4.1.11 Content Delivery Network Services (L.34.1.4)

Qwest's Networx Content Delivery Network Services combines our converged Internet Protocol-based network and our team member [redacted] content delivery platform to enable fast and reliable delivery of Web-based content globally.

Qwest's Content Delivery Network Services (CDNS) provides a suite of capabilities that off-loads origin servers and delivers content on their behalf. Our CDNS combines the unparalleled Qwest Internet Protocol (IP) network capability with [redacted] industry-leading content delivery network. Qwest's CDNS extends world-wide through Qwest's international Internet presence and [redacted] extensive global infrastructure. Qwest and [redacted] have a proven record of working together to provide CDNS for Government and commercial clients, including award-winning service for the [redacted]

4.1.11.1 Qwest's Technical Approach to CDNS Delivery (L.34.1.4.1)

The Qwest technical approach to providing a fully compliant CDNS has been developed and refined using our well established, highly reliable, and secure fiber optic infrastructure and global distribution of content servers, our commitment to our customers by our Operations and Engineering personnel, and our adherence to proven engineering practices. We recognize the importance of investing in research and development, are affiliated with key technology standards groups, and are represented on key Government advisory organizations, such as the National Security Telecommunications Advisory Council. Qwest has fine-tuned processes to research, evaluate, engineer, deploy, and operate new CDNS features and functionality.

The sections that follow describe our approach to service delivery and how our approach benefits the Government. We'll also describe how Qwest

CDNS will facilitate the Federal Enterprise Architecture (FEA) objectives, how Qwest proposes to address problems that may be encountered in providing CDNS, and how our synchronization network architecture supports CDNS.

4.1.11.1.1 Approach to CDNS Delivery (L.34.1.4.1(a))

Qwest's approach to effective CDNS delivery combines Qwest's proven global IP core network, [redacted] our proven deployment methodology, and the combined and dedicated Government service staffs at [redacted] and Qwest. The combination of a proven delivery platform and refined processes ensures Agencies of customized, effective solution deployment.

CDNS consists of a collection of surrogate servers that offload work from origin servers by delivering content on their behalf. Our approach to CDNS leverages the [redacted] content delivery infrastructure, thereby supporting world-wide distribution of content to meet Networx requirements. Our CDNS addresses four key technical/operational issues:

1. ***Latency*:** [redacted] extensive distribution of content servers ensures the least possible delay in delivering content to Networx subscribers.
2. ***Scalability*:** The high capacity of the CDNS infrastructure meets the requirements of Agencies. Our successful support of [redacted] demonstrates the depth of Qwest's capability.
3. ***Reliability*:** Our network monitoring and content distribution algorithms ensure [redacted] content availability for connected users. Our security management capabilities ensure content integrity.
4. ***Flash Crowd Control*:** The capacity of the CDNS solution ensures our ability to meet unexpected high usage.

Qwest's proven CDNS approach offers Agencies access to an unparalleled CDNS capability. [redacted] consisting of [redacted]

Internet Service Provider (ISP) networks in [redacted] countries—a true, granular global platform. No other CDNS provider can provide [redacted] global reach and resulting performance, scalability, and availability (see ***Figure 4.1.11-1***).

The Qwest Control Networx Portal will enable Agencies to configure their CDNS capability. The Qwest Control Networx portal will link to [redacted] delivers a wide range of operational and reporting services. The [redacted] places control of the CDNS platform in the hands of Agencies to perform a wide range of services. [redacted]

[redacted]

4.1.11.1.2 Benefits of Qwest's Approach to CDNS (L.34.1.4.1(b))

Figure 4.1.11-2 summarizes Qwest's CDNS customer benefits.

Figure 4.1.11-2 Benefits of Qwest's Approach to CDNS

Feature	Benefit	Substantiation
Optimal Edge Server Identification	Optimal performance levels and content accessibility.	[redacted]
Redundant and Resilient Network	Qwest's solution provides 100% availability and high scalability, ensuring consistent performance and reliability regardless of load.	[redacted]
Infrastructure Reduction/ Optimization	By moving substantial content from the origin site to our network, Qwest dramatically reduces the need for distribution infrastructure. Customer Web and application servers, bandwidth, and software and hardware maintenance typically are reduced significantly.	[redacted]

CDNS also supports the FEA objectives. ***Figure 4.1.11-3*** summarizes how our CDNS features support FEA objectives.

Figure 4.1.11-3. Qwest's CDNS supports FEA objectives

FEA Objective	Qwest's CDNS Support to FEA Objective
Improving utilization of Government information resources to focus on core Agency mission and service delivery to citizens by using the FEA	CDNS reduces the resources necessary to manage Agency content by providing a flexible service that addresses the spikes typical of Web-based information dissemination. With CDNS services, Agencies can configure origin websites to meet steady-state demand and satisfy high traffic load periods through CDNS. CDNS reduces the resources necessary to manage the origin site—and the hardware, software, and bandwidth necessary at the origin data center—allowing Government information resources to focus on core Agency missions.
Enhances cost savings and avoidance	CDNS allows Agencies to move content off origin infrastructures and significantly reduce the costs of provisioning origin data centers. [redacted]

FEA Objective	Qwest's CDNS Support to FEA Objective
Increased cross-Agency and inter-Government collaboration	CDNS provides an open platform for both horizonal and vertical service delivery. The ability of CDNS to increase performance, improve scalability, and ensure availability of information among federal, state, and local Agencies can dramatically enhance effective collaboration.

4.1.11.1.3 Solutions to CDNS Problems (L.34.1.4.1(c))

Qwest has extensive experience in delivering CDNS services. We apply this experience to ensure the delivery of high-quality CDNS to Agencies. Extensive pre-deployment laboratory system and integration testing identifies the majority of problems, and Qwest's proactive network and configuration management/fault management systems and methods are leveraged to quickly resolve unforeseeable operational issues. ***Figure 4.1.11-4*** summarizes some of the key problems we have encountered and the solutions we apply to resolve issues.

Figure 4.1.11-4. Qwest's Approach to Common CDNS Delivery Challenges

Problem	Solution
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]

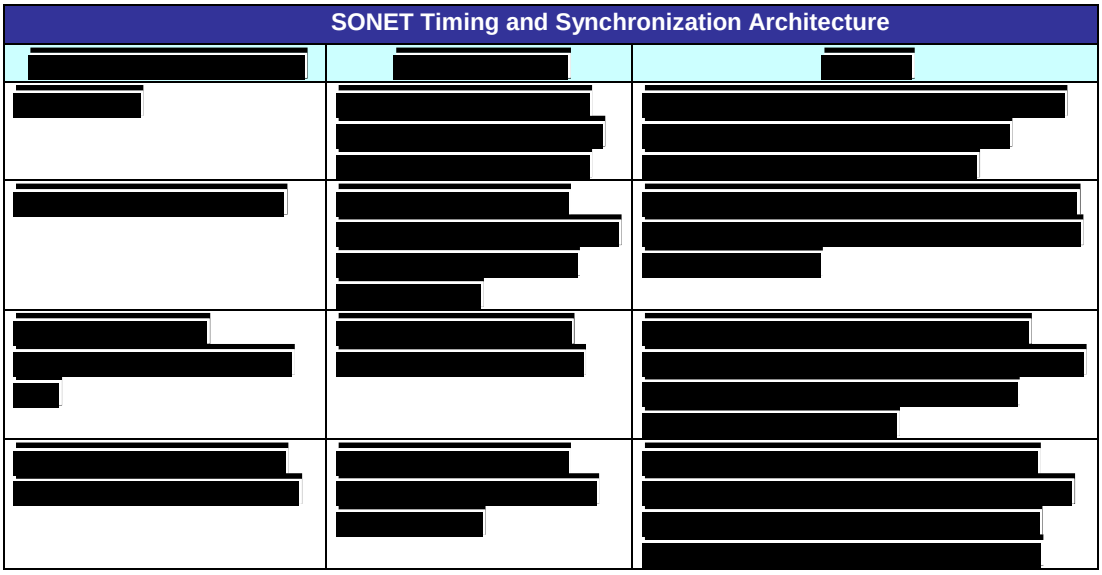
Problem	Solution
[redacted]	[redacted]

4.1.11.1.4 Synchronization Network Architecture (L.34.1.4.1(d))

[redacted]

[redacted]

Figure 4.1.11-6. Qwest's Timing and Synchronization Architecture Provides Multiple Levels of Redundancy



Qwest monitors [redacted] all synchronization facilities and equipment with a [redacted] coordinates the sectionalization, removal from service, and return to service of the defective synchronization equipment in accordance with normal trouble clearance procedures. Integrity of the synchronization network is maintained by Qwest's stringent surveillance of all facilities. [redacted]

Qwest's timing and synchronization architecture is compliant with all applicable standards, including:

- [redacted]
- [redacted]

4.1.11.2 Satisfaction of CDNS Performance Requirements (L.34.1.4.2)

Qwest meets the performance requirements for CDNS.

4.1.11.2.1 CDNS Quality of Service (L.34.1.4.2(a))

Qwest will meet all Quality of Service requirements for Networx CDNS.

Figure 4.1.11-7 provides Qwest's Acceptable Quality Levels (AQLs).

Figure 4.1.11-7 Qwest's CDNS Meets All Networx AQLs

Key Performance Indicator (KPI)	Service Level	Performance Standard (Threshold)	Acceptable Quality Level (AQL)	[redacted]
Availability (CDNS network)	Routine	100%	100%	[redacted]
Latency (static content download)	Routine	Mean = 1.5 sec	Mean < 1.5 sec	[redacted]
Grade of Service (Time to refresh content)	Routine	5 minutes	≤ 5 minutes	[redacted]
New Time to Restore (TTR)	Without Dispatch	4 hours	≤ 4 hours	[redacted]
	With Dispatch	8 hours	≤ 8 hours	[redacted]

Qwest understands each of the KPIs and meets the requirements for Availability, Latency, Grade of Service (time to refresh content), and new TTR.

Availability: Qwest's CDNS leverages [redacted]

Latency for Static Content Download: The combination of Qwest's [redacted] ensures that we will meet the Networx latency performance requirements.

Grade of Service (GoS) (Time to Refresh): Qwest's CDNS meets the requirement. [redacted] as described in Section 4.1.11.3.2.

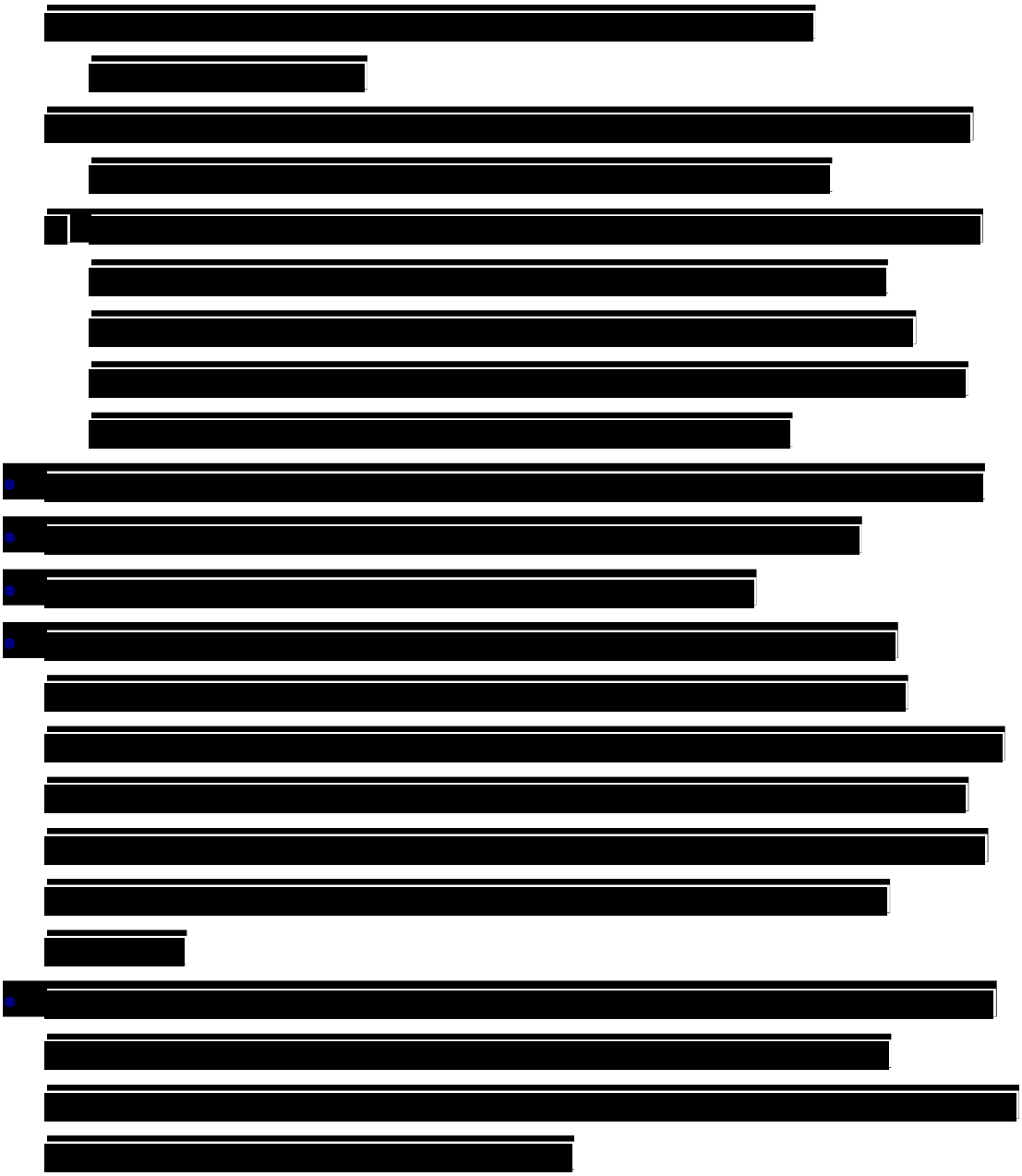
Time to Restore: Our CDNS has been designed from the ground up to require [redacted]

4.1.11.2.2 Approach to Monitoring and Measuring CDNS KPIs and AQLs (L.34.1.4.2(b))

The Qwest Control Networx Portal will provide Agencies with easy-to-use monitoring and measurement tools to support management, operations, and billing of CDNS, including performance data. Through our portal, [redacted]

Qwest uses the following approach to measurement of CDNS Availability. This approach will also measure performance enhancement relative to the existing origin site, including Time to Refresh (GoS) and Time to Restore:

- [redacted]
- [redacted]



Each performance metric is based on a daily average of performance for the service, hits, and the Agency's production Web server—measured directly and computed from data captured across all regions. An outage is defined

[redacted]

Qwest's CDNS will establish a configuration file for each website or application. Within the [redacted] refresh rates or caching times may be defined down to very granular levels ([redacted].) Once the content refreshing rules are established, the content may be updated continually by the content manager. [redacted]

For all services that Qwest offers, we use the [redacted] From this system, we collect many useful metrics that we use internally to evaluate and improve our processes including TTR. The calculation for TTR uses the same business rules as the Government requires for its services.

Measuring SDP-to-SDP Latency, and the Role of Service Enabling Devices

All of Qwest's IP-based services, which include the eight mandatory services (Internet Protocol Service (IPS), Network Based Internet Protocol Virtual Private Network Service (NBIP-VPNS), Premises-based IP VPNS

(PBIP-VPNS), Layer 2 Virtual Private Network Service (L2VPNS), Converged IP Services, CDNS, Voice Over Internet Protocol Transport Services, and Internet Protocol Telephony Services) are provided over the same IP services infrastructure. As a point of reference, Qwest has structured [redacted]

Following standard convention, the Service Delivery Point (SDP) is the Customer Edge (CE) router, as depicted in [redacted]

Monitoring for SLA reporting operates as follows:

- [redacted]

[redacted]

[redacted]

Qwest's approach consumes few resources at the SDP ([redacted]) as probes are sent from the Qwest network. This methodology does require that the customer respond to [redacted] messages.

[redacted]

Qwest's solution was designed from the beginning for its commercial offering to be SED-vendor agnostic. Qwest's performance management (PM)

[redacted] architecture is standards-based, scalable and flexible, as well as network centric, imposing the minimal requirements or load at the SDP level to achieve a rich set of PM metrics. The only major requirement is that the SDP allows ICMP polls from designated Qwest probes. This is nothing more than an Access Control List configuration on the SDP device.

[redacted]

Qwest further understands that in these situation(s) and unless otherwise agreed to by Qwest and the user Agency, Qwest, when directed by the user Agency or by General Services Administration (GSA), will monitor,

measure, and report the performance of the service for KPI/AQL and for SLA purposes either (1) on an SDP-to-SDP basis, by defining the SDP for performance metric measurement purposes for affected location(s) as being located at the connecting Point(s) of Presence (POP(s)) of the location(s), or (2) on a POP-to-POP basis. If directed to use the latter method by the Agency, Qwest will comply with the following:

[redacted]

Use of Statistical Sampling in lieu of Direct KPI Measurements

[redacted]

The Use of Government Furnished Property

If an Agency orders a Transport/IP/optical service in which they are employing a Government Furnished Property device, Qwest will provide KPI monitoring and measurement of the delivered service in three ways:

[redacted]

[redacted]

Qwest further understands that in these situation(s) and unless otherwise agreed to by Qwest and the user Agency, Qwest, when directed by the user Agency or by GSA, will monitor, measure, and report the performance of the service for KPI/AQL and for SLA purposes either (1) on an SDP-to-SDP basis, by defining the SDP for performance metric measurement purposes for affected location(s) as being located at the connecting POP(s) of the location(s), or (2) on a POP-to-POP basis.

4.1.11.2.3 CDNS Performance Improvements (L.34.1.4.2(c))

[redacted] In the event an Agency has a specific business need or application problem, Qwest will to discuss service enhancements. Qwest will operate in good faith to engineer a CDNS solution to serve unique Agency needs. Qwest is able to leverage our vast CDNS product portfolio, which includes a variety of SED providers and specific CDNS solutions. Through a special combination of vendor solutions and talented engineering capabilities, Qwest will serve an Agency's business needs.

4.1.11.2.4 Additional CDNS Performance Metrics (L.34.1.4.2(d))

[redacted]

4.1.11.3 Satisfaction of CDNS Specifications (L.34.1.4.3)

Qwest understands and complies with the designated standards, connectivity requirements, and technical capabilities for CDNS. Both team members actively participate in a number of standards-related organizations and have played an active role in bringing new standards to the market. For example, [redacted]

4.1.11.3.1 Satisfaction of CDNS Requirements (L.34.1.4.3(a))

The following three sections describe how Qwest satisfies all of the capabilities, features, and interfaces for CDNS.

4.1.11.3.1.1 Satisfaction of CDNS Capabilities Requirements (L.34.1.4.3(a); C.2.4.6.1.4)

Qwest fully complies with all mandatory stipulated and narrative features, capabilities, and interface requirements for CDNS. The text is intended to provide the technical description required per L.34.1.4.3(a) and does not limit or caveat Qwest's compliance in any way. Qwest fully supports the CDNS capabilities for Networx. The requirements are organized into content distribution and site monitoring/server performance measurements.

Content Distribution

Our specific service offerings include static content download service, real-time streaming, and on-demand streaming. The approach to each is briefly described in the following paragraphs.

Static Content Download Service: For delivery of static site content, each end-user request [redacted]

[redacted]

Real Time Streaming: For live streaming, depending on the format of the encoded media, [redacted] nto the CDNS service. If the media being provided to Qwest is in a raw (un-encoded) state, the stream [redacted]

On-Demand Streaming: For on-demand streaming, when a user clicks on a stream, they are routed to the optimal server. Encoding for On-Demand Streaming is handled in the same way as Real Time Streaming [redacted]

[redacted]

Site Monitoring/Server Performance Measurements

Available through the Qwest Control Networx Portal, the ECMC is a dashboard that provides a comprehensive collection of network management tools. This provides Agencies [redacted]

4.1.11.3.1.2 Satisfaction of CDNS Feature Requirements (L.34.1.4.3(a); C.2.4.6.2)

Qwest fully complies with all mandatory stipulated and narrative features, capabilities, and interface requirements for CDNS. The text in ***Figure 4.1.11-8*** is intended to provide the technical description required per L.34.1.4.3(a) and does not limit or caveat Qwest's compliance in any way. Qwest supports the mandatory and optional CDNS features as summarized in ***Figure 4.1.11-8***.

Figure 4.1.11-8 Technical Approach to CDNS Features

ID Number	Name of Feature	Qwest's Technical Approach
1	Failover Service	Qwest meets this requirement and offers several additional features of failover service described in Section 4.1.11.3.2. [redacted]
2 (Optional)	Redirection and Distr bution Service (Global Load Balancing)	Qwest meets this requirement. [redacted]

Qwest's CDNS provides a flexible failover service that ensures multiple options for Agencies. Websites that rely on centralized infrastructure often find that ensuring uptime is a continuous challenge. A typical solution involves mirroring a website at an alternate location; however, this approach creates additional capital and management costs. [redacted]

4.1.11.3.1.3 Satisfaction of CDNS Interface Requirements (L.34.1.4.3(a); C.2.4.6.3)

CDNS is an application layer service supported by the connectionless data services available with the IP suite of protocols via the User-to-Network

Interfaces discussed in Section 4.1.14.3.1.3. The CDNS provides data transfer from an origin server to the CDNS servers via IP. The service is available to all Agency servers reachable by IP.

4.1.11.3.2 Proposed Enhancements to CDNS (L.34.1.4.3(b))

Qwest's CDNS exceeds both the Failover Service and Redirection and Distribution Service requirements and offers several additional capabilities to Agencies.

Failover Service: As described in the previous section, Qwest [redacted]

Failover Option 1—Failover to Qwest's Net Storage: If an Agency wants to ensure that a complete origin site will be available to end users regardless of the health of the origin site and/or Internet connectivity, Qwest can establish a back-up site on [redacted] By running the back-up site on [redacted], Qwest is able to ensure a much higher degree of reliability, security, and performance, in addition to offloading the need for additional infrastructure. The Agency can store a default page [redacted]

Failover Option 2—Failover to Alternate Data Center (Mirror Failover): In the event that an Agency wants to be protected against the failure of an origin site and is running a backup or alternate site, [redacted]

[redacted] the edge server will obtain the requested content from the mirror site in a fashion invisible to the end user.

Failover Option 3—Failover to Edge Server: If the edge server needs to contact the origin server to fetch or revalidate content but cannot reach the origin server, it can be configured to serve the expired (most recent) version currently in cache. Agencies can configure the time it takes for the Qwest server [redacted] depicts the Failover to Edge Server.

The needs of a particular Agency's site and available infrastructure will determine which Site Failover option is appropriate. In all three scenarios, however, [redacted]

Potential Service Enhancements: Additional content delivery features, application accelerators, on-demand events, and performance

[redacted]

management tools can be provided. These include:

- **Flexible TTL and Time to Refresh Settings:** Agencies can define the TTL for every object or page, a designation that can be assigned [redacted]
- **Access Control:** Access Control allows Agencies to limit access to content by integrating with authorization policies defined on an origin server.
- **Advanced Cache Control:** Advanced Cache Control enables [redacted]
- **Content Targeting:** [redacted] Content Targeting enables Agencies to customize content to drive targeted business strategies online. The possible applications are limited only by imagination.
- **Download Manager:** Download Manager provides a simplified method of distributing, downloading, and installing digitized assets via the Internet. It can be used with websites that deliver content via SSL as well as with sites that require authentication before providing access to content. Download Manager is available as an add-on component for Agencies that use their websites to deliver digitized files such as software, movies, or other large objects.
- **Dynamic Content Assembly:** Dynamic Content Assembly enables Agencies to assemble and customize Web pages on [redacted]

- **Enhanced DNS:** Qwest's Enhanced DNS provides a robust, reliable, and scalable solution to direct end-users to customer websites. [redacted]
- **FTP:** Qwest's FTP is a managed service that [redacted] The result is a scalable, high-performance and highly available storage and FTP Download service.
- [redacted] By using this fault-tolerant storage service, Agencies can make rich media content available to users on demand, anytime, and anywhere.
- **Secure Content Delivery:** SSL processing is extremely slow and often requires content providers to substantially overprovision sites to maintain performance and scalability. [redacted] Secure Content Delivery is a highly secure, outsourced solution that addresses the performance and security needs of customer SSL content, while reducing costs and complexity. It supports the reliable and secure delivery of SSL objects and pages and runs on a dedicated section of the [redacted] Secure Content Delivery offers the highest degree of physical security and is optimized for SSL traffic.
- **SureRoute:** This unique feature, [redacted]

[redacted]

- **Tiered Distribution:** Tiered Distribution is offered specifically to enterprises that experience flash crowds or that offer a large number of sizeable files for download. [redacted] Tiered Distribution enables customers to effectively and quickly deliver content to end-users while minimizing the number of hits back to the origin website. With [redacted] Tiered Distribution, Agencies ensure high performance and dependability for their end users while reducing their Information Technology staff's planning requirements and costs.

4.1.11.3.3 Network Modifications Required for CDNS Delivery (L.34.1.4.3(c))

[redacted]

4.1.11.3.4 Qwest Experience with CDNS Delivery (L.34.1.4.3(d))

Qwest and [redacted] have collaborated to deliver CDNS to both commercial and Government customers. [redacted] Together, we offer a coordinated, proven capability to the Networx program.

[redacted]

Qwest and [redacted] have extensive experience with and understanding of the Government environment. [redacted] summarizes our CDNS experience.

Figure 4.1.11-10. Qwest CDNS Experience

Client	Qwest Products/Services	Results
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]

4.1.11.4 Robust Delivery of CDNS (L.34.1.4.4)

Qwest's CDNS combines the industry leaders in IP connectivity and content delivery. We have examined the Networx traffic model and find that even the Year 10 requirements would be easily satisfied by our respective infrastructures. Our CDNS also provides a robust and reliable platform for the delivery of content to Agencies. [redacted] has successfully expanded its CDNS infrastructure globally and demonstrated its ability to deliver service in the most challenging of network conditions. Likewise, Qwest's IPS platform

[redacted] to ensure a resilient and robust service capability.

4.1.11.4.1 Support of Government CDNS Traffic (L.34.1.4.4(a))

Over the course of the 10 years delineated in the Government's pricing model, committed bandwidth for both domestic and global—[redacted]

4.1.11.4.2 CDNS Measures and Engineering Practices (L.34.1.4.4(b))

Qwest's CDNS alliance, [redacted] closely monitors traffic, plans for the future, and routinely upgrades and expands its platform capacity based on current and anticipated demand. In addition, Qwest's centralized engineering team applies a consistent capacity management model to all data services. Qwest's proactive assessment and enhancement of our network capacity ensures our clients that we will always be able to deliver their data, regardless of network conditions.

Our CDNS has built-in, automatic, self-healing properties, such as the ability to route around congested points, and to divert traffic away from data centers that are down. These fundamental engineering practices ensure resiliency in a dynamic environment.

4.1.11.5 CDNS Optimization and Interoperability (L.34.1.4.5)

Qwest CDNS understands the vital importance of service optimization and interoperability. The following sections describe our approach, methods, techniques, and vision for CDNS optimization and interoperability.

4.1.11.5.1 Qwest's Approach to Optimizing CDNS (L.34.1.4.5(a))

Qwest's CDNS platform optimizes content assembly and delivery to efficiently deliver Web content and applications from [redacted] The content delivery platform is connected with the clients' content generation infrastructure using optimal paths through the Internet and using intelligent routing algorithms supported by real-time network information. The delivery of content is then served by [redacted] edge servers that are deployed near all end users.

Intelligent Request Routing: Qwest's CDNS platform uses [redacted]

We employ a variety of techniques for Internet [redacted] and for measurement of [redacted] to a variety of points on the Internet. These network performance measurements are then combined with [redacted] As a result, [redacted]

High Performance Communications: The Qwest CDNS platform has highly optimized communications [redacted], as well as between [redacted], to ensure that content and data are always readily available form all edge servers. Two of the core communications systems are [redacted]

[redacted] identifies alternate paths from our edge server to the origin server and uses those alternatives to improve performance of content delivery. Using both [redacted]

The [redacted] is a highly scalable and reliable system to transmit Agency configurations (metadata) to edge servers. Unique aspects of this infrastructure are its application of [redacted] for high-performance routing to edge servers, robust mechanisms of replicating data submitted to our content delivery platform, and the ability to transport data to the entire content delivery network very rapidly.

Network Management and Monitoring: To ensure ongoing optimization of this diverse and distributed platform, Qwest has built a comprehensive set of tools to administer a [redacted]

Proactive Performance Monitoring: In addition to the NOC, Qwest has a variety of [redacted]

[redacted]

4.1.11.5.2 Qwest's Approach to Optimizing Network Architecture for CDNS (L.34.1.4.5(b))

The technology behind [redacted] that continuously monitors Internet conditions and routes users to the optimum edge servers [redacted] Users benefit from the best performance possible.

4.1.11.5.3 Qwest's Approach to Access Optimization for CDNS (L.34.1.4.5(c))

Our CDNS approach is driven by the Mapping Process algorithms described in Section 4.1.11.5.2—algorithms that were initially developed at the Massachusetts Institute of Technology by the founders of [redacted] content delivery servers are deployed in more than [redacted] networks, ensuring close proximity to large concentrations of diverse customers and enabling us to handle their requests efficiently.

[redacted] has also made several enhancements to first and last mile access, such as [redacted]

4.1.11.5.4 Qwest's Vision for CDNS Internetworking (L.34.1.4.5(d))

Qwest, the leader in the development of IP-based convergence, and [redacted] firmly believe in a common, IP-centric architecture. Qwest and [redacted] have implemented this vision. The foundation of the content delivery business lies in providing IP-based services that leverage common standards and network interoperability. Qwest's broad and deep solution set of IP-based service offerings ensures support for any CDNS or related requirement, ranging from the division to the department.

Qwest is well-positioned to support the continuing evolution toward IP convergence—delivering content around the world—to meet the ever-increasing demand for IP-based services.