1.3.6 Common Architectural Components

Agencies will access a national and global telecommunications infrastructure integrated to share many common architectural components and capabilities to dramatically improve service delivery. A more fully integrated network offers Agencies greater accuracy with monitoring performance measurements and streamlined methods for optimizing services improving interoperability.

1.3.6.1 Network Architecture Synchronization [L.34.1.4.1.d]

(d) Describe the synchronization network architecture to support the offeror's access and transport networks.

Today's AT&T synchronization network is based on the global positioning system (GPS). The GPS is operated by the Department of Defense (DoD) and is intended to deliver both precise position and precise timing. It is composed of 24 operational satellites, each of which is in sidereal orbit. In a sidereal orbit, satellites orbit at a distance of approximately 11,000 miles from the earth and appear twice a day. Like the sun, GPS satellites come over the horizon, track across the sky to various elevations depending on their particular orbit, and then set. GPS receivers require a good view of the sky so they can track the satellites as they rise, move through their orbits, and set. **Figure 1.3.6.1-1** depicts the generic AT&T synchronization architecture.

[redacted]

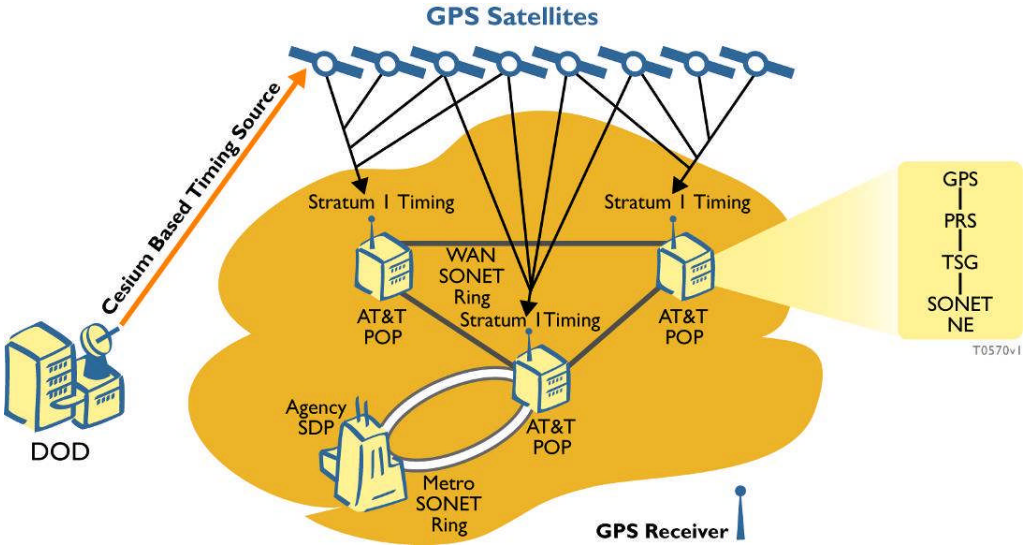


Figure 1.3.6.1-1: Generic AT&T Synchronization Architecture. *The synchronization network receives its timing source from a series of GPS satellites that is based on a cesium-based timing source transmitted by the DoD.*

[redacted] Details on the transport and access network synchronization are discussed in **Table 1.3.6.1-1**.

SYNCHRONIZATION FEATURE	DESCRIPTION
GPS of Orbiting Satellites	Provides synchronization source for AT&T Network. [redacted]
Longhaul (Transport) Network Synchronization	Longhaul synchronization is based on signals from GPS: [redacted]
Local (Access) Network Synchronization	Local network synchronization is based on signals derived from GPS: [redacted]

Table 1.3.6.1-1: Network Synchronization. *The longhaul and local networks are synchronized using the GPS system.*

[redacted]

[redacted] predictions are uploaded several times to refresh the navigation messages. **Table 1.3.6.1-2** describes the GPS system's two levels of accuracy.

LEVEL OF ACCURACY	DESCRIPTION
Standard Positioning Service (SPS)	Available to all users. Navigation and timing signals from SPS are intentionally degraded. The timing error is approximately 340 nanoseconds.
Precision Provisioning Service	Reserved for U.S. Military. More accurate than SPS.

Table 1.3.6.1-2: Levels of Accuracy of GPS Service. *The GPS service offers two levels of accuracy.*

[redacted] **Figure 1.3.6.1-2** [redacted]

Jitter, wander, and phase transient performance for the AT&T synchronization network is monitored to verify compliance with Telcordia GR-436. Monitoring for slips, pointer justification count, and synchronization is done to verify compliance with Telcordia GR-436 standards.

Figure 1.3.6.1-2: AT&T Core Synchronization Network. *Locations of the AT&T PRS provide Stratum 1 traceable timing to the AT&T transport network.*

Figure 1.3.6.1-3 shows the office synchronization architecture that times the AT&T transport network.

[redacted]

Figure 1.3.6.1-3: AT&T Office Synchronization Architecture. *Synchronization architecture used to time the AT&T longhaul and access transport networks.*

[redacted] All inter-office timing distribution is compliant with Telcordia GR-436 standards.

[redacted] All administrative functions are compliant with Telcordia GR-378.

Local network synchronization is based on signals derived from the GPS. Larger offices or offices collocated with the longhaul network have GPS receivers, which generate a highly accurate timing reference. [redacted]

[redacted]

AT&T monitors synchronization technology upgrades throughout the lifetime of the Networx contract so that Agencies receive the benefits of the latest available features that synchronization networks have to offer. The AT&T synchronization network operates worldwide, is uniform, flat, robust, and insensitive to network growth, churn, or technology changes. The network architecture provides high-quality verified performance and ease of maintenance.

1.3.6.2 Satisfaction of Performance Requirements [L.34.1.4.5]

1.3.6.2.a Approach to Optimizing IP-Based Services [L.34.1.4.5.a]

(a) Describe the offeror's approach for optimizing the engineering of IP-Based and Optical Services.

Due to the industry move toward Internet protocol (IP)-based services, AT&T has built and operates a multiple-layer network core architecture with access at the edge that supports multiple services. In this network, optical performance is gained using the latest fiber strand, wave division multiplexing (WDM), and optical switching equipment. The IP network core forwards packets solely using multiprotocol label switching (MPLS).

[redacted] **Table 1.3.6.2-1**.

INTELLIGENT OPTICAL NETWORKING	
Technology	***Feature***
Non-Zero Dispersion Fiber (NZDF) Type Fiber	[redacted]
Bandwidth Multiplication	[redacted]
Intelligent Optical Switching	[redacted]

Table 1.3.6.2-1: Optical Technology is at the Root of the AT&T Network. *Using the latest in fiber technology along with WDM technology, Agencies are provided service from a network that is optimized for low-cost bandwidth. The addition of intelligence in the OEO system provides this bandwidth in a reliable format.*

[redacted] **Table 1.3.6.2-2** lists the major optimization elements that come from the AT&T implementation of MPLS.

ELEMENT	OPTIMIZATION
Performance	[redacted]
Virtual Private Network (VPN)	[redacted]
Scalability	[redacted]
Provisioning	[redacted]
Class of Service (CoS)/Quality of Service (QoS)	[redacted]
Traffic Engineering (TE)	[redacted]

Table 1.3.6.2-2: MPLS Optimizes Packet Network. *Using the advantages of MPLS to carry multiple protocols, Agencies are provided with networking that has the best possible performance at a lower cost.*

Along with all the benefits of operating and MPLS network, the key benefit is network performance. With the ability for MPLS to make very fast decisions on packet forwarding, including route failure and congestion avoidance decisions, excellent network performance is offered across the MPLS core, as listed in **Table 1.3.6.2-3**. Using this technology, AT&T offers TDM-like performance for packet-based services, such as IP, ATM, and frame relay.

METRIC	AT&T TARGET	TYPICAL OBSERVED MPLS CORE AVERAGES*		
		Month 1	*Month 2*	*Month 3*
Contiguous United States (CONUS) Round-Trip **Latency**	[redacted]	[redacted]	[redacted]	[redacted]
End-to-End **Packet Loss**	[redacted]	[redacted]	[redacted]	[redacted]
Network **Availability**	[redacted]	[redacted]	[redacted]	[redacted]
Packet **Jitter**	[redacted]	[redacted]	[redacted]	[redacted]

Table 1.3.6.2-3: Using MPLS in Packet Network Core Provides Very Good Routing Characteristics. *Once in the core, Agency packet data is routed with a high level of performance and integrity, allowing Agencies to focus on their mission instead of communications issues.*

An additional benefit to using MPLS in the core that is beyond transport performance is the service interoperability between packet-based technologies. Using the MPLS core, an Agency can have multiple sites, all using different access networks (e.g., frame relay, ATM, IP), all interoperating with each other on a single PVC-free, network-based VPN. In addition, MPLS allows Agencies to use network-based services from multiple protocols, which are starting to optimize service convergence.

1.3.6.2.a.1 Service Convergence

AT&T networks are architected to provide a variety of services from a single access infrastructure, the multiservice access (MSA). The MSA networking is coupled with multiple service edge (MSE) technologies to provide a complete

multiprotocol networking service. Using this access/edge architecture, in combination with the high-capacity MPLS core, provides optimal access to services, as compared to the traditional method of using service silos in discrete networks (**Figure 1.3.6.2-1**).

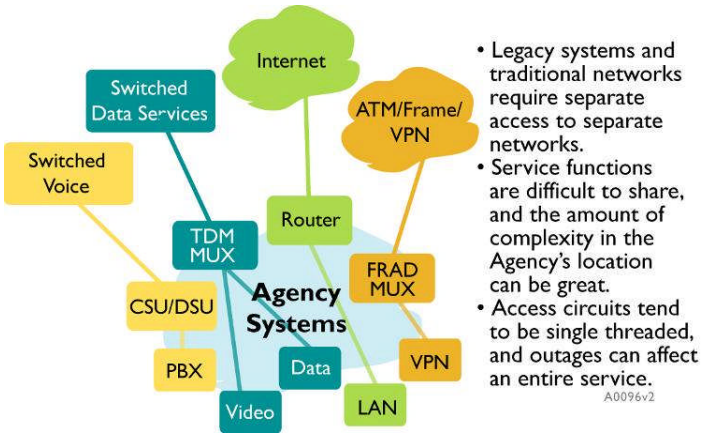


Figure 1.3.6.2-1: Traditional Networking Places Complexity in Access and at Agency. *Using the traditional connectivity and product usage methodologies, Agencies end up taking on the technical responsibility for access and the management of the differing systems and protocols. The separate service networks also require separately managed access circuits that each contains costly overhead bandwidth.*

This traditional, discrete networks method is compared with the re-engineered AT&T network (**Figure 1.3.6.2-2**)**.** The complexity has been moved from the customer network into the service provider's network, where overall complexity is diminished by using IP and MPLS. Using an IP/MPLS-based topology, Agencies receive a single, resilient network-based access that supports multiple network-based services. The architecture supports both legacy services, such as circuit-switched voice and ATM, and the new IP-based services, such as VoIP.

Figure 1.3.6.2-2: The re-engineered the networking model. *The re-engineered access and service networks from AT&T offer Agencies simplified and managed access. In addition to the new simplicity, access is bundled in the QoS enabled access network and the services are offered in a high capacity MPLS network that provides service availability.*

1.3.6.2.b Methods for Optimizing the Network Architecture [L.34.1.4.5.b]

(b) Describe how the offeror will utilize methods such as remote concatenation, switching/routing capabilities, and high bandwidth transmission facilities to optimize the network architecture

The AT&T network has optimizing elements engineered into the network at every layer, such as MPLS and high-capacity fiber. **Table 1.3.6.2-4** lists the physical and optical layers, and the optimizations in those layers.

LAYER	OPTIMIZATIONS	FUNCTION/BENEFIT
Physical		
Optical		
SONET		

LAYER	OPTIMIZATIONS	FUNCTION/BENEFIT
Packet Transport	[redacted]	[redacted]

Table 1.3.6.2-4: Network Optimizing Technologies Provide High-Bandwidth Network. *Using optical, sonet and packet high end switching and routing technologies allows AT&T to transport nearly [redacted] of data daily with very low error rates.*

To provide the best possible reliability in the lowest possible layers of the network, AT&T uses an OEO switch, shown in **Figure 1.3.6.2-3**, on the optical layer to take advantage of the diverse redundant paths that are built into the physical layer. [redacted]

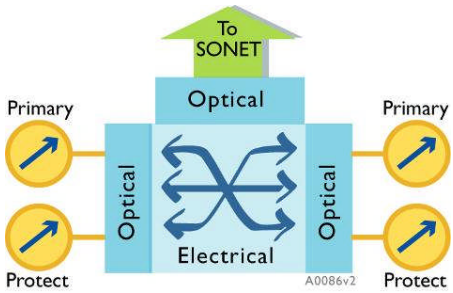


Figure 1.3.6.2-3: Optical Electrical Optical Switch Provides Redundancy at Core Optical Network Level. *By converting optical to electrical at nodal points, the OEO technology can monitor optical paths and provide redundancy to all upper layers of the network.*

In the SONET systems, two topologies are used for different levels of cost and reliability. [redacted] (**Figure 1.3.6.2-4**). [redacted] (**Figure 1.3.6.2-4**) [redacted] This network takes advantage of the OEO

redundancy that is built into the optical layer for primary and backup paths. The [redacted] allows provisioning systems to be fully automated, and more bandwidth is available for live circuits, thus reducing the per circuit costs.

Figure 1.3.6.2-4: [redacted] Networks Co-Exist. [redacted] The virtual concatenation technology provides mechanisms to break up standard SONET STS into smaller bundles and reassemble the individual bundles into proper STS quantities at the far end. This allows better use of bandwidth resources when transporting Ethernet over SONET (**Figure 1.3.6.3-5**) and the ability to fill unused bandwidth on a SONET segment with a circuit that previously was too large to provision (**Figure 1.3.6.2-6**).

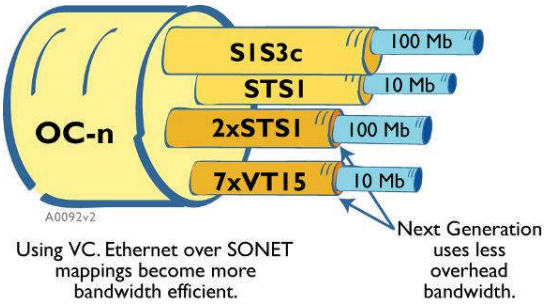


Figure 1.3.6.2-5: Virtual Concatenation (VC) provides better use of bandwidth on Ethernet over SONET Applications. *Using the VC technology, the amount of stream data in a SONET system is greatly reduced for carrying Ethernet over SONET. This allows more services to be applied per network and reduces overall cost.*

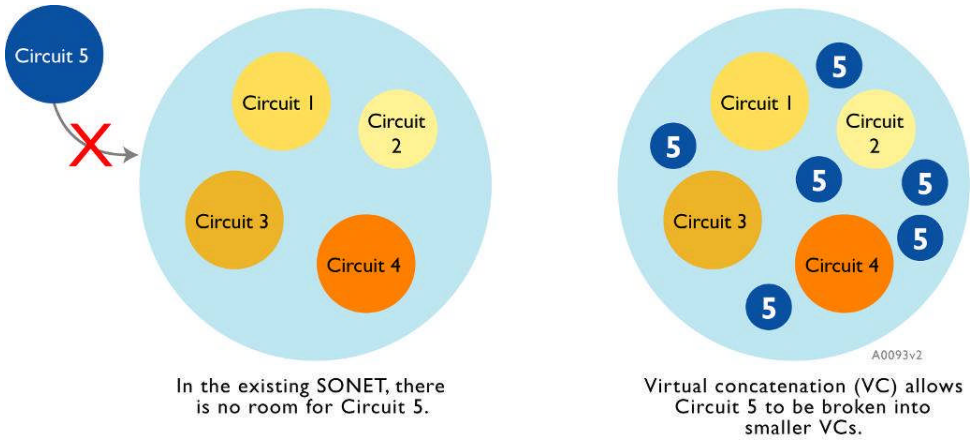


Figure 1.3.6.2-6: Virtual Concatenation (VC) Provides Better Use of Bandwidth for Transport SONET Applications. *Using the VC technology, the amount of stream data in a SONET system is greatly increased for carrying multi-ring data over SONET. This allows more primary and secondary circuits to be mapped over a set of rings and reduces overall cost.*

1.3.6.2.c Performance Level Improvements [L.34.1.4.5.c]

(c) Describe the engineering techniques for optimizing access for improved performance or increased efficiency in areas where large concentrations of diverse customer applications exist (e.g. the use of multi-service edge platforms).

The basic architecture for an MSA/MSP configuration is shown in **Figure 1.3.6.2-7.** [redacted]

Figure 1.3.6.2-7: MSE/MSA Architecture Provides Resilient Access to AT&T Networks and Services.
Using the available underlying network layers, Agencies are provided resilient access to transport and services using multiple network protocols. This is an important step in the converged network strategy that supports both the new and old network types in a single system.

1.3.6.2.c.1 Multiservice Access (MSA)

The MSA refers to the network through which customers connect to AT&T's network services. [redacted]

Key to this implementation is support for protocol independent virtual circuits through which the Agency accesses the AT&T multiprotocol transport core. [redacted]

This new network architecture provides the Agencies with increased service flexibility and performance. Agencies will have the ability to connect multiple locations using multiple network protocols seamlessly all on a single, secure, flexible, and highly reliable network. In addition, Agencies will be able to evolve the service network types to match their ever-changing missions, without completely re-engineering their network access.

1.3.6.2.c.2 Access Network Strategies

To facilitate Agency access to the MSA strategy, AT&T has built and operates [redacted] of metro fiber configured with SONET rings. Along with packet network transport, these rings support traditional TDM services, such as T-1, T-3, and SONET, as well as metro Ethernet over concatenated STS segments. [redacted]

Worldwide, where metro fiber networks are not owned, AT&T creates a similar access level by leasing bandwidth from local exchange carriers (LECs) and foreign postal telephone and telegraph (PTT) entities at the lowest possible network layer. This often means that the access provided to AT&T is at the optical, SONET, or circuit level. [redacted]

1.3.6.2.c.3 Multiservice Edge (MSE)

The MSE will terminate customer access into the global packet network and provide all the service specific features for Layer 2 (e.g., FR/ATM) as well as Layer 3 (IP) services. [redacted]

This topology is depicted in **Figure 1.3.6.2-8**.

The MSE acts as the termination point, a QoS arbitration system, and an on-ramp to the MPLS core network. Additional functions within the MSE are systems that control access, security, and protocol conversion for services such as VoIP.

Figure 1.3.6.2-8: MSE Contains Both Physical and Virtual Elements.

1.3.6.2.c.4 Network Evolution

The AT&T MSE/MSA access strategy is in alignment with the evolution of network solutions that is underway throughout the industry. In this evolution, traditional products that are supported by separate networks and topologies are consolidated into a single access and backbone strategy, which is coupled with applications aware networking. An example of this migration is VoIP, where the traditional TDM access has been merged into IP, and network-based intelligence provides call routing and features.

1.3.6.2.d Vision for Service Interoperability [L.34.1.4.5.d]

(d) Describe the offoror's vision for implementing service internetworking over a common infrastructure (e.g.; IP-Centric architecture). Include a view on network interoperability, control plane integration, and optical infrastructure support for IP-Based Services. Describe the benefits and rational of the offeror's approach.

1.3.6.2.d.1 Standardized Service Delivery Platform

An emerging technology that AT&T envisions will be developed is the services over IP (SoIP) service delivery platform (SDP).

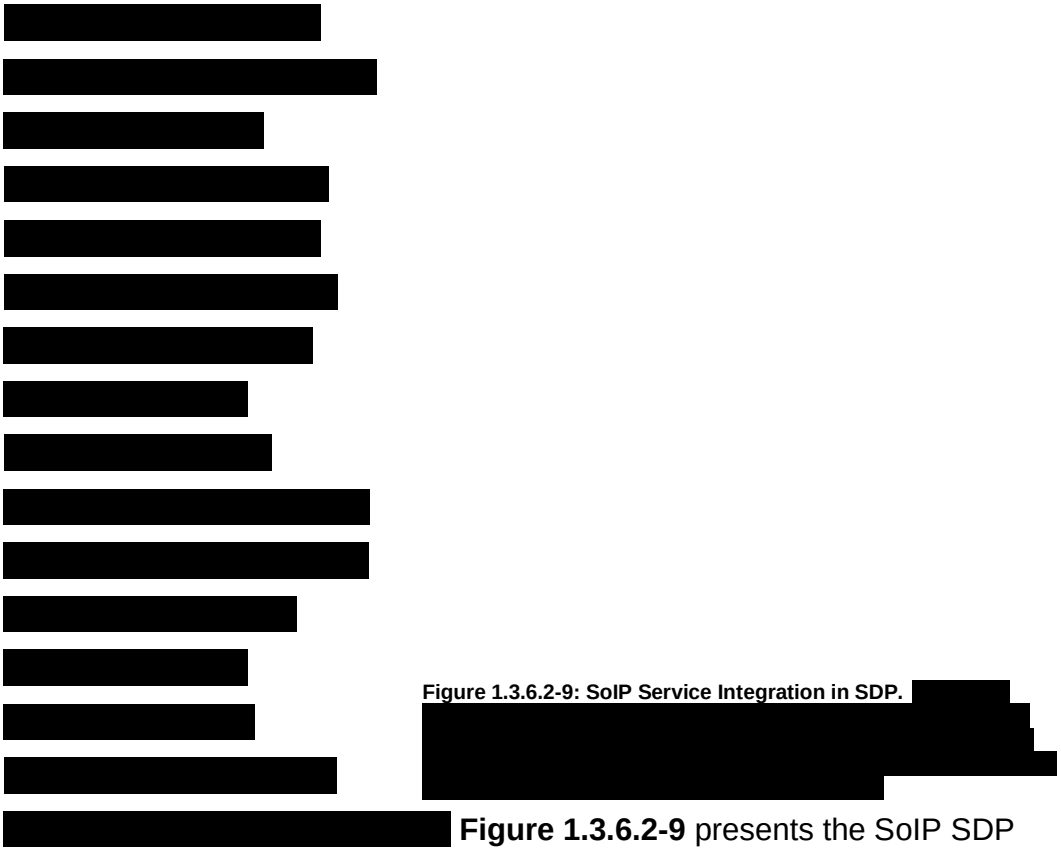


Figure 1.3.6.2-9: SoIP Service Integration in SDP.

Figure 1.3.6.2-9 presents the SoIP SDP architecture that includes the VoIP products that AT&T offers.

The AT&T SDP provides a plug and play environment so emerging IP-based applications services do not require a separate, unique development process. Among the reusable application elements are software logic, modules, processes, and server technology. The AT&T SDP provides fast, flexible mechanisms to create new services that integrate with the underlying network and drastically shorten the service development cycle.

The AT&T SDP is implemented as a service oriented architecture (SOA). [redacted]

1.3.6.2.d.2 Standardized Service over IP Infrastructure (SoIP)

Given the explosive federal and commercial customer's demands for IP-based service (voice, video, multimedia, and others) and applications, AT&T is developing a common SoIP infrastructure. **Figure 1.3.6.2-10** shows a service network representation of the SoIP architecture.

Figure 1.3.6.2-10: SoIP Service Network Components, [redacted]

The main goal of the AT&T SoIP infrastructure is to provide a single, common, and shared infrastructure for all existing and evolving IP-based services. [redacted]

[redacted] Additionally, AT&T's SoIP is access-agnostic and will support all common access technologies.

[redacted]

1.3.6.2.d.3 Standardized Network Application Infrastructure

AAN provides a network-based computing infrastructure to run SoIP applications servers and other web application servers. [redacted] This standardized computing environment allows AT&T to provide a common resource layer that will be shared by different IP-based applications, resulting in faster service introduction and reduced service costs and risks.

1.3.6.2.d.4 Transport Layer Control Plane

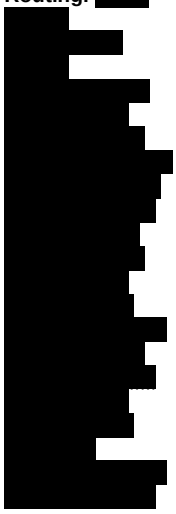
A guiding principle of AT&T network evolution is a converged MPLS/IP/optical network. [redacted] This converged network will be better positioned to address security, service continuity, and performance requirements of fast-emerging, IP-based applications.

[redacted]

[redacted]

As IP-based traffic becomes dominant in the network, the MPLS layer's efficiency in grooming and traffic integration will become key to service performance. The amount of MPLS traffic in the optical core will increase dramatically with the move to IP-based services and AAN. Even with this dominance of IP/MPLS traffic, the optical core will receive and transport data from other sources. [redacted] (**Figure 1.3.6.2-11**).

Figure 1.3.6.2-11: Common Control Plane Optimizes Routing. [redacted]



In addition to optimizing the use of the optical network, the common control plane promises to reduce costs by easing provisioning tasks across the core, reducing the operations and management load, decreasing equipment and maintenance costs. [redacted]

1.3.6.3 Transport/IP/Optical KPI Monitoring

1.3.6.3.a Approach for Measuring SDP-to-SDP KPIs

(Q1) Describe in greater detail the offeror's approach for measuring SDP-to-SDP latency, packet loss and jitter for each of the mandatory IP-based services (8) to include the role of SEDs in the Processes.

End to end performance measurement and reporting follow the same basic principles of operation for all Internet Protocol (IP) specific services. Variations on the basic operation are applied to specific products, such as the voice over IP (VoIP) suite of products, as needed, to satisfy the quality of service needs for the end users.

The basic principle of performance measurement includes separate measurements of the IP/MPLS Core transport network as a single operating unit, separate measurements of SDP-to-SDP performance through Service Enabling Devices (SEDs), and measuring performance on the access facility. This core and edge measurement principle is easily illustrated using an IP-based Virtual Private Network (IP-VPN) as an example network. The basic IP-VPN service, depicted in **Figure 1.3.6.3-1**, would include two or more Customer Edge (CE) networks interconnected in a closed IP network using the IP/MPLS Core network between Provider Edge (PE) egress points.

Figure 1.3.6.3-1: Network Based VPN Service: In the NB-IPVPN, two or more SDP are tied together. [redacted]

AT&T continuously monitors and measures the performance of the IP/MPLS core network between network egress points - the PE routers. [redacted]

[redacted]

In order to generate and capture the SDP-to-SDP performance data, an SED is required. [redacted]

[redacted]

Using the methodology provides the government with accurate measurement of network performance with very little network data overhead. This method is also very cost effective due to fact that the network is not bogged down in retrieving the performance data.

[redacted] **Table 1.3.6.3-1**.

FEATURE	APPROACH
[redacted]	[redacted]

Table 1.3.6.3-1: Agencies have choices when configuring networks for managed KPI. [redacted]

Using technology that has been proven in the AT&T IP/MPLS core network, the Government is provided with IP-based services that have a reliable method for monitoring end to end performance.

1.3.6.2.b Proposed Statistical Sampling

(Q2) Please discuss in detail any proposed use of statistical sampling of network parameters in lieu of direct KPI measurements in your proposal for transport/IP/optical services.

AT&T uses a combination of both statistical sampling and direct measurements for KPI measurements. Direct measurements are used when possible. Statistical sampling is used when it is not feasible or practical to use direct measurements due to scalability or scope of the KPI measurement.

1.3.6.3-2 outlines the data collection method used for each KPI measurement.

KPI	ASSOCIATED SERVICE	DATA COLLECTION METHOD
Call Blocking	VS, CSDS, TFS, Combined	[redacted]
Data Delivery Rate	FRS	[redacted]
Latency	FRS	[redacted]
Cell Loss Ratio Cell Transfer Delay Cell Delay Variation	ATM	[redacted]

KPI	ASSOCIATED SERVICE	DATA COLLECTION METHOD
Data Delivery Rate Latency	IPS	[redacted]
Packet Loss, Data Delivery Rate, Packet Delivery Rate	VoIPTS, CIPS, IPTelS, L2VPN, Ethernet	
Latency	NBIP-VPN, PBIP-VPN, VoIPTS, CIPS, IPTelS, L2VPN, Ethernet	
Jitter	VoIPTS, CIPS, IPTelS, L2VPN, Ethernet	
Bit Error Rate	SONET, OWS	
Restoration Time	OWS	

Table 1.3.6.3-2: Data Collection Methods Transport/IP/Optical Services. *AT&T uses a combination of direct and Statistical measurements to capture data to calculate KPI parameters for the Transport/IP/Optical services.*

[redacted]

1.3.6.2.c Proposed Statistical Sampling

(Q3) Describe in greater detail how service instance availability information (incident based) is collected and moved to an aggregation point to support the KPI reporting process.

To maintain high-quality service and verify that service performance meets the KPIs, AT&T has implemented an integrated service assurance system, as shown in **Figure 1.3.6.3-2**. [redacted]

[redacted]

Figure 1.3.6.3-2: Service Assurance Architecture. [redacted]

[redacted]

Table 1.3.6.3-3. [redacted]

[redacted]

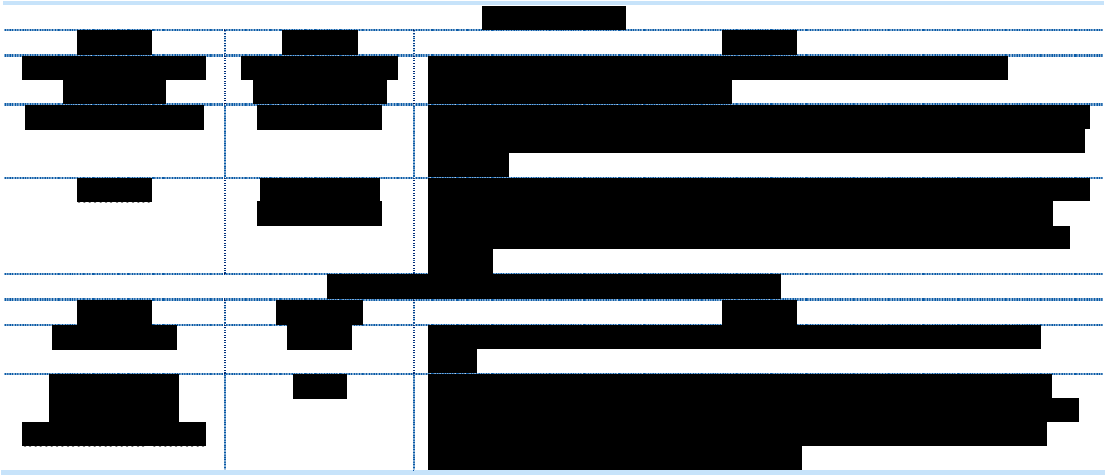


Table 1.3.6.3-3: Availability Information: Collection, Aggregation and Reporting. [redacted]

AT&T has the systems in place to capture service impacting events and report these events in the format of availability reports as defined by the Networx RFP. These systems allow AT&T to meet the KPI availability reporting requirements in Networx.

1.3.6.2.d Proposed Statistical Sampling

(Q4) Should the government wish to use Government Furnished Property (GFP) in lieu of contractor provided SEDs, how will the offeror provide the required KPI monitoring and measurement of the delivered service? If there are more than one approach, please describe each approach and discuss the advantages and disadvantages of each.

In order to capture SDP-to-SDP performance data, an SED is required. [redacted]

[redacted]

[redacted]

[redacted]