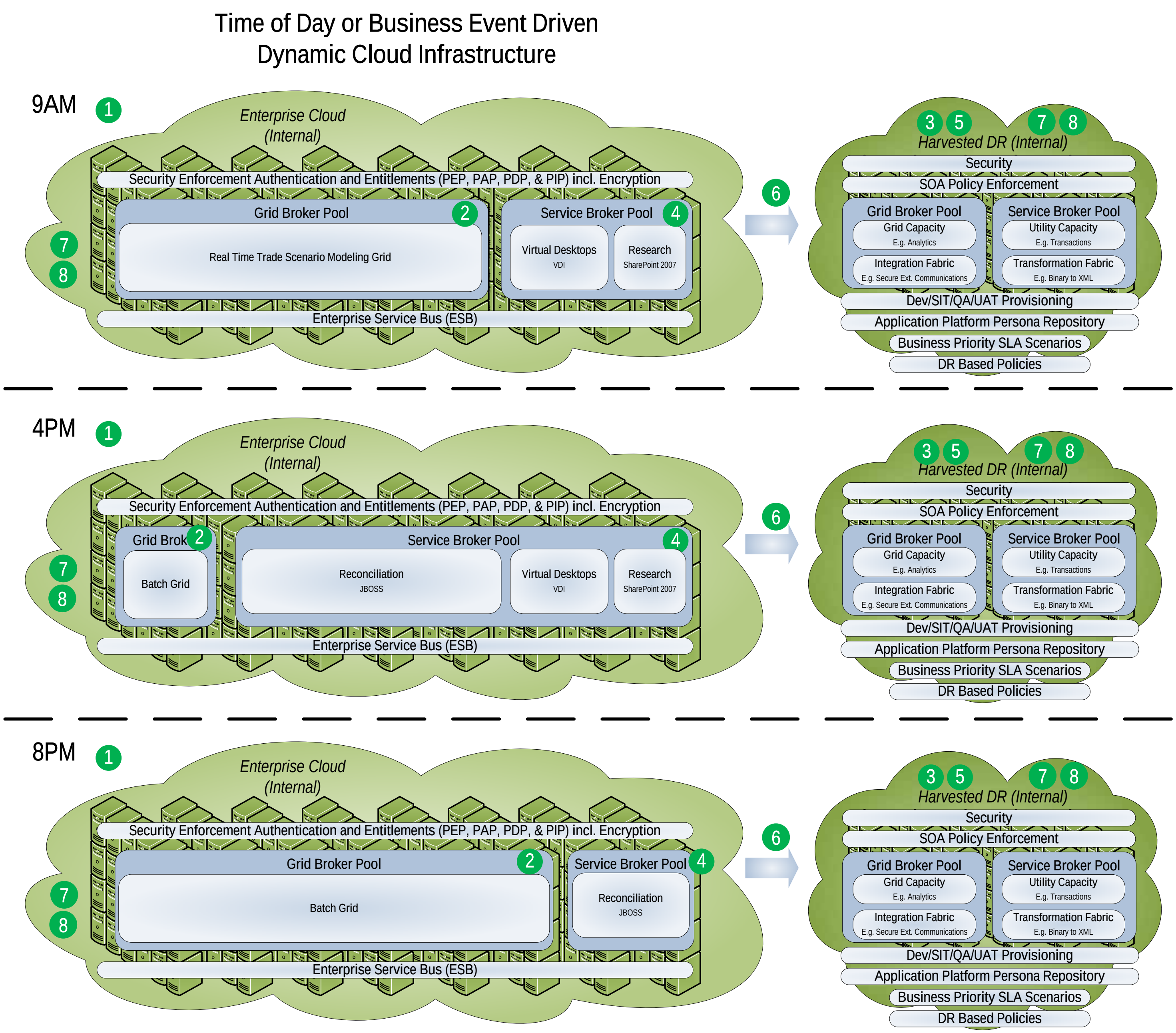
- **Datacenter Sprawl:** Inefficient use of heavily invested resources is a massive waste of network, server, power, space, cooling and storage; yet additional resources are always needed to meet application peaks.
- **Unstructured Data Proliferation:** Use of collaboration tools such as Microsoft SharePoint and MOSS increase network demand, while creating a massive data sprawl problem.
- **Lack of Business Alignment:** The applications do not grow in proportion to revenue, creating an alignment mismatch that starves agility.
- **Network Utilization:** The proliferation of hardware (CPU, memory, and disk) and the stress of datacenter floor space cause excessive and inefficient bandwidth utilization.
- **Support Costs:** The skillsets required for such diverse configuration maintenance are not leveraged across business lines, driving up costs.
- **Idle Capacity:** High performance resources lay dormant, while critical applications are resource starved.
- **Growth Driver:** The current regulatory environment will drive the need for better risk and reporting forcing individual applications to grow, even as the apparent utilization of resources continues to dwindle below 25% (when viewed from a 24-hour perspective).



Problem Areas:

1. **Time of Day:** Many operations are only needed at certain parts of the day. The rigidity of the software installs makes it *not* possible to share infrastructure because each grid is uniquely configured to run on a specific set of servers.
2. **Utilization:** There are hundreds to thousands of nodes in the grids. Each dedicated grid is sized to its peak processing; when not running at a peak, the capacity lays dormant.
3. **DR Capacity:** A mirror of resources are allocated in case disaster strikes the Production datacenter. Since DR resources are not dynamically allocated they sit idle pending a disaster.
4. **Specialization:** A heterogeneous environment of application servers is utilized in the environment. Resources are fixed, such that changing the application server type requires a rebuild.
5. **DR Assurance:** The DR environment must be tested regularly to validate its readiness. Patches and maintenance changes cause differences between DR and Production which are often missed due to the manual and time consuming execution of DR testing.
6. **DR Synchronization:** The timely movement of data files and configurations is critical to DR success. Achieving DR synchronization is difficult due to uncoordinated and arbitrarily large data transfers, which takes time to transfer.
7. **Connectivity:** Each server resource needs connectivity to the network. Layer 2 connections are treated independently leaving each resource to separately manage resiliency making recovery complex. Connections are not virtual machine aware causing contention.
8. **Network Management:** There are 10s to 100s of network switches that need configurations. Each switch must be independently managed which increases complexity and reduces resiliency. Limited support for Virtual Access Layer and Security Policies management.

Figure 9 - Traditional Fixed Infrastructure



Solutions:

1. Time of Day: Many operations are only needed at certain parts of the day. Each grid is dynamically allocated and right sized to the demand in real time, which makes it possible to share infrastructure as desired.
2. Utilization: There are hundreds to thousands of nodes in the grids. Each dynamically allocated grid is sized to its current processing demand; unused capacity is available for other tasks.
3. DR Capacity: A mirror of resources are allocated in case disaster strikes the Production datacenter. Since DR resources are dynamically allocated they can be tasked with other work while not needed for a disaster and quickly brought to bear when there is.
4. Specialization: A heterogeneous environment of application servers is utilized in the environment. Resources are dynamically allocated and can be spun up as any platform type.
5. DR Assurance: The DR environment must be tested regularly to validate its readiness. The automated provisioning and configuration of the DR environment facilitates this process; it is possible to automate this validation.
6. DR synchronization: The timely movement of data file and configurations is critical to DR success. Inter-cloud communications are optimized because Cisco QoS and CSR optimize bandwidth utilization.
7. Connectivity: Each server resource needs connectivity to the network. Cisco Nexus switches enable Layer 2 connectivity across Data Centers by leveraging the Nexus' Virtual Port Channel (vPC) feature. This increases resiliency with less complexity while providing enhanced support for VDI, virtual machines and DR mobility.
8. Network Management: There are 10s to 100s of network switches that need configurations. With Cisco Nexus switches as row and rack ends, an entire row can be managed from a single location, including the Virtual Access Layer and Security Policies thereby reducing complexity and increasing reliability.

Figure 10 - Cisco's Dynamic Cloud Infrastructure

Disaster Recovery Infrastructure Use Case

Day in the Life of Disaster Recovery Platforms

Disaster recovery (DR) platforms are a business and regulatory requirement for key financial service applications. Generally financial service institutions prioritize applications into tiers. In case of a disaster the most critical applications move first. Many of these critical applications collaborate heavily; therefore, moving a top-tier application may require lower priority applications to move as well. Application tiers are useful in determining how much of the standard production capacity must duplicated in the DR site, as providing 100% DR site infrastructure redundancy for all applications is neither cost effective nor feasible.

Traditionally DR platforms remain idle waiting for a disaster event to happen. The idea is that by having the 'warm' infrastructure standing by, confusion will be minimized and therefore so will recovery time. The flaw in this approach is that on the production side demand continues to grow, and so do software changes. In many cases it is very hard to maintain an exact copy of the current production configuration, guaranteeing that confusion will occur, even as the hardware sits idle to avoid that confusion.

Requirements to Fulfill Disaster Recovery System's Needs

The operational needs are dictated by each application, but there are needs that transcend all applications. Every DR system needs updated start-of-day information delivered every night. Any overnight preparation needs to be run, just in case a disaster strikes. If the configuration of the primary application changes, then the DR system must receive it—the same applies to patches and software upgrades. In the average week of an application, changes could be numerous; all changes for all applications must be processed in preparation for the next day. Ideally, new configurations should be tested at the DR site when the change occurs, not when DR needs to be invoked. Finally, the DR site should be invoked and tested or even become primary on a periodic basis to ensure that processes remain relevant for operations. Maintaining DR facilities is very expensive, so consideration should be given to using internal DR sites for the highest priority applications while renting external DR facilities with contracted SLAs for lower priority applications. Another alternative is to consider a mixed DR scenario where multiple sites assume part of the DR responsibility, and N+1 model, but that requires a level of maturity that will allow DR to be available from multiple locations, which is more complex in traditional operating environments

Problems and Consequences in Meeting that Need

DR systems have all the normal operational constraints faced by the primary in traditional IT arrangements. What makes DR unique is the extra burdens imposed by the following.

- **Limited capacity yields unknown performance constraints, while most DR sits idle:** most DR systems are given the same capacity as the primary; therefore, the performance limits are not well known. Meanwhile, all DR systems are built as dedicated and stand alone, with no ability to share the infrastructure
- **Getting end of day data in a timely manner:** DR sites are remote from the primary, but need all changes to files and all data to run start of day. The sending of files to DR is typically ad-hoc and lacks priority or structure. The amount of data that needs to be sent on a given night could be hundreds of gigabytes, clogging WANs. Sent as the primary application is ready, there is no guarantee that high priority applications will successfully complete their transmission.
- **Utilization is poor**: there is reluctance to leverage remote DR for testing, UAT, or other independent tasks as the risk of not responding to a DR situation is too great.
- **DR assurance and Environment matching**: there is no guarantee that all changes from the primary have been properly applied to the DR platform. Routine testing is not done often enough and periodically alternating primary/DR responsibilities between sites is rarely considered as feasible.

Traditional PoC, Performance, UAT, and Development Environments

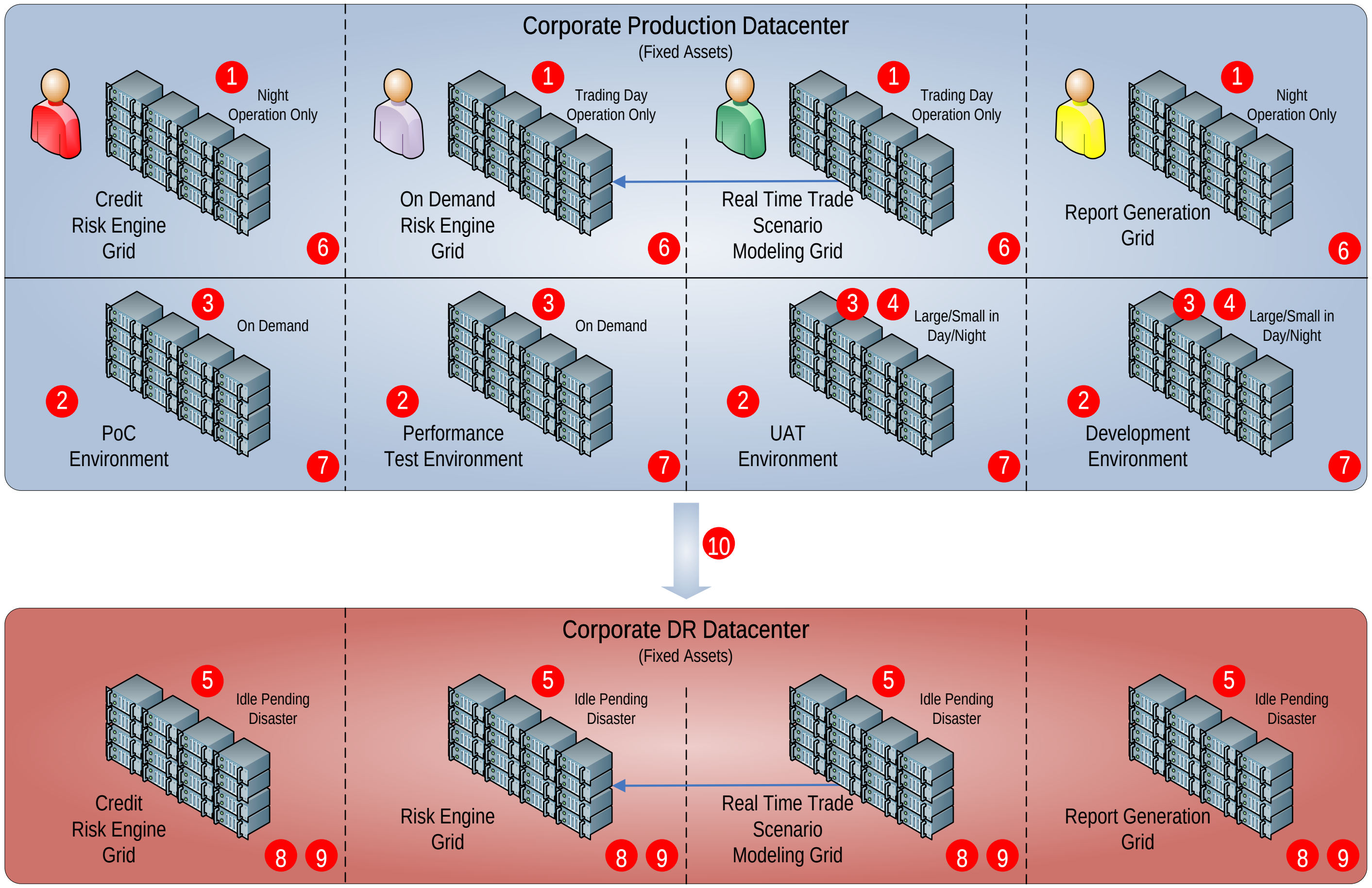
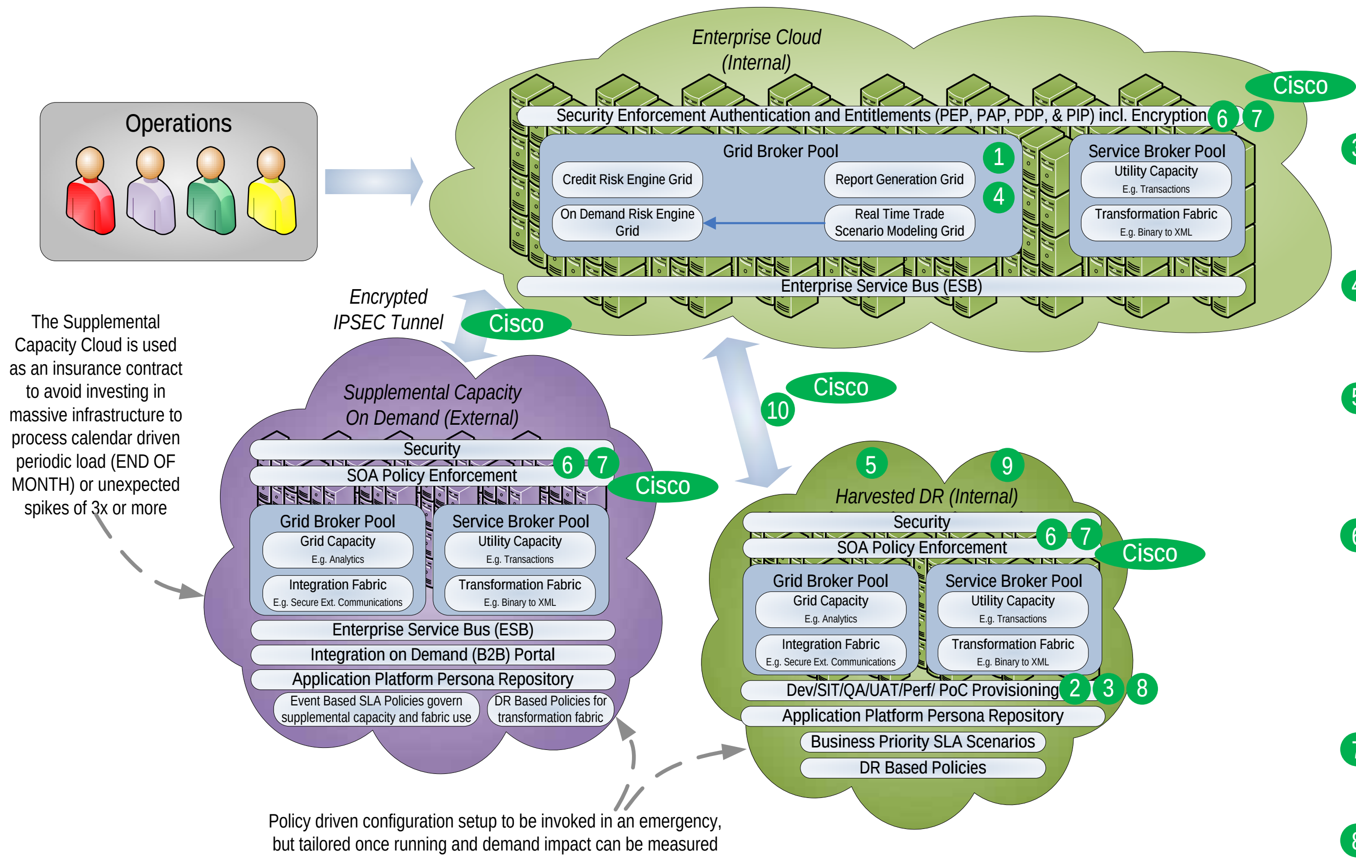


Figure 11 - Traditional PoC, Performance, UAT, and Development Environments

Problem Areas:

1. Time of Day: Many operations are only needed at certain parts of the day. The dedicated grids make it *not* possible to share infrastructure because each grid is uniquely configured to run on a specific set of servers.
2. Resiliency: The availability of the PoC, performance testing, UAT, and development environments is critical to meeting promised development deadlines. A failure of any piece of equipment or mis-configuration can cause large delays while the problem is repaired.
3. On Demand: PoC and performance test environments are temporary in nature and are only needed for short periods of time, but must be able to be brought online when needed. Environments are static and costly/time consuming to stand up and tear down.
4. Utilization: UAT and development environments tend to be heavily utilized in the day, but not at night. Environments are static and can't grow or shrink easily as needs change.
5. DR Capacity: A mirror of resources are allocated in case disaster strikes the Production datacenter. Since DR resources are not dynamically allocated they sit idle pending a disaster.
6. Security: Access to resources must be secured. Security and permission measures are often ad-hoc, and checked only occasionally by manual effort
7. Security: The development teams should have access to a standardized security model to develop against. No security standardization exists so developers create ad-hoc solutions.
8. Environment Matching: The test and load environment should replication production as closely as possible. Due to the cost, this rarely is possible.
9. DR Assurance: The DR environment must be tested regularly to validate its readiness. Patches and maintenance changes cause differences between DR and Production which are often missed due to the manual and time consuming execution of DR testing.
10. DR Synchronization: The timely movement of data files and configurations is critical to DR success. Achieving DR synchronization is difficult due to uncoordinated and arbitrarily large data transfers, which takes time to transfer.

Harvested PoC, Performance, UAT, and Development Environments



Solutions:

1. Time of Day: Many operations are only needed at certain parts of the day. Each grid is dynamically allocated and right sized to the demand in real time, which makes it possible to share infrastructure as desired.

2. Resiliency: The availability of the PoC, performance testing, UAT, and development environments is critical to meeting promised development deadlines. These environments now run within the DR harvested cloud, which self heals if a failure occurs; Environment is available except for when a full fledged disaster occurs at which point it is not needed.

3. On Demand: PoC and performance test environments are temporary in nature and are only needed for short periods of time, but must be able to be brought online when needed.. Environments are dynamic and cost efficient / available on demand.

4. Utilization: There are hundreds to thousands of nodes in the grids. Each dynamically allocated grid is sized to its current processing demand; unused capacity is available for other tasks.

5. DR Capacity: A mirror of resources are allocated in case disaster strikes the Production datacenter. Since DR resources are dynamically allocated they can be tasked with other work while not needed for a disaster and quickly brought to bear when there is.

6. Security: Access to resources must be secured. Cisco Policy Manager and Policy Enforcement Points; ensures WIRE SPEED fine grained auth disallowing invalid requests before they waste resources.
   Business Policy Driven:
   - Policy Enforcement Points (PEPs)
   - Policy Administration Points (PAPs)
   - Policy Decision Points (PDPs)

7. Security: The development teams should have access to a standardized security model to develop against. Cisco Policy Manager and PEPs are a standardized security model.

8. Environment Matching: The test and load environment should replication production as closely as possible. Harvested DR resources that facilitate the duplication of the production environment makes it easy to accomplish this.

9. DR Assurance: The DR environment must be tested regularly to validate its readiness. The automated provisioning and configuration of the DR environment facilitates this process; It is possible to automate this validation.

10. DR synchronization: The timely movement of data file and configurations is critical to DR success. Inter-cloud communications are optimized because Cisco QoS and CSR optimize bandwidth utilization.

Figure 12 - Cisco's Harvested PoC, Performance, UAT, and Development Environments

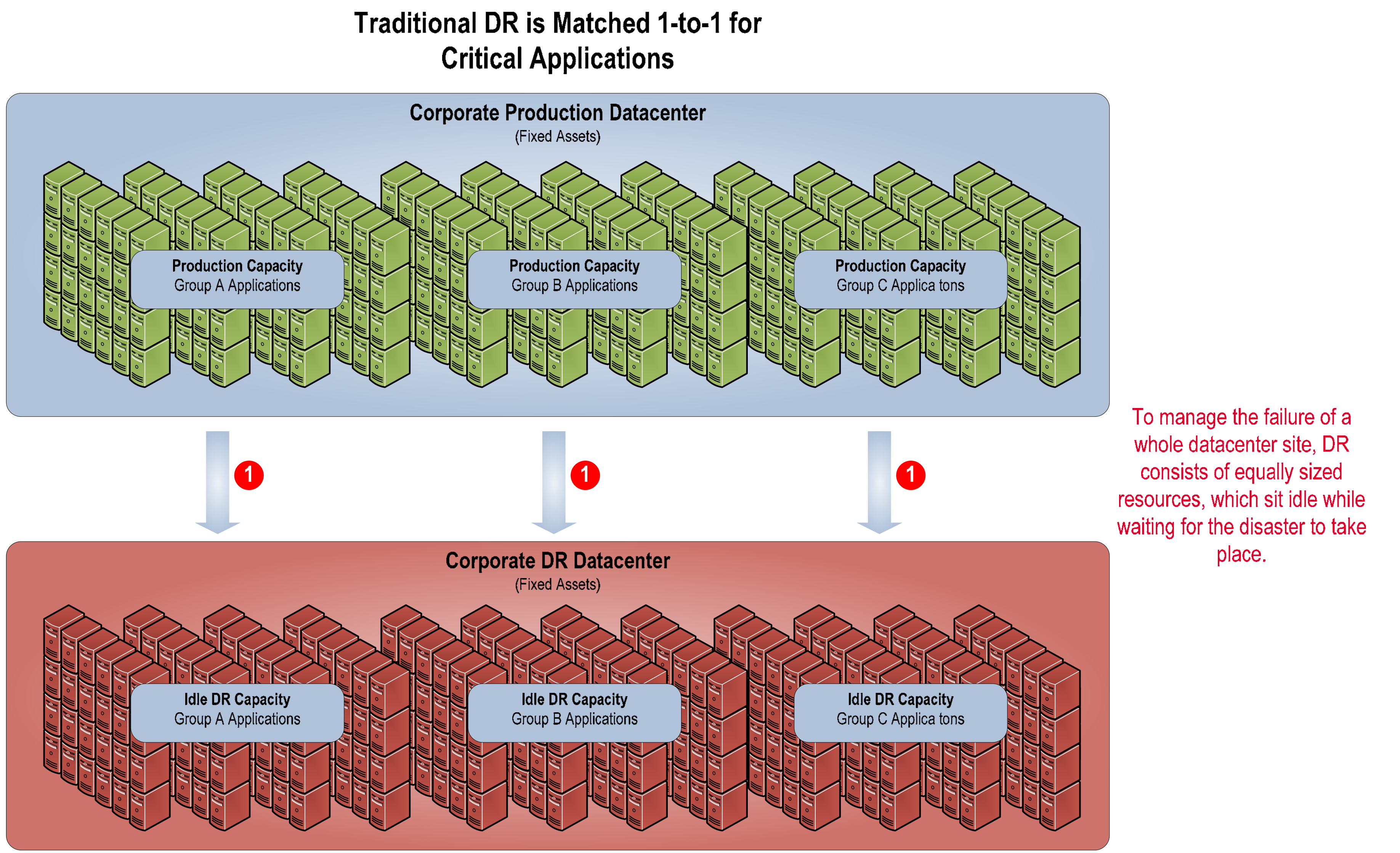


Figure 13 - Reduced DR Footprint with Multiple Production Cloud Locations

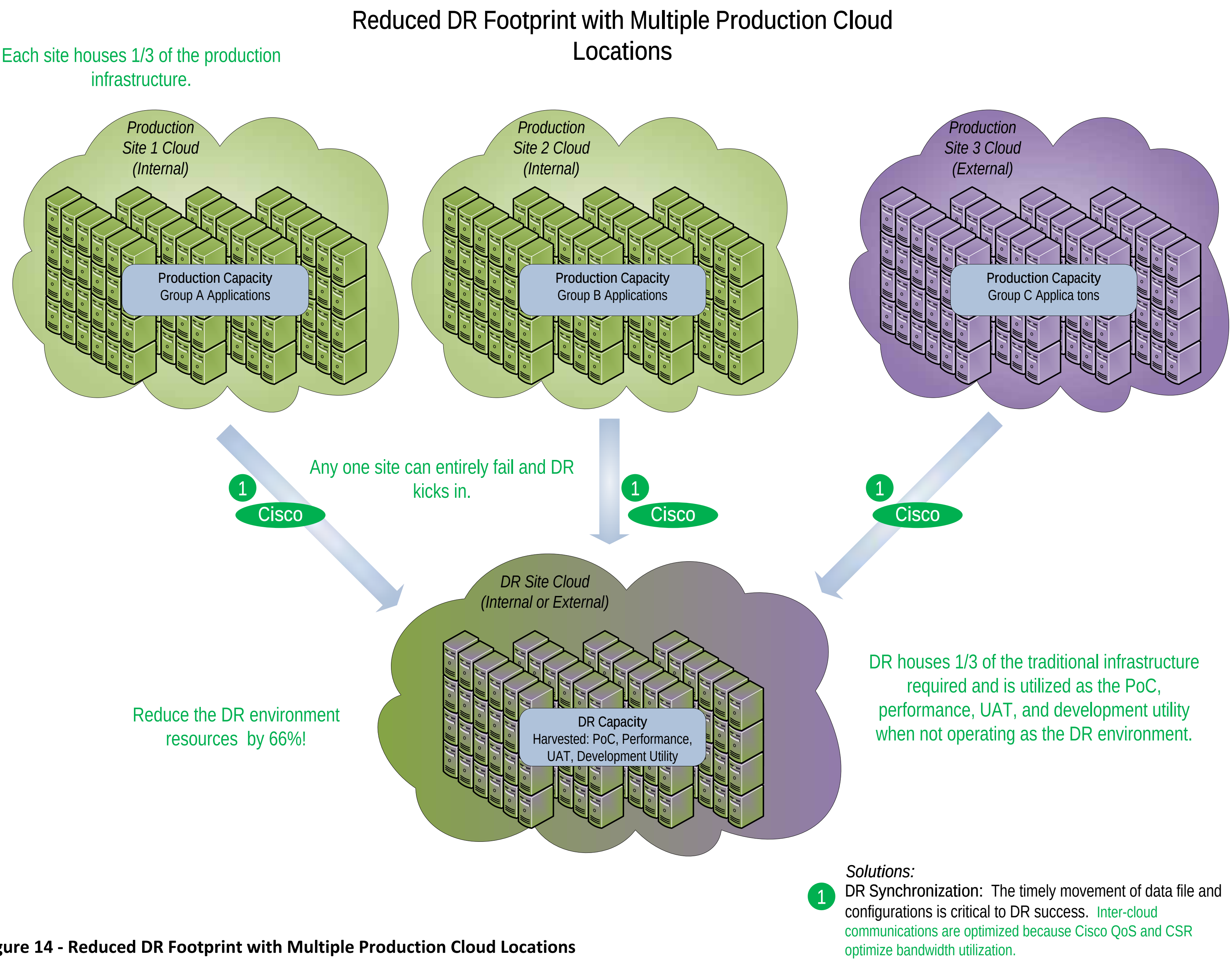


Figure 14 - Reduced DR Footprint with Multiple Production Cloud Locations

Cisco Cloud Enablement Strategy

Cisco, in conjunction with a few select partners, has pulled together all the building blocks needed to rapidly deploy or transform existing resources in to cloud based infrastructures. Delivered as tailored ensembles, they are well positioned to enable, enforce and secure he full spectrum of operational qualities that will meet the required SLAs of a real-time enterprise.

Workload Mobility

- **User Experience:** Tailored entitlement and collaborative tools (IM, video, etc.) to provide rich and fast interactive interfaces that are safe, open architecture, simple, virtualized and converged.
- **Deployment:** Dynamic real time and on demand delivery of resources so they are put to work where needed, as needed.
- **Virtualization:** A broad view of virtualization provides a Unified Computing platform to include the full breadth of servers, network and data to dynamically manage abstracted infrastructure, platform and software services, including the use of Scalent VOE, FabricServer™, GridServer®, VMWare, etc**.**

Security and Control

- **Security and Integration:** Authentication, role authorization, and fine-grained authorization through Cisco ACE and Cisco Policy Manager (PEP/PAP/PDP/PIP) plus ESB functionality to ease integration.
- **Service Execution:** Cisco is a certified partner with DataSynapse; the premiere vendor for fabric and grid solutions. This provides a Unified Fabric for service execution enabling resources to be dynamically repurposed.

Integration and Interoperability

- **Data / Content Delivery:** Comprehensive Data Center Networking (Switches, routers, handlers, protocol accelerators, edge computing and content caching devices) operating at wire speeds to provide flexible high-performance dynamic data delivery within both Inter-cloud and Enterprise-class cloud infrastructures to meet business demand.
- **Transaction Processing:** Low latency, high throughput, high availability connectivity with reduced hops and as needed transformation acceleration to facilitate efficient and performing resource inter-communications.
- **Cost to Execute:** Leverage use of virtualization, abstraction, and simplifying technology (such as fiber channel over ethernet—FCoE) to deploy less Infrastructure and execute more transactions with less People.

For a more detailed look at products and venders, please refer to Appendix A

Table 2—Cloud Technology and Product Domains.

Next Step: Contact Cisco

Our approach helps firms quickly establish a strong foundational cloud core. This can be leveraged to drive mass customizable, reusable building blocks of new IT capabilities that differentiate qualities of user experience while achieving new levels of lean efficiencies. We institute a sustainable culture of continuous innovation for new business capabilities through IT.

Our offerings arm firms with tools necessary to enable the Service Orientation of IT Operations. We build these capabilities through:

- **Playbooks:** Aligning IT Strategy with Business Value; Multi-Year Strategic Platform Roadmaps; Creative Funding Models; Cloud Computing Strategies, Change Management Strategies; Packaging and Promotion of Service Offerings; Engineering Performance into Critical Systems; Legacy Infrastructure Transformation; Datacenter in a Box Strategy
- **Execution Blueprints:** Business Use Cases/IT Strategies; Workload Patterns/Optimized Architectures; Infrastructure Patterns/Intuitive Deployment Models; Service Oriented Architectures/Service Oriented Infrastructures; Cloud Utility/Applications; Information and Infrastructure as Dynamic Services
- **Operating Models:** Strategy and Architecture Program; Service Offerings/Product Management; Portfolio Management; Service Delivery/Service Support

Appendix A

Table 2—Cloud Technology and Product Domains

Cloud Domain	Asset Type	Function	Vendor	Technology	Problem Addressed
Network Security	Policy Enforcement Firmware on Network Appliance	Policy Manager and Policy Enforcement Points; ensures WIRE SPEED fine grained auth disallowing invalid requests before they waste resources. Business Policy Driven: (Client and Trader Entitlements) - Policy Enforcement Points (PEPs) - Policy Administration Points (PAPs) - Policy Decision Points (PDPs)	Cisco	Cisco Enterprise Policy Manager	Security policies are no longer application point solutions, fine grained authorization performed based on roles from Human Resources database. Third party authentication possible.
Network Service Differentiation	Service Policy Software on Switch	QoS policy manager prioritizes traffic flow based upon message type to ensure highest value messages get top priority during heavy network use.	Cisco	Cisco QoS Policy Manager on Switch	Optimizes traffic during network spikes, ensuring timely delivery of critical messages, limits the degree of over-provisioning required for period spikes.
Network Optimization	Network Compression Device	Optimize bandwidth utilization through compression of all traffic, compression occurs at wire speed.	Cisco	Cisco Compression Device	Reduces bandwidth utilization during peak traffic, avoiding excessive investment to handle periodic spikes.
Collaboration	Appliance	Improve collaboration and drive new business models, by adapting customizing content for different video needs while making sure that the network does not become overloaded.	Cisco	Cisco Media Experience Engine 3000®	Provides a media processing platform for user-generated content. It provides a turnkey solution for extending the reach and relevance of communication within organizations. • Media adaptation functionality enables users to view any media content on any end-point device. Media files can be shared easily between digital signage, desktop video, mobile devices and other applications. • Editing and production capabilities allow users to customize content with company logo overlays, transitions, file clipping, and color and video quality enhancements.
Collaboration	Appliance	Enable the enterprise to become more collaborative through better interaction technologies that support mobility.	Cisco	Unified Communication Manager	Cisco Unified Communications Manager is an enterprise-class IP telephony call-processing system that provides traditional telephony features as well as advanced capabilities, such as mobility, presence, preference and rich conferencing services.

Cloud Domain	Asset Type	Function	Vendor	Technology	Problem Addressed
Mediation	Service Bus	A multi-protocol service bus that transforms formats at wire speed.	Cisco	ACE XML Gateway	Makes fast asynchronous, secure web services feasible. Offloads large xml translations from servers, saving 40% cup utilization.
Operating Platform	Blade Rack Storage	Dense compute and storage with vertical cooling.	Verari	Vertically Cooled Blade Racks	Floor space, power, cooling requirements significantly reduced; exploiting the fact that heat rises.
Operating Platform	Multi-core CPUs	Allows multi-threaded applications to run simultaneously on one chip. Can also multiple single threaded applications to run on one chip.	Intel	Multi-core CPUs	Allows applications to run more efficiency, using less power, increasing throughput.
Operating Platform	Network Attached Appliance	Provides virtually transparent access to 800+CPUs and 700+ GB memory which can be shared by multiple platforms running Java (e.g. Sun< IBM, HP SNMPS and any blade rack). Provides 140 GB/sec inter-JVM communication.	Azul	Azul Vega™ 3 Network Attached Processor	Eliminate java application garbage collection pauses increase throughput by 10x, reduce floor space, and cooling requirements, reduce inter JVM communication, improving response time.
Network Dependency Awareness	Network Discovery Appliance	Automatic discovery of application relationships across a network, with detection of incremental changes.	Tideway	Tideway Foundation™	Foundation maps business applications to their underlying physical and virtual infrastructure, making it possible to see exactly how the infrastructure supports the business. It automatically discovers configuration items across disparate technology layers (e.g. business applications to switches) capturing all dependencies. It provides the information in a single, automated view. This transparency provides the ability to slash costs, reduce risk and manage change.
Provisioning	Software	Bare metal provision of application personas.	Scalent	Scalent VOE	Guaranteed application server deployment s service levels, automation of deployments reduce error, reduce deployment time.
Resource Allocation	Software	Real time dynamic demand driven resource allocation based on business policy and need. Container lifecycle is managed to provide optimal resource.	DataSynapse	Dynamic Application Service Management™	Provide resources on demand based on business policy. Resource allocating becomes fluid so that as peak changes, resources can be reallocated

Domain	Asset Type	Function	Vendor	Technology	Problem Addressed
Virtual Processing	Software	Provide real-time allocation of workload to optimize resources based on business policy, workload demand.	DataSynapse	GridServer®	Policy based execution of workloads based upon real time demand, adaptive service provisioning and self managed environment.
Virtualized Operating Platform	Software	Provide a virtualized environment that allows an application to be run on a variety of platforms.	VMWare	VMWare ESX®	VMs can be allocated to run in minutes across a set of platforms and operating systems.
Interface	Software	Provide a facility to give internet-based applications an immersive look and feel.	Adobe	Flex®	Creates engaging, cross-platform rich Internet applications. Flex is a framework for building and maintaining expressive web applications that deploy consistently on all major browsers, desktops, and operating systems.
Transaction Performance Management	Software	Provide a uniform view of the resources a transaction consumes across all tiers of operation.	Precise	Precise™	Precise provides a consolidated view of resource consumption by transaction type, which helps an enterprise understand the consequences of meeting demand.
Monitoring	Software	Find out the latency of every transaction as it is processed across tiers.	Optier	CoreFirst®	Optier CoreFirst traces the latency of every single transaction in real time, providing very accurate assessments of where a transaction spans most of its time.
Predictive Analysis	Software	Provide predictive analysis of possible failures through real time correlation of events.	Integrien	Alive™	Provided predictive analysis of problems in real time, enabling operations to be proactive about upcoming failures.
Consumption Reporting	Software	Provide consolidated resources consumption reporting.	Evident	Evident ClearStone™	Provides cross domain reporting and analytics across heterogeneous infrastructure and application stacks. Evident ClearStone meters, aggregates, normalizes, correlates and enriches usage information from multiple sources including compute grids, off-grid servers, data grids (data cache) and the enterprise network infrastructure.
Data Access Transparency	Software	Achieve data federation of disparate sources to provide better access for all information stakeholders in an organization without the continual massive movement and duplication of files.	Composite	Composite Discovery and Information Center™	With Composite you can access and combine data from disparate data sources including packaged applications such as SAP, custom applications, data warehouses, XML data stores, and more. Composite lets you deliver a greater breadth of information on demand to a business intelligence tools and a variety of composite applications such as call center and customer self help systems.

Domain	Asset Type	Function	Vendor	Technology	Problem Addressed
Distributed Data Caching	Software	Provide distributed caching to improve application performance.	Oracle	Coherence®	Coherence provides distributed transactional caching and Object / relational transaction to ensure performance and integrity of distributed applications.
Operating Platform	Software	Provide a scalable enterprise files system that is secure and reliable while accelerating access time.	IBRIX	IBRIX Fusion®	An enterprise-class file serving software suite that includes a highly scalable parallel file system with data protection, high availability features, and a comprehensive management interface. Because the product is software only it can be installed on any server with connection to any storage device, and customers can avoid vendor lock-in by selecting best-of-breed hardware.
Network Optimization	Network Switch	Provide a switch that optimizes traffic across the entire infrastructure., eliminating contention between disk and IP traffic	Cisco	Nexus 2000™ Nexus 5000™ Nexus 7000™	The Cisco Nexus Series is a modular switching system designed to deliver 10 Gigabit Ethernet and unified fabric in the data center. This new platform delivers scalability, continuous operation, and transport flexibility. The Nexus switches combines network and SAN physical access to enable FCoE via Unified I/O and Priority Flow Control, reducing complexity, connections, and hardware per server. They also enhance and centralize management capabilities for the Virtual Access Layer (VAL) and security while support spanning Layer 2 connectivity across data centers reducing configuration complexity.

Appendix B –Nexus Switch Features

Priority Flow Control

In order support Fibre Channel frames over Ethernet (FcoE), no frames can be dropped throughout the entire transmission. Priority Flow Control (PFC) extends the granularity of IEEE 802.3x PAUSE to accommodate different priority classes. With the capability to enable PAUSE on a per-user-priority basis, a lossless lane for Fibre Channel can be created while retaining packet-drop congestion management for IP traffic. This mechanism allows storage traffic to share the same link as non-storage traffic. PFC uses IEEE 802.1p class of service (CoS) values to map traffic to a particular virtual lane. A link is divided into eight lanes, and PAUSE can be applied on a single lane and not affect the other lanes. The IEEE 802.1p standard allows allocation of resources according to user priority. Products with the PFC function allow administrators to assign resources, including buffers and queues, based on user priority, resulting in a higher level of service for critical traffic where congestion has the greatest effect.

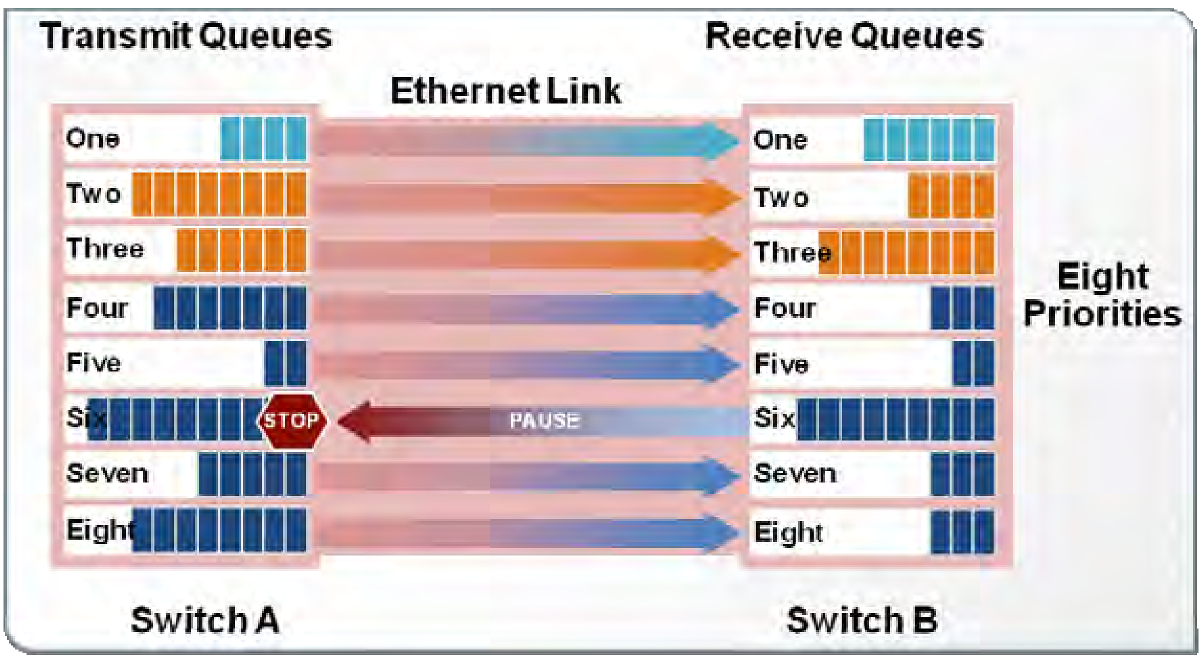


Figure 15 - Priority Flow Control

Additional information on FCoE is available at:

http://www.cisco.com/en/US/solutions/collateral/ns340/ns517/ns224/ns783/white_paper_c11-462422.html

POD Architecture Management Benefits

The POD architecture with the Nexus 2000 Fabric Extender and Nexus 5000 switches solution allows a simple way to reduce complexity and manage an entire row of compute nodes via two central switches. The architecture also provides deterministic latency between any nodes in the entire row vs the tradition rack unit. The Virtual Access layer model allows the Edge of the network to be virtualized to create an environment where independent racks can be deployed on-demand with “zero-touch” configuration at the rack-level. In a cloud environment, scaling workload becomes much easier and OPEX is dramatically decreased through a flexible architecture. The different rows can be consolidated into Nexus 7000 Aggregation switches provide high density compute farms with high availability. The Aggregation switches can be configured with Virtual Device Contexts to logically partition rows where each row is dedicated to a different client. Virtualization of the Nexus 7000 allows complete robust isolation of traffic so multiple tiered services can be offered with no compromise to performance and security.

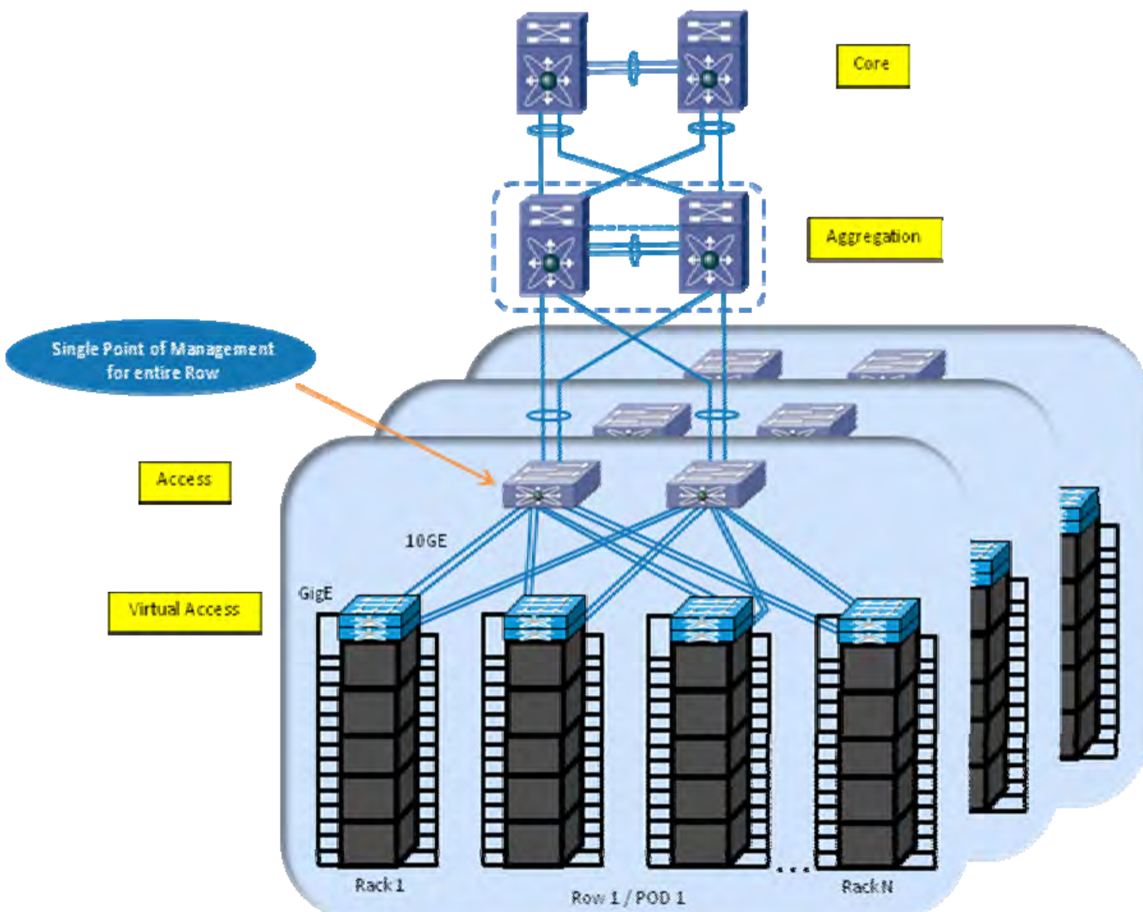


Figure 16 - POD Architecture Configuration

Layer 2 Data Center Interconnect

In order to provide resiliency for Virtual Machine mobility and clustering services across multiple data centers, there are increasing requirements in the cloud to allow stretched Layer 2 connectivity between sites. In lieu of implementing MPLS and managing the complexity of the protocol and configurations, the Virtual Port Channel (vPC)feature of the Nexus 7000 platform can be used to provide the Layer 2 data center interconnect with which does not depend on spanning-tree for forwarding traffic. Each pair of Nexus 7000 in a vPC domain appears as 1 logical entity from a peering perspective. The vPC feature increases higher resiliency from the server Access layer in the data center since one Nexus 5000 switch can create a logical port-channel across two Aggregation switches. Higher resiliency and quick failover mechanisms enable flexible and resilient architecture to support environments such as VDI and cluster services.

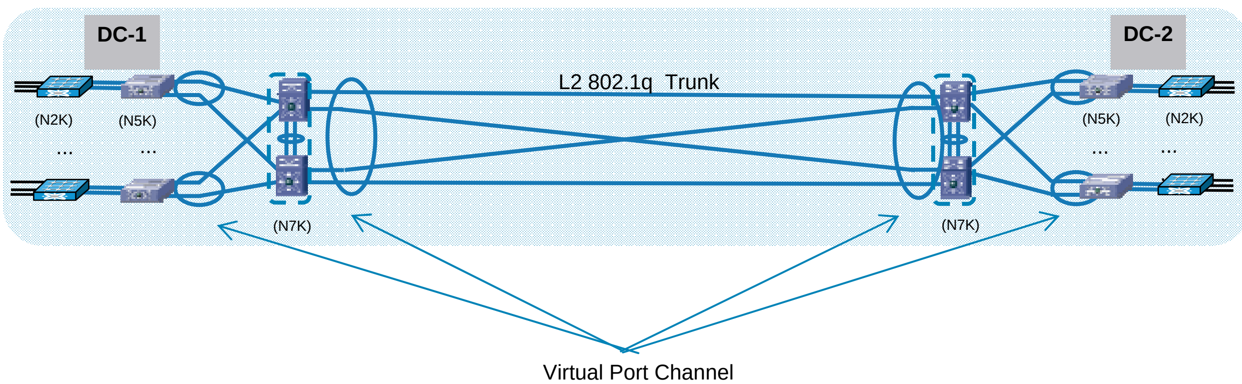


Figure 17 - Layer 2 Interconnect across multiple Data Centers

Unified I/O at Server

A Unified I/O link to the host can present multiprotocol traffic to a unified fabric on a single cable. A unified fabric is a single, multipurpose Ethernet transport that can transmit IP and Fibre Channel traffic simultaneously across the same interface and the same switch fabric preserving differentiated classes of service. There are dramatic savings in power, cooling and cabling facilities costs due to less adapter and cables being provisioned to provide connectivity to the various networks in the environment. All the hosts in a particular POD can be equipped with Converged Network Adapters thus provide the capability to provide any storage to any host regardless of physical location. Ubiquitous storage capabilities in the cloud environment are beneficial as demands various storage based networks are required to be addressed.

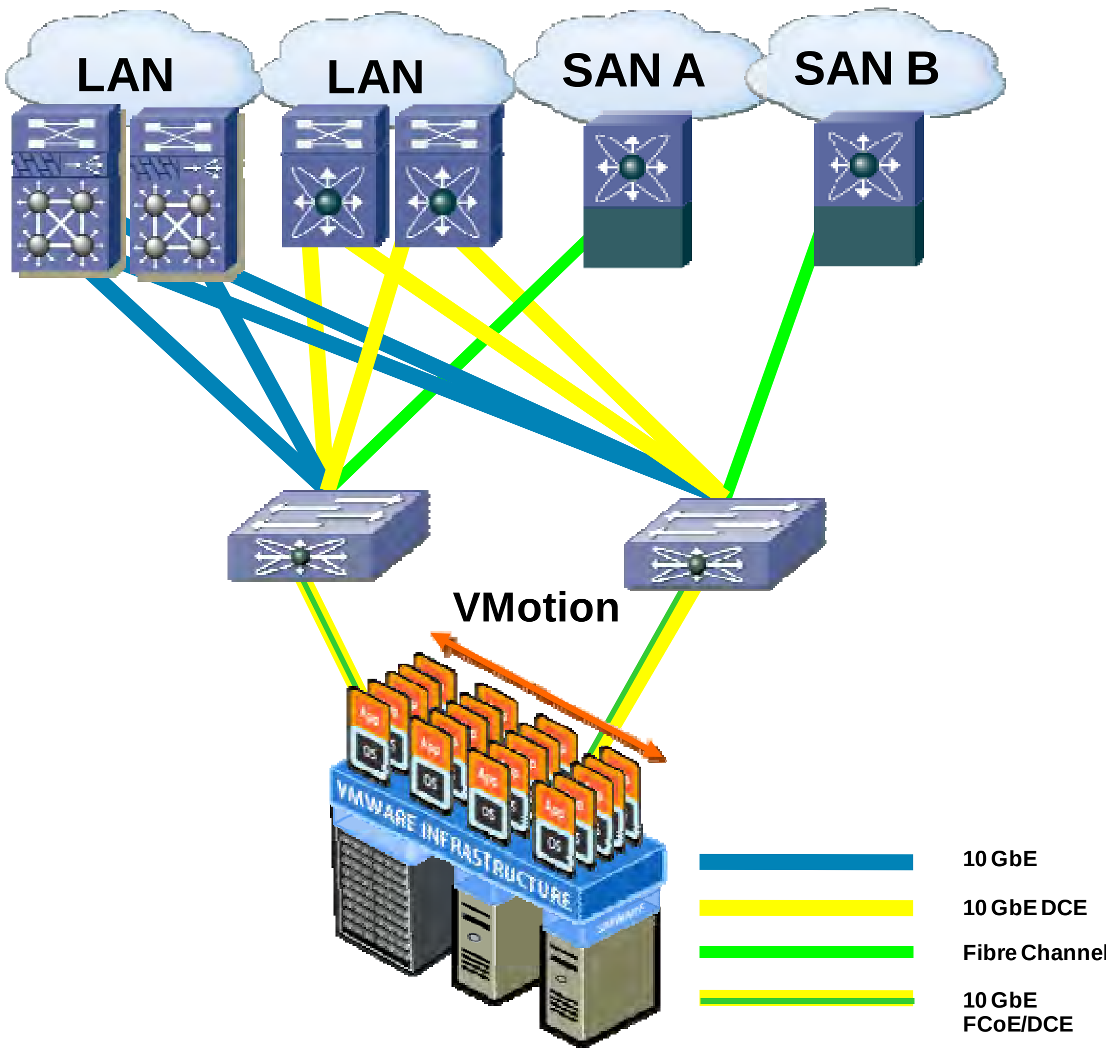


Figure 18 - Unified I/O: Single Connection between Server and Nexus Switch