



CENTER FOR ADVANCED AVIATION SYSTEM DEVELOPMENT (CAASD)

Future Trends for IP Over FAA Telecommunication Infrastructure

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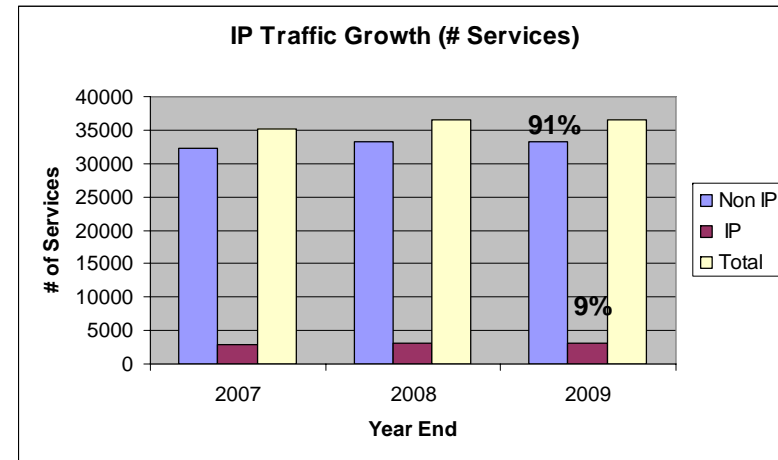
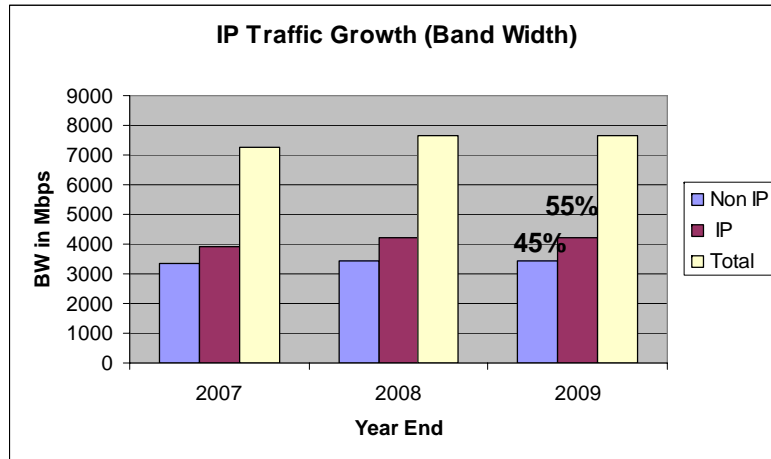


Outline

- **IP traffic growth in FTI network**
- **IP traffic bandwidth growth at large FAA sites**
- **Technologies to overcome the need for increase in IP access bandwidth**
- **Where WAN optimization appliances are deployed?**
- **Standard IP-based applications**
- **Survey of WAN optimization vendors and appliances**
- **Major IP applications in a typical ARTCC site**
- **Preliminary relationship between FAA applications and layer 4 classifications**
- **Evaluation of appliances effectiveness for FAA IP applications**
- **Findings and Next step**



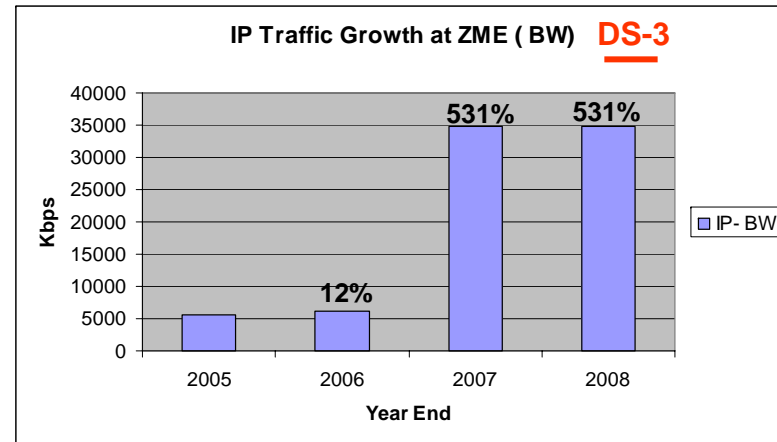
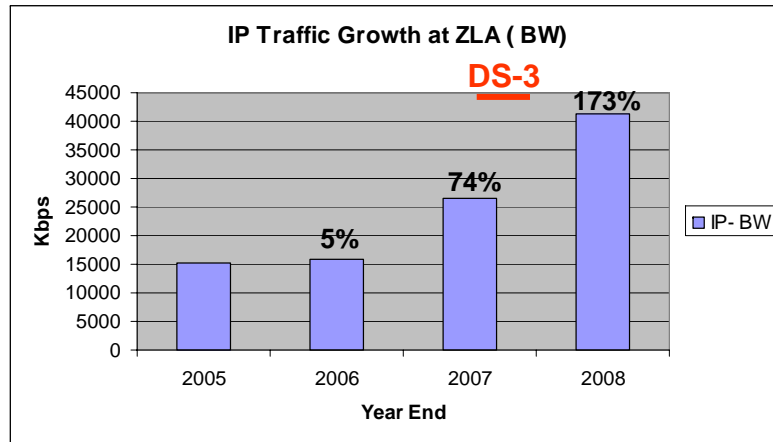
IP Traffic Growth in FTI Network



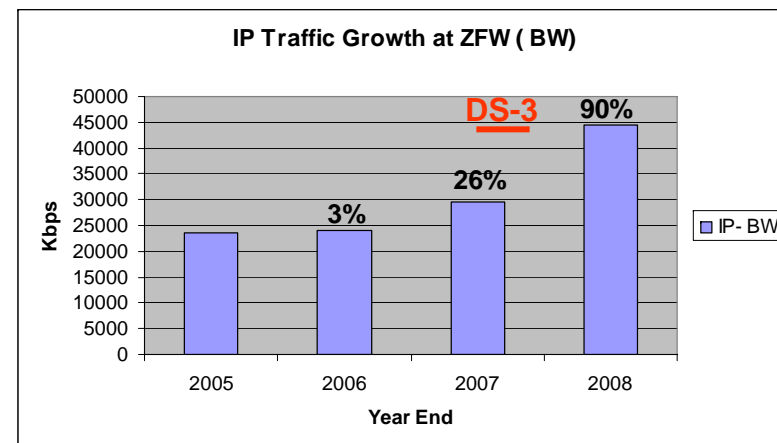
- Total system bandwidth utilization by end 2009 = 77 Gbps
 - 55% is IP traffic
- Total system number of services by end 2009 = 36,500 Services
 - 9% is IP traffic
- IP traffic demands much higher bandwidth per service than non-IP traffic



IP Traffic Bandwidth Growth at Large FAA Facilities



- IP access bandwidth requirements is experiencing significant growth at large FAA facilities
 - More than doubled in one year
 - Most are reaching DS-3 level by end 2008
 - Growth is likely to continue in the next 15 years





Impact of IP Traffic Growth

- **Rapid growth in IP traffic will pose a challenge to the FAA**
 - Increase in facility access capacity requires long lead time to address
 - Increase in telecommunication capacity is costly to FTI stake holders
 - NAS services require high levels of reliability that is met in FTI network by multiple, physically diverse paths from large FAA sites to Inter-Exchange carriers' POPs
 - Will impose an even greater challenge to satisfy increase in bandwidth demand in a timely manner

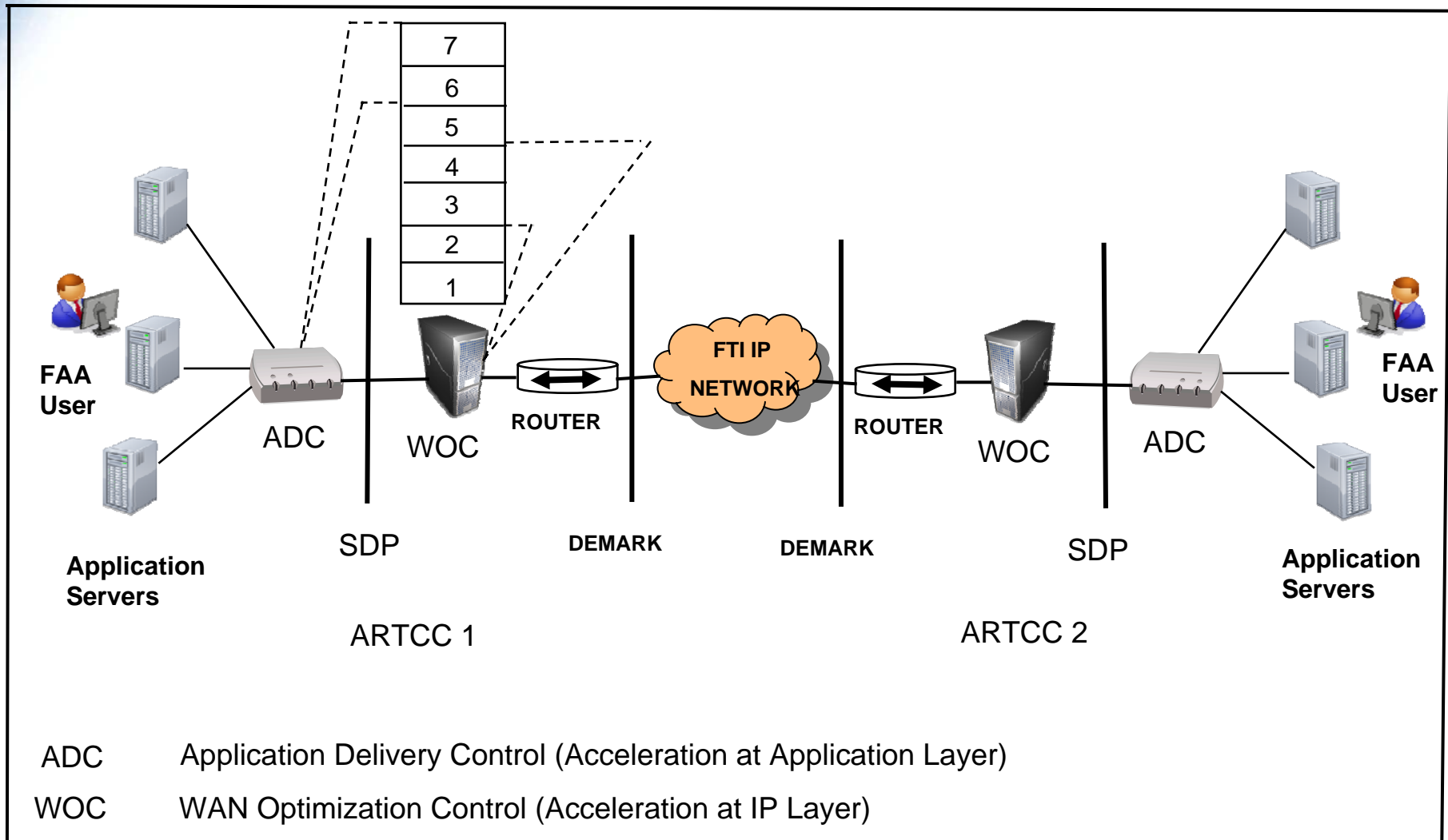


Technologies to Overcome the Need for Increase in IP Access Bandwidth

- **Two types of technologies are used**
 - **WAN Optimization Control (WOC) appliances**
 - Apply acceleration at IP and TCP/UDP Layers (ISO- layers 3 and 4)
 - Caching and network memory
 - Redundancy detection and match patterns
 - **Application Delivery Control (ADC) appliances**
 - Apply acceleration at Application Layer (ISO- layers 6 and 7)
 - BW management, Protocol optimization, object caching, Byte caching and compression
- **Both types require network IP traffic performance monitoring and management**
 - **Network visibility**



Where WAN Optimization Appliances Are Deployed?





Standard IP-based Applications

- **Bulk TCP Applications:**
 - File share CIFS (Common Internet File System)
 - Email exchange, SMTP (Simple Mail Transfer Protocol)
 - HTTP (Hyper Text Transfer Protocol)
 - FTP (File Transfer Protocol)
- **Interactive TCP Application**
 - Citrix (Protocol for safe on-demand access of information)
 - Telnet
 - Remote Desktop
 - SQL (Structured Query Language)
- **Bulk UDP Applications**
 - Data replication
 - NSF (Notes Storage Format)
 - TFTP (Trivial File Transfer Protocol)
 - Others
- **Real Time UDP Applications**
 - Voice Over IP
 - Video
 - Streaming Data



Survey of WAN Optimization Vendors and Appliances (1 of 3)

- **Blue Coat ProxySG is an Application Delivery Controller (ADC) appliance**
 - Accelerates application delivery (BW management, Protocol optimization, object caching, Byte caching and compressing)
 - CIFS, HTTP, MAPI, SSL, RTSP applications
 - Minimize time to perform backups
- **Cisco Wide Area Application Services (WAAS) Network and Software modules**
 - Compression, redundancy elimination, transport optimization and content distribution
 - **Citrix NetScaler for ADC**
 - Data compression, caching, protocol optimization
 - Error control detection to help TCP acceleration
 - No additional appliances at branch offices



Survey of WAN Optimization Vendors and Appliances (2 of 3)

- **F5 Networks BIG-IO-8800 Appliance is ADC**
 - For TCP/IP-based applications such as FTP, HTTP, SSL, Compression, Caching
 - Claimed to be tested and provided superior performance to their competition
- **Ipanema Technologies Traffic Management tool**
 - Deliver accurate measures of performance through automatic measurements at headquarters' site only
 - Provide dynamic optimization of network resources
- **Juniper- WX WAN Accelerators and Central Management System**
 - Compression, caching and system-wide visibility
 - WX -100 for 500-200 remote sites and up to 155 Mbps
 - WX -500 for 60-150 remote sites and up to 20 Mbps
 - WX -250 for 2-15 remote sites and up to 2 Mbps

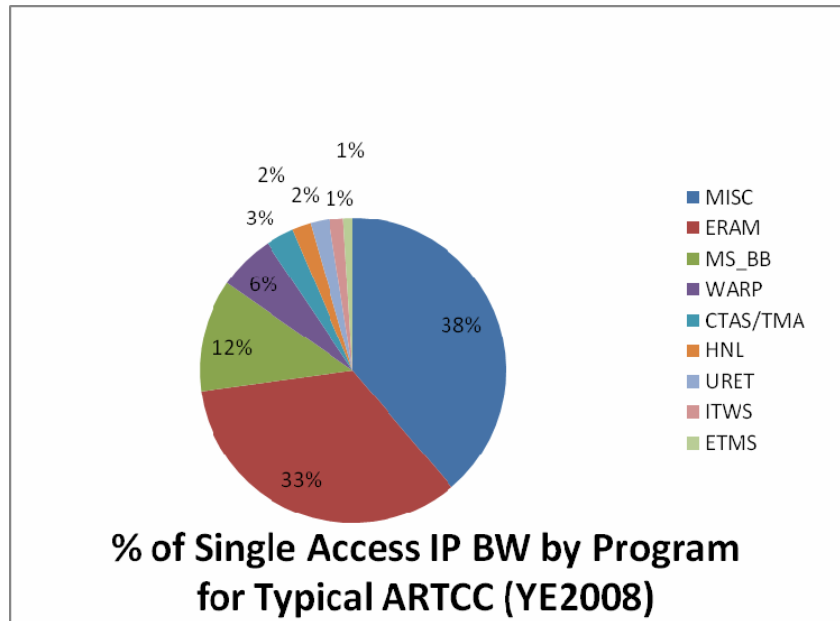


Survey of WAN Optimization Vendors and Appliances (3 of 3)

- **Riverbed Technology Steelhead Accelerator and RiOS software**
 - All TCP-based and UDP-based applications
 - Data, Transport, Application and Management streamlining
- **Silver Peak – NX Series of WAN Acceleration appliances**
 - Provides Network Memory in its WOC appliance
 - Performs Byte-level redundancy detection and match patterns
 - Detects network-wide picture of information sent and its destinations
 - Honors QoS marking or provides outer packet marking for priority.
 - For TCP, introduces adaptive FEC coding at packet level to accelerate delivery



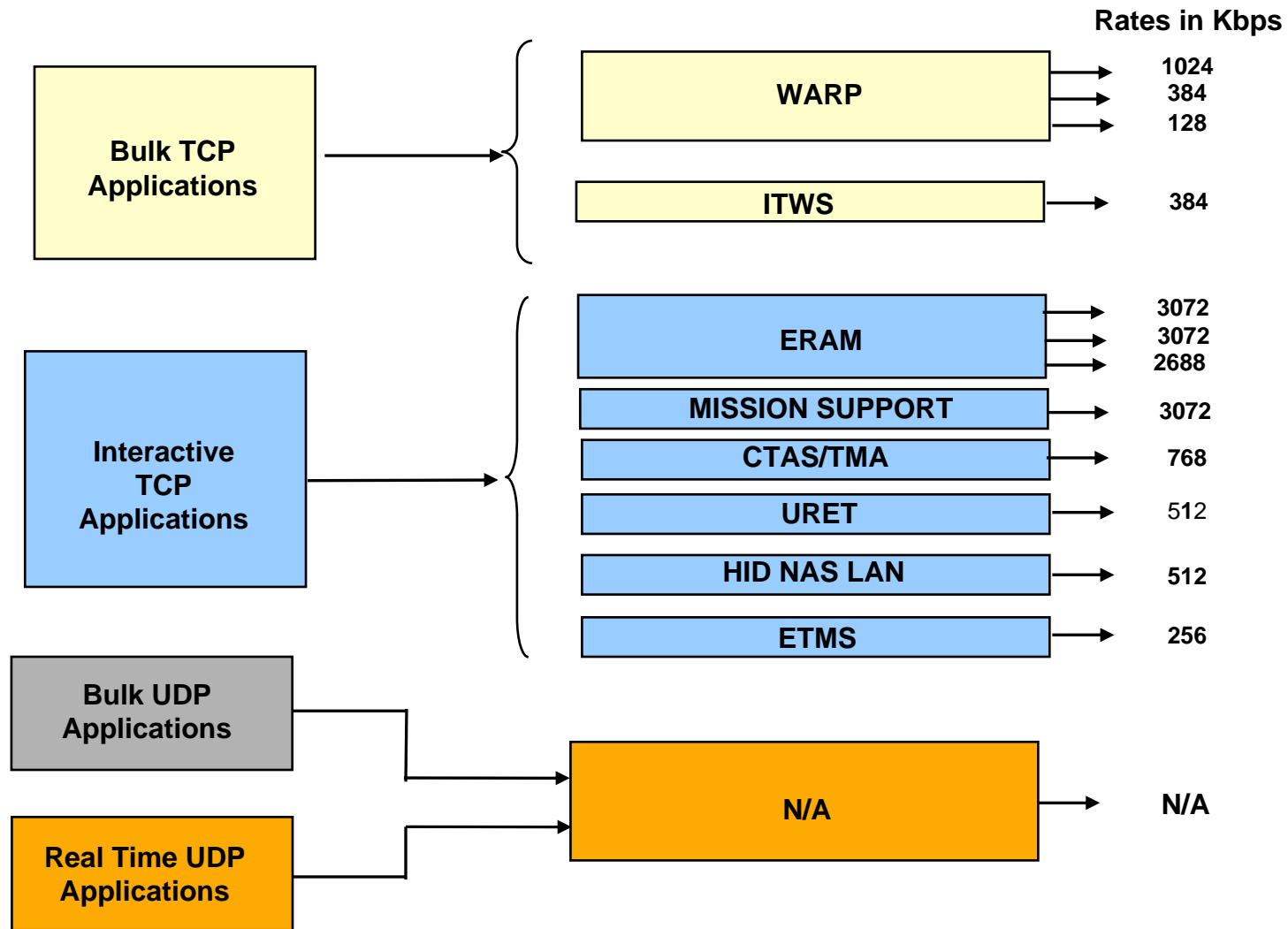
Major IP Applications in a Typical ARTCC Site



Program	Peak Rates (Kbps)	%	Program Description
MISC	10060	38%	Miscellaneous Circuits (Provision of FIRMET traffic during transition)
ERAM	8832	33%	En Route Automation Modernization
MS_BB	3072	12%	Mission Support Backbone
WARP	1536	6%	Weather and Radar Processor (WARP)
CTAS/TMA	768	3%	Center/TRACON Automation System/Traffic Management Advisory
HNL	512	2%	HID/NAS LAN
URET	512	2%	User Request Evaluation Tool (URET)
ITWS	384	1%	Integrated Terminal Weather System
ETMS	256	1%	Enhanced Traffic Management System



Preliminary Mapping Between FAA and ISO Layer 4 Classifications





Evaluation of Appliances' Effectiveness for FAA IP Applications

- **Three FAA applications are selected from the 8 major applications for testing with WAN Acceleration/Optimization appliances across simulated FTI IP network**
 - **En Route Automation Modernization (ERAM)**
 - **Weather and Radar Processor (WARP)**
 - **Integrated Terminal Weather System (ITWS)**



Perform Laboratory Simulation Phase I

- **Use MITRE Telecommunication Laboratory to set up a pair of appliances and load data flows from simulating the above three applications**
- **Set up network monitoring tools to evaluate performance**
- **Test two of the most promising WAN Optimization products for:**
 - **Throughput and latency**
 - **Optimized Operating System**
 - **Traffic Shaping/QoS (Quality of Service)**
 - **Compression**
 - **Data reduction**
 - **Loss mitigation**
 - **TCP protocol optimization**
 - **Application-Specific protocol optimization**



Perform Laboratory Simulation Phase II

- **Expand the test to all current and future major applications to and from the ARTCCs**
- **Increase the number of vendors' appliances by adding the most promising ones surveyed in this paper**



Findings and Summary

- **Future demand for IP-based traffic in the FTI network is expected to dramatically increase in the next 15 years**
- **Enterprises are using the new technology of WAN optimization to limit the increased demand for bandwidth capacity without affecting application layer performance**
- **Examining the performance of some vendors' appliances shows that multiple FAA services may benefit from the new technology**
- **Laboratory evaluation is planned to assess these benefits**



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