Innovative Satellite Networking Solutions to Support Growing End User Demands

Air Traffic Control (ATC)

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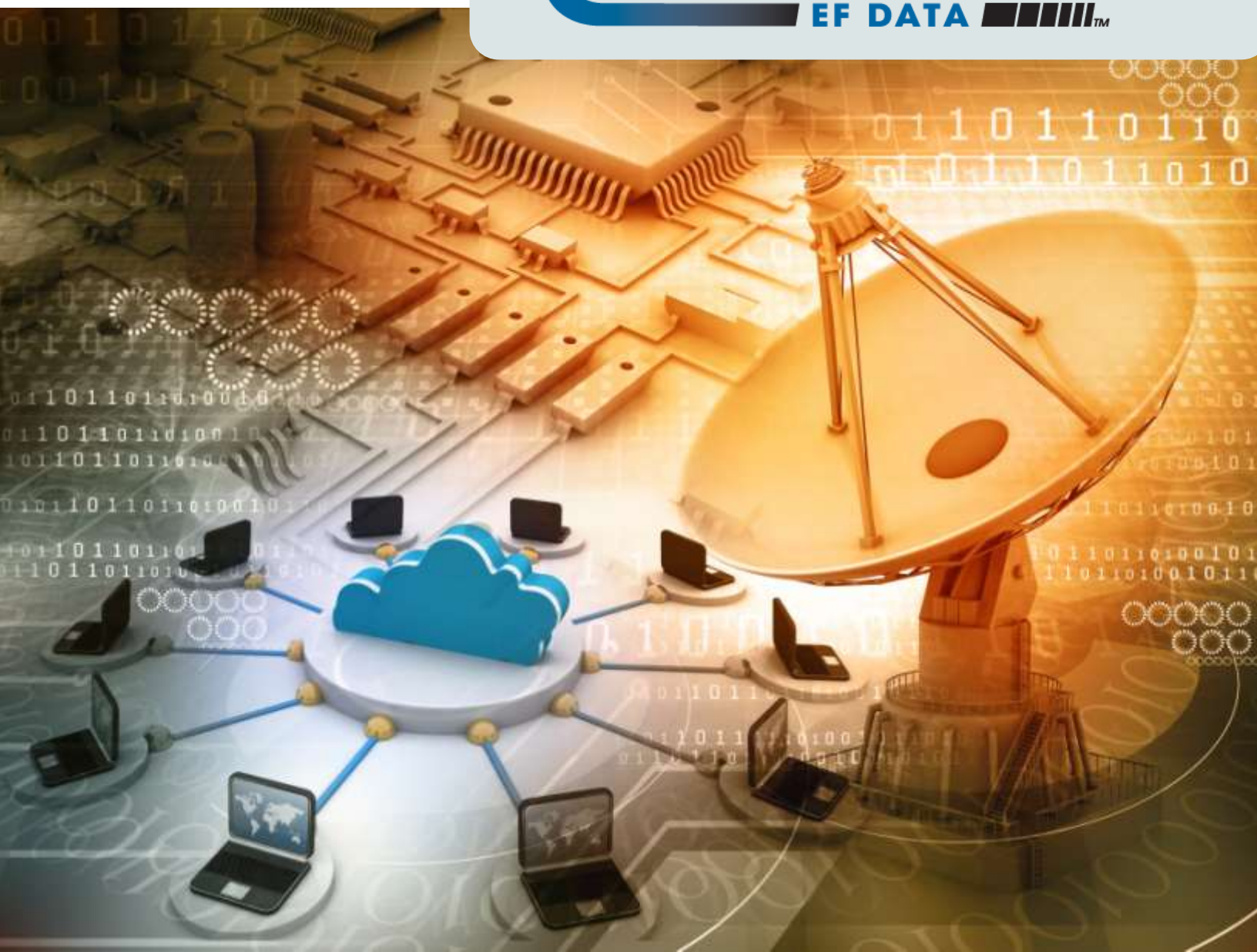

Introduction

The present air traffic control (ATC) system has seen a significant evolution since the time it was introduced in the 1930s. Radars, air traffic control centers, VHF radio communications stations, are some of the means needed for an accurate, efficient, reliable and safe management of air traffic operations. Communications backbone infrastructure is one of the most critical elements to support all above mentioned means.

Today, ATC organizations operate extensive data networks for the transmission of radar and flight plan data, but the limited data capacity of current communications networks places a severe burden on applications and their functionality in the industry. Existing ATC networks support the basic functionality necessary to manage air traffic. However, a shift to an IP broadband communications platform will undoubtedly unleash the scope and effectiveness of current and new applications. Voice over IP (VoIP), for example, will be absolutely essential for the safe handling of air traffic.

The rapid development in technology will definitely open up new opportunities for ATC organizations, from the migration of legacy TDM-based equipment to IP, to the convergence of voice and data for cost savings.

Today's Main Market Challenges

A high-performance communications network that can scale with emerging applications has become a critical requirement for ATC organizations. There is no doubt about the rapid expansion of the digital world in the ATC market. Customers will experience the demand for more packets per second and more bandwidth. The emergence of High Throughput Satellites (HTS) may accelerate this demand.

ATC organizations need a cost efficient solution that will allow the migration of TDM equipment to the IP world. Low-cost hub configurations are needed with the flexibility to expand as more sites are added in the network and higher throughput is required to accommodate bandwidth-intensive applications.

Flight controllers depend on reliable communications for voice, radar and messaging traffic between ATC sites. As aircraft move from one airspace zone or sector to another, the transfer must be clearly communicated and seamless. Terrestrial infrastructure may not be available anywhere and anytime to connect radar signals or messaging traffic.

The challenge here is the ability to provide regional to global seamless connectivity where and when it is needed and to be able to do so automatically and dynamically.

Market Demand Drivers and Applications

Communication is a key element in the ATC system, and advances in technology are opening new options for configuring the system in the future. Historically radio has been the primary and almost exclusive method of communicating between aircraft and the ground. Today, the ATC world is faced with the increasing use of IP technology in other communication networks. Let's review a few of the main factors driving change in the ATC market:

- **Migration of legacy TDM equipment to IP –** Telecommunication service providers are now phasing out their leased line TDM services as the equipment becomes obsolete and increasingly difficult to maintain and repair. IP equipment offers higher reliability, greater flexibility, higher capacity and lower costs. Initiatives such as the FAA NextGen in the US or the Single European Sky (SES) in Europe require existing airports to modernize their telecommunications network.
- **Voice over IP as a key ATC technology –** VoIP is the technology of the future in ATC. VoIP offers operational functionality and flexibility which would have been unthinkable with the TDM-based systems of the past. It also provides significant financial advantages. The trend towards VoIP will be accelerated by its successful standardization in the ATC sector by the European Organization for Civil Aviation Equipment (EUROCAE) Working Group (WG67), and the adoption of these standards by the International Civil Aviation Organization (ICAO). After years of transferring radar data for air traffic management over IP networks, IP technology is now expanding its way into voice communications. This creates synergies in procurement, installation, operation and maintenance; all of which lead to reduced infrastructure costs. This has a direct impact on the return on investment.

Moving to all IP also increases the reliability of the system as IP networks do not rely solely on duplicating high-cost centralized equipment like TDM systems, but instead rely on various, distributed IP equipment to avoid a single point of failure.

- **Interoperability –** Eurocontrol, the Federal Aviation Administration (FAA) and other organizations mandated interoperability requirements to handle increased air traffic. The EUROCAE issued the standard ED-137 which specifies the use of IP for voice communications in ATC environments. This standard was defined jointly between EUROCAE, ATC authorities and ATC equipment manufacturers. Customers that select equipment which meets this standard can be assured that the various system components interoperate properly with one another.
- **Increase of system capacity –** The ATC market is **a**dopting live and high-definition video as an attractive tool for traffic control and management and video surveillance. One of the challenges is the increased difficulty of moving huge flows of data up to the Traffic Operations Center (TOC) and connecting multiple control sites to accommodate growth.

End users in the ATC market require assured, secure, and reliable satellite communications for their mission-critical applications, and communicate safely within closed user groups. The migration towards IP, though beneficial to applications, dramatically increases bandwidth demands. As secure VoIP and data transmission requirements evolve, and satellite transmission costs grow, the ATC market faces the challenges of delivering more data with greater reliability while minimizing the Total Cost of Ownership (TCO).

Comtech EF Data understands the challenges and the inherent security requirements of this market as evidenced by the use of our products in ATC systems around the world. Our extensive range of satellite modems and networking platforms are bandwidth-efficient, provide high throughput and packet processing capabilities and are TRANSEC compliant and FIPS 140-2 Level 2 certified. In addition, our new RF products, LPOD-R Block Up Converters (BUCs) are compact in size and weight, which make them an ideal choice for remote sites with real estate constraints.

Comtech EF Data Product Positioning and Suitability for ATC

Comtech has the Heights Networking Platform and the CDM-570A Satellite Modem products for addressing the different aspects of the ATC market.

Supplemental to this and certainly enhancing our modems and networking platforms are our line of Memotec NetPerformer™ multiplexers and RF products. Any of these products, in any band and any power levels can be managed by our NetVue Network Management System.

Figure 1 below provides an overall graphic representation of our products for the ATC market.

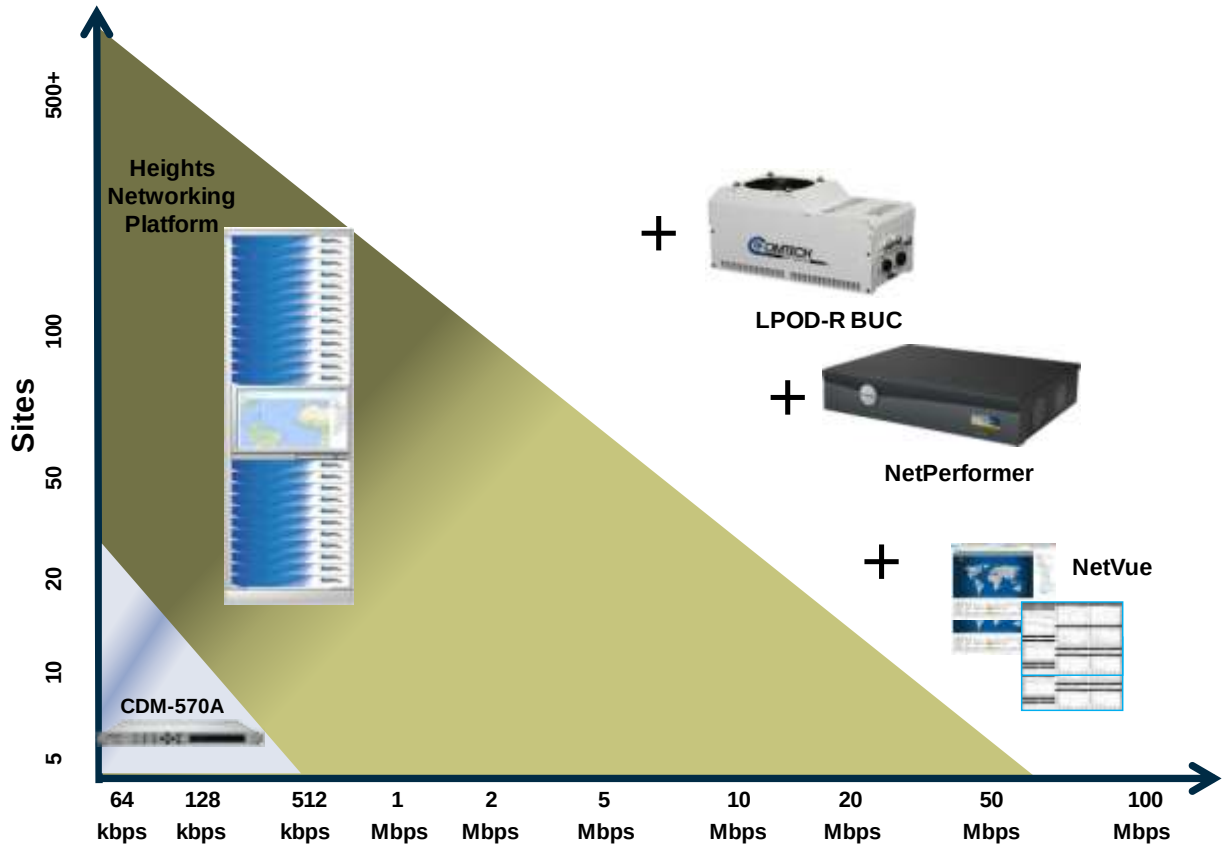

Figure 1: Product Positioning

Facing Future Challenges – Comtech EF Data Product Suite

Comtech EF Data offers reliable, secure, flexible and cost-effective solutions for your satellite-based network infrastructure. Our solutions enable a seamless integration with existing infrastructures and are interoperable with any IP-based hardware.

Heights™ Networking Platform Solution

Designed to address the market challenges, Heights is a scalable networking platform that utilizes a fully managed platform with seamless integration into your network. The most net efficient, flexible and powerful platform in the industry, Heights leverages a single comprehensive user interface teamed with a powerful traffic analytics engine that allows you to easily design, implement, monitor, control and optimize your network. The result is an elevated QoE for you. It is equipped to support the most demanding networks on traditional wide beams, new HTS spot beams or a combination of both.

The intelligence, horsepower and efficiency of this platform as outlined in Figure 2 provide unmatched performance while minimizing the Total Cost of Ownership.

Heights Key Differentiators

- Comprehensive and dynamic bandwidth management
- Bandwidth efficiency
- Military-grade security
- Highest link availability with bi-directional Adaptive Coding and Modulation (ACM)
- Advanced multi-level Quality of Service (QoS)
- True layer 2 operation
- Low latency and jitter
- High throughput and packets per second processing capacity

Figure 2: Heights Attributes

CDM-570A – Point-to-Point or Point-to-Multipoint (Hub-and-Spoke) Modem

Comtech EF Data has been a thought leader in the high-end satellite ground equipment market for decades, providing customers in the ATC market the most cost-effective satellite networking solutions.

The CDM-570A Satellite Modem (Figure 3) has industry-leading performance and flexibility in a 1 RU package at a very competitive price. With support for VersaFEC® low latency LDPC Forward Error Correction (FEC), the revolutionary DoubleTalk® Carrier-in-Carrier® bandwidth compression, and optimized transmit filter rolloffs, the CDM-570A provides significant bandwidth savings.

This entry-level modem is perfectly positioned to provide the most efficient solution to best support low data rate point-to-point links, while also powering the point-to-multipoint shared satellite networking market for small to medium networks.

Figure 3: CDM-570A Satellite Modem

Memotec NetPerformer

The NetPerformer line of equipment combines the functionality of a data router, a multiplexer and a voice gateway in a single device, enabling ATC users to create converged networks and transport any type of traffic over satellite or terrestrial links.

Designed to provide maximum network performance and reliability in low-bandwidth environments, the NetPerformer reduces network infrastructure costs and simplifies Wide Area Network (WAN) connectivity for mission-critical applications. The NetPerformer's voice and data compression technology, prioritization and multiplexing capabilities and the ability to route all traffic over a highly efficient cell-relay based protocol, make it the product of choice for converged voice and data applications over satellite.

The NetPerformer provides a safe migration path from legacy TDM or Frame Relay networks to IP-centric networks. It includes support for the latest VoIP (SIP) standards and robust IP/Ethernet Quality of Service (QoS), with eight classes of service and 16 levels of prioritization to ensure that mission-critical applications always receive sufficient bandwidth. In addition, specialty features are available for handling the particulars of radar, voice push-to-talk (PTT) and VHF voice applications common to air traffic control networks.

The SDM-9220, SDM-9230 and SDM-9606 NetPerformer models maximize network performance and provide superior convergence capabilities to ensure efficient and secure transport of multiple communications services. With support for up to five expansion slots, the NetPerformer protects your investment, ensuring network scalability that matches your expansion requirements.

The SDM-8400 Serial Port Extender enables SDM-9220, SDM-9230 or SDM-9606 users to increase serial port connectivity allowing those products to scale linearly with either 4 or 8 port extenders. The SDM-8400 supports all the same protocols and capabilities as the SDM-9220, SDM-9230 and SDM-9606 Integrated Access Routers.

Our line of NetPerformer multiplexers is depicted in Figure 4 below.

NetPerformer Key Differentiators

- Extensive telephony, legacy data & LAN interface
- Wide range of voice codecs
- VHF Extended Range (ER) support (low delay codec, VHF over IP, Link delay compensation)
- Voice traffic routing
- Data routing & bridging
- PowerCell: Traffic shaping
- Efficient and proven QoS for carrier-grade voice quality
- Flexibility, network resiliency and high availability

SDM-9606 – 5 expansion slots

- SDM-9606 blades
- 6 T1/E1
- Up to 120 channels per blade

SDM-9230 – 3 expansion slots

- 120 digital voice
- Up to 6 T1/E1s (data or voice)
- Up to 12 analog

SDM-9220 – 2 expansion slots

- 2-8 analog
- Up to 4 T1/E1(data only)

SDM-8400 – 4 or 8 serial port models

- Provides incremental scalability of satellite and broadband networks
- Units daisy chained with PVCR/IP protocol
- All ports support synchronous, asynchronous or transparent

Figure 4: Line of NetPerformer Multiplexers

RF Products

Our LPOD-R family of Outdoor Amplifiers / Block up Converters deliver rated power, guaranteed to the transmit waveguide flange at the 1 dB compression point. There are three LPOD-R models available – PS .5, PS 1 and PS 1.5. Each LPOD-R consists of a SSPA module with the Monitor/Control Processor (MCP), a power supply and a fan assembly. To ensure the maximum usable output power with stable operation over a wide range of environmental conditions, the units feature a low loss combining technique and MCP-based temperature-versus-gain compensation. Figure 5 shows our range of LPOD-R BUCs.

Figure 5: Family of LPOD-R BUCs

Comtech EF Data Product Matrix for ATC

Table 1 below provides a feature summary of the different satellite products and where each fits.

Features		Heights	CDM-570A
Network Topology	Point-to-point		√
	Hub-and-spoke	√	√
	Mesh network support	√	√
Network Topology / Network Size / Data Rate	Point-to-point (any size)		√
	< 2 Mbps / link		√
	> 2 Mbps / link		
	Hub-and-spoke		
	• Small network, < 5 Mbps outbound		√
	• Small network, < 512 kbps return		√
	• Medium network, > 5 Mbps outbound	√	
	• Medium network, > 512 Kbps return	√	
	• Large network	√	
VLAN support/Layer 2 operation	Point-to-point		√
	Hub-and-spoke	√	
QoS	Single layer		√
	Multi layer	√	
DoubleTalk Carrier-in-Carrier	Point-to-point		√
Bi-directional ACM	Point-to-point		√
	Hub-and-spoke	√	
Data encryption		√ (Future)	√ (3xDES)
Data interfaces		Gigabit Ethernet	Sync EIA-422/530, V.35, EIA-232, G.703 T1/E1, 10/100Base T

Table 1: Satellite Product Matrix for ATC

Focus on Quality of Experience (QoE) and System Interoperability

There are a multitude of vendors claiming the best optimization available. However, we believe that for a successful business model, customers for ATC must place a focus on QoE. QoE is a necessary benchmark, which provides a true end-to-end view of offered services, even though it is subjective and based on end-users' perceptual feedback.

Figure 6 summarizes the key attributes needed in order to deliver the best QoE to end users. Let's delve into what QoE means for you.

Figure 6: Main attributes for a maximized QoE

Robust Intelligence

Managing large-scale and geographically distributed ATC facilities is extremely difficult, especially with sites that do not have technical personnel. End users must be able to monitor and control remote sites anytime, and from anywhere.

Throughout the life of a network, a great deal of intelligence is required to ensure you are delivered a maximized QoE. The ability to acquire and apply knowledge, to gather network information, and to dynamically manage bandwidth operations are key issues to address.

Comtech EF Data's solution to these issues is our NetVue™ Integrated Management System with dynamic bandwidth management.

NetVue leverages a single intuitive graphical user interface teamed with a powerful traffic analytics engine that acts as a user-friendly front-end to monitor and control network equipment and allows simplified design, implementation, monitor, control and network optimization for an elevated QoE. It is a comprehensive network management system that allows you to intelligently maximize resources, ensures network uptime and makes it easy to quickly set up and manage new remote sites.

NetVue is coupled with a dynamic bandwidth manager to provide scalable, dynamic satellite capacity management that facilitates bandwidth-sharing, automates space segment allocation and manages "pools" of available bandwidth. This feature provides the architecture to dynamically manage bandwidth operations without requiring dedicated bandwidth for each remote location. Users can remotely modify bandwidth allocations as requirements change automatically by the type of traffic or the traffic load, or manually, without requiring costly upgrades or site visits. Unlike other MF-TDMA systems on the market, return traffic packets are not fragmented to meet the burst length criteria, which in those systems impose additional overhead management traffic.

Using NetVue for network provisioning, monitoring and control reduces NOC personnel workloads and data duplication through operations optimization and automation. It also reduces CAPEX and TCO through increased efficiency of network usage and improves QoE through error minimization, proactive troubleshooting and trouble ticket prioritization.

Availability and Reliability

The ATC market demands efficient and reliable connectivity available on a 24/7 basis to support the communications needs between remotes and hub facilities, even during the most adverse weather conditions. As terrestrial infrastructure may be lacking in some of the remote areas, end users are increasingly depending on satellite communications that can support the required throughputs. These are concerns that we are addressing with the implementation of bi-directional Adaptive Coding and Modulation (ACM) with Heights, our newest networking platform.

Bi-directional ACM embedded in the Heights Networking Platform provides a unique and important feature to provide high availability and reliability. With the ability to maximize throughput under all conditions – rain fade, inclined orbit satellite operation, interference and other impairments – bi-directional ACM allows for automatic change in modulation and coding (MODCOD) in response to link conditions in both directions. Each remote can achieve maximum throughput thereby maximizing network efficiency and availability. An average throughput gain of 100% (or more) can be realized, when compared to using traditional rain fade margins. Integrated in Heights with advanced QoS and other optimization technologies, bi-directional ACM maximizes network efficiency and availability to maintain desired service levels.

Security

Security is a necessity and a top priority for the ATC market. The ATC system is constrained by national security considerations as it must meet both civil and military requirements. A security breach in the system could have disastrous consequences. There is, of course, the possible very negative impact on flight safety. It could also impact the provision of communications between air traffic controllers and airlines, between air traffic controllers and airport authorities and potentially the confidentiality, integrity and availability of data. It is important to have ground equipment that is secure enough to mask the content, location, type and amount of information sent via satellite and hide satellite communications patterns.

Encryption and anti-jam capability are the primary factors determining the availability and reliability of a system. The way we are tackling this issue is with the implementation of Transmission Security (TRANSEC) and AES-256 encryption. Our equipment is Federal Information Processing Standard (FIPS) 140-2 level 2 compliant. Our satellite modems include a single FIPS card that will perform bulk encryption of all packets for transmission over the satellite regardless of the protocol, the format of data, or existing encryption on the incoming data. The TRANSEC module uses 256-bit AES for bulk encryption of any data and control information requiring encryption and provides the highest level of security for a satellite network.

Building a TRANSEC-compliant IP-based network prevents transmission activity from being used for intelligence gathering. Implementing FIPS 140-2 negates the risk of detection of repetitive data streams. Providing public-key cryptography for authentication ensures that remotes and hubs are authorized and validated in the network.

Minimize Latency & Jitter

Business applications such as Citrix and other similar applications are sensitive to latency. Timeouts cause unnecessary retransmissions further straining the satellite network or even terminating connections. This leads to unsatisfactory user experience with negative impacts on your bottom line.

Real-time applications such as VoIP and videoconferencing require minimal jitter. The high quality transmission of Push-to-Talk (PTT) requires minimal and constant propagation delay to deliver the voice traffic to the VHF base stations at different remote locations simultaneously. If packets are not received with near-constant time variation, tight jitter thresholds are surpassed for many applications, causing connections to terminate. On the same token, a variable packet reception reduces perceived voice and two-way video quality, thus lowering the QoE.

Minimizing jitter and latency is crucial for accommodating real-time voice and data. Our assured transmission media access, Single Channel per Carrier (SCPC) and dynamic SCPC (dSCPC), provides minimal jitter (no waiting for bandwidth allocation) and minimal latency, offering performance and a user experience that TDMA cannot match.

Another way we are tackling this issue is by combining our multi-level group QoS with our technology efficiencies while providing the levels of horsepower in the remote equipment required for faster packet processing.

With Adaptive Coding and Modulation (ACM), group QoS is an important feature to improve bandwidth management while meeting and maintaining desired SLAs. It enables service providers to seamlessly share the outbound and inbound among multiple customers for differentiated services with a focus on Quality of Experience.

Another powerful feature is our next generation, inbound VersaFEC-2 high-performance LDPC Forward Error Correction (FEC) waveform with short-block, suitable for applications requiring minimal latency and jitter. VersaFEC-2 short block was designed for low to medium throughput. It is one of the two operational modes and provides 36 MODCODs (BPSK to 32-ARY) with better performance than the industry-proven VersaFEC at similar or better data latencies. VersaFEC-2 High Rate, designed for higher throughput provides 38 MODCODs (BPSK to 32-ARY) with coding gain and spectral efficiencies better than DVB-S2 and on par with DVB-S2x at approximately 1/8 the data latency of these two standards.

Coupled with Group QoS and VersaFEC-2 are the Heights Remote Gateways. These powerful tiered Remote Gateways are designed to meet the specific needs of users in the ATC market with inbound user IP throughput of up to 64 Mbps and packet processing from 35,000 packets per second (pps) up to 140,000 pps with all optimization features such as compression enabled. With these performance levels, the Heights Remote Gateways have the most powerful IP packet processing engines in the market.

With Group QoS, VersaFEC-2 short block and our powerful remote equipment, you will ensure your most latency and jitter sensitive applications operate properly to maximize productivity and ensure the lowest overhead with highest bits/Hz ratios while minimizing oil rigs and above-deck real estate requirements.

Efficiency, Flexibility and Scalability

With tight budget constraints ground equipment manufacturers must constantly strive to maximize efficiency, to improve bandwidth utilization and user throughput to stay ahead. Another challenge is to support multiple network configurations and frequency bands and have the ability to dynamically reallocate bandwidth where needed. This calls for the use of advances in modulation, coding gain, fade adaptation and intelligent data processing to provide increased capacity, improved reliability and substantial savings in bandwidth while maintaining contracted SLAs.

The Heights platform provides the most attractive economics for mission-critical services via multi-layer optimization to provide the highest spectral efficiency (user IP bits / Hz) in its class.

Implemented in the inbound is our VersaFEC-2 high-performance LDPC Forward Error Correction (FEC) waveform as mentioned above. The Efficiency Boost (EB) waveform for the outbound provides a 10-35% increase in efficiency over the DVB-S2 standard, controlling operating costs while providing up to 450 Mbps outbound user IP throughput. This is accomplished by virtually doubling the number of available MODCODs from previous Comtech products, introducing three optimized roll off factors (5%, 10% and 15%) in addition to 20%, 25% and 35% and minimizing implementation loss to near theoretical operation.

Our dynamic bandwidth management capability using dSCPC enables dynamic allocation and sharing of bandwidth and power among users. Bandwidth requests can be based on:

- Load switching based upon traffic level, providing additional bandwidth to remotes under heavy load conditions.
- Type of Service (ToS) switching based upon pre-defined ToS / DSCP values, providing dedicated bandwidth for applications such as video and voice that require it.

Like TDM/TDMA systems, in our TDM/dSCPC networks, the outbound traffic from all remotes shares a common carrier, enabling the advantages of dynamic bandwidth allocation and associated statistical multiplexing. The difference between both systems is on the inbound link. With our system, in the dSCPC inbound link, each terminal is assigned a dedicated SCPC carrier. Dynamic allocation of capacity is achieved by varying modulation, FEC type, center frequency and channel bandwidth of return carriers assigned to individual terminals in response to traffic demands.

The Heights Networking Platform provides the lowest cost solution for hubs supporting fixed or remote terminals, scaling from tens to thousands of sites economically. Two hub options are offered:

- Heights Solo – Single network hub with single outbound carrier and shared bandwidth pool for inbound connections.
- Heights VNO – Multi-network hub with multiple outbound carriers along with multiple associated shared bandwidth pools for inbound connections.

The scalability and flexibility of Heights removes the traditional barriers to entry in the satellite market and provides a gradual network expansion to quickly adapt to changing requirements.

Higher Throughput and Packet Performance

Our remote equipment meets the unique needs of ATC customers. This includes the capability to support data telemetry (tracking and weather radars, control lines) and specialized voice applications (VHF radio support, hotlines).

Each remote in the network is assigned bandwidth on-demand from a shared bandwidth pool by the dynamic bandwidth management engine using dSCPC and leverages its own optimal modulation and coding method. The dynamic bandwidth allocation is ideal for bulk file transfers since bandwidth is dynamically assigned where needed. Our Remote Gateway's processors are capable of supporting high packets per second (pps), from 35,000 pps up to 140,000 pps with all multi-layer optimization features enabled, thus overcoming the packet processing limitation found in other competitive products on the market.

These performance levels enable the Heights Remote Gateway suite to support the most demanding traffic mixes in a single unit. We leverage an extensive combination of modulation and coding for maximum efficiencies to provide the ability to transmit the high throughput needed.

Traffic Shaping

To ensure air traffic controllers have access to the mission-critical information when needed, it is important to segregate bandwidth by real-time applications versus non real-time "delay-tolerant" applications across shared satellite bandwidth, or prioritize critical monitoring functions to take precedence over non-critical applications.

Our multi-level QoS feature sets Comtech EF Data apart and leverages a powerful classification and traffic shaping engine that ensures the highest "value" traffic is prioritized, the most important services are uninterrupted and crucial applications continue to function properly.

For efficient IP networking and transport over satellite, Heights features high-performance packet processing capabilities with header compression, lossless payload compression for non-encrypted data, very low overhead encapsulation and multi-level QoS that is fully integrated with ACM and dSCPC. By removing and intelligently reassembling the header of an IP packet at the other end of the satellite link (IP header compression) and similarly applying a compression algorithm to the entire frame payload (payload compression) for non-encrypted traffic results in significant additional bandwidth savings.

Our header compression technique inspects the IP headers and examines the data flow to determine what we can remove as unimportant data before we send that information over the satellite, and intelligently reinsert that data on the receiving end. In addition, there is a lot of redundancy in data streams, some of which can be removed before transmission over the satellite. If a stream of data has been transmitted in the past, a much smaller representative set of data is sent along with a lookup location of past bit streams. By removing this unnecessary data and replacing it with a much smaller marker, users can realize additional savings, increasing net efficiency even further.

With lossless compression, Comtech EF Data ensures the complete accuracy of each bit on the remote end of the link, a key consideration for your end user's mission-critical applications. This type of accuracy requires significant horsepower on board the platform to be able to process this data at tens or hundreds of Mbps, which is what our Remote Gateways provide.

The result of leveraging these intelligent compression techniques is the conversion of a given number of "router bits" (those packets delivered to our units) into the least "satellite bits" (those transmitted through the spacecraft). Our equipment does all of this while providing the proper application-based and protocol-dependent QoS throughout the network.

Heights for High Throughput Satellites

High Throughput Satellites with the combination of spectrum efficiency and performance of overlapping spot-beam with ultra-wideband transponders are an attractive option to the ATC market. The potential of HTS to reduce costs, especially during these budget constraint times will be very attractive.

The operational environment of HTS carries unique issues for the ground equipment, namely, its scalability, a multiple outbound transmit capability and the digital power of the ground equipment. The private network Solo and the VNO hub of the Heights platform are flexible and scalable to support any satellite architecture in any frequency band. The Heights VNO hub provides a lower cost approach to enter service.

The Heights Networking Platform has a multiple outbound transmit capability that is very unique. This design of a single modulator to be able to transmit smaller, multiple outbound carriers fits the spot beam requirements of High Throughput Satellites. On the receive side of the hub, there is sharing of the demodulator banks for a lower hub CAPEX solution.

The digital power of the ground equipment provides an extensive number of modulation and coding combinations to maximize the efficiency across the satellite links. There is also the high processing power on the remote gateways to insure increased throughput. Together these capabilities are such that it enables the promise of HTS to deliver greater throughput to any given location for the same antenna size and the same BUC size than with existing satellites.

Use Case – ATC Network in Latin America

A customer in Latin America needed to replace its old ATC network with a new satellite networking solution to connect its 20 sites to support its mission-critical applications. The organization initially selected a vendor with a traditional TDMA/multiplexer solution, but quickly realized that the installed system did not meet the unique requirements of their ATC network and could not support future network expansion.

In the TDMA oversubscribed network solution proposed by the "other" vendor, latency and jitter increased significantly. In an oversubscribed network, as oversubscription ratios rise the network compensates by increasing processing delay, thereby raising latency. TDMA architectures with shared bandwidth functionality are well suited for highly "bursty" traffic but the effect of bandwidth sharing techniques on the burst demodulators at the hub resulted in high latency and increased jitter that could not be tolerated by the customer's applications.

After review of other solutions, Comtech EF Data/Memotec was selected to replace the TDMA network and provide the satellite solution that will address the customer's needs and challenges.

Requirements

The customer needed a point-to-multipoint solution that provides reliable (with satellite diversity), clear and secure communications for radar traffic and E&M PTT with low latency and low jitter and 99.9% reliability which is crucial for ATC networks. It also needed the solution to provide ultra-low delay codec (LDCD) 16 Kbps for VHF point-to-multipoint. The customer also wanted to deploy a highly efficient satellite networking platform that minimizes OPEX, provides increased operational efficiency and accommodates current and future networking needs.

Solution

We provided a solution based on our dSCPC hub-and-spoke platform with CDM-570AL Satellite Modem, CDD-564A Demodulator and the NetPerformer SDM-9230 multiplexer for multiplexing of legacy voice and data systems and routing of IP traffic over VSAT.

At the forefront of the proposed solution was our NetVue Integrated Management for monitoring and control of remote sites anytime, from anywhere and our Dynamic Bandwidth Manager for dynamic bandwidth allocation. NetVue, coupled with our Dynamic Bandwidth Manager provided scalable, dynamic satellite capacity management that facilitates bandwidth-sharing, automates space segment allocation and manages “pools” of available bandwidth without requiring dedicated bandwidth for each remote location.

Figure 7 depicts the high level network diagram of the proposed solution.

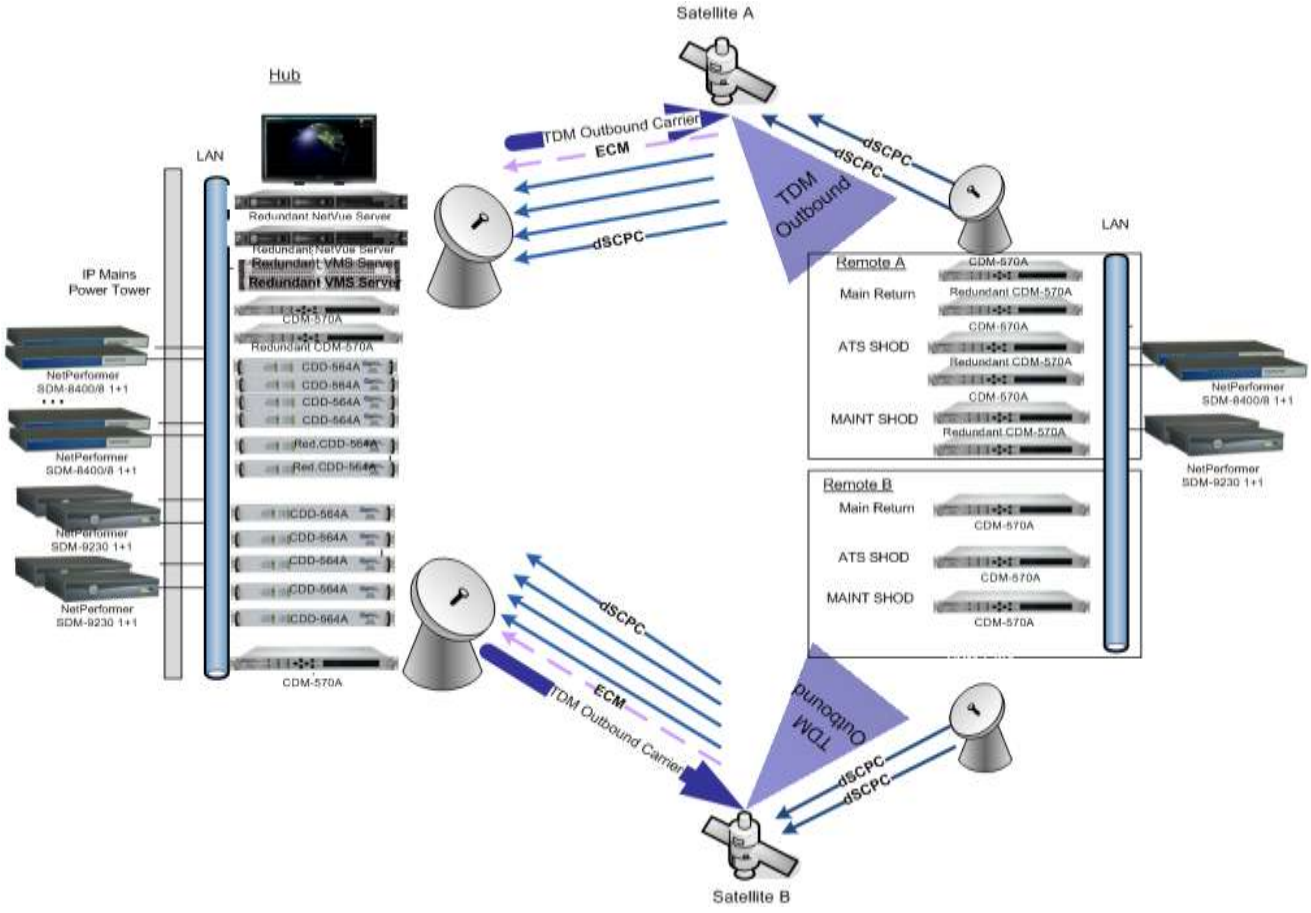

Figure 7: High Level Network Diagram - ATC Solution

The difference between our proposed system and the “other” vendor TDMA option is on the inbound link. In the dSCPC inbound link, each terminal is assigned a dedicated carrier. Dynamic allocation of capacity is achieved by varying modulation, FEC type and/or channel bandwidth of return carriers assigned to individual terminals in response to traffic demands. Our dSCPC solution provides SCPC bandwidth based on demand, thus being dynamic bandwidth utilization with the benefit of SCPC. Using this method the remote sites share one or more pools of bandwidth for their return or inbound links.

The Dynamic Bandwidth Manager coordinates the bandwidth requests and use of each of the remote sites in the network. Bandwidth requests are based on load switching based upon traffic level or Type of Service (ToS) switching based upon pre-defined ToS / DSCP values.

Deployed around the world by multiple ATC organizations, our Memotec NetPerformer SDM-9230 efficiently groomed voice and data traffic streams to optimize bandwidth capacity and minimize satellite costs without compromising performance.

Push-to-talk communication was an integral component of the customer's ATC communications needs. The safety of the entire airport population, from the ground crew, to the flight crew, passengers and airport staff, depends on reliable, clear and timely communications to and from the control tower. High quality transmission of Push-to-talk requires minimal and constant propagation delay to deliver the voice traffic to the VHF base stations at different remote locations simultaneously. By integrating the Push-to-talk interface within the system and using an ultra-low delay codec (LDCD) with an exclusive sampling time of only 0.625ms, Memotec NetPerformer ensured the highest voice quality possible. The bandwidth management techniques guaranteed service integrity and safe transmission of the VHF voice signal. The dynamic jitter buffers also compensated for the satellite link delay variations and enabled timely delivery of the VHF voice signal.

The optimal satellite bandwidth to reduce OPEX was achieved with our efficient modems with dozens of advanced MODCODs, optimized roll off filters and compression techniques.

Outcome

The outcome of the implementation of our solution was:

- 99.9% network reliability achieved via a customized A/B automatic switch-over approach.
- A reliable and clear communications over satellite for both Radar Traffic and E&M Push-to-talk providing low jitter, low latency and high Quality of Service (QoS) due to our assured SCPC based transport with multi-level QoS.
- A LDCD 16 Kbps for VHF point-to-multipoint for 5 ms sampling achieved via our proprietary design technique.
- A robust intelligence to maximize the QoE.
- An optimal satellite bandwidth lease and reduction of OPEX achieved with our dSCPC solution, our groundbreaking, industry-leading bandwidth efficiency and network optimization and voice compression techniques.

Conclusion

Is your satellite networking infrastructure ready to meet market demands? To achieve your business growth goals, you need a powerful, dynamic networking platform that outperforms the rest and guarantees optimal levels of service beyond a one- or two-year business case.

Comtech EF Data's extensive range of satellite networking platforms, satellite modems, multiplexers, RF products and dynamic bandwidth management tools will provide you with the solution for your ATC mission-critical applications. Our CDM-570A with DoubleTalk Carrier-in-Carrier allows you to minimize OPEX, maximize throughput without using additional transponder resource and maximize availability (margin) without using additional transponder resources. Our newest networking platform, Heights is future-proof, reliable, flexible, scalable and HTS-ready with minimal site intervention. The platform meets the tight security requirements for this market and provides a higher QoE per user, at a lower cost per delivered bit. Heights is a fully managed platform focused on the intelligence to enable dynamic allocation of bandwidth when and where it is needed, on efficiency and horsepower to maximize the QoE, all while minimizing the TCO, and meeting stringent SLAs and tight security requirements.

For additional information, please contact us.

Email: sales@comtechefdata.com
Voice: +1.480.333.2200
Fax: +1.480.333.2540
Web: www.comtechefdata.com