UNIVERSAL® AVIONICS
SYSTEMS CORPORATION

Understanding Data Comm Systems with FANS 1/A+, CPDLC DCL and ATN B1

White Paper

Doc No.: WHTP-2013-18-10
January 2017

Safely guiding pilots and their passengers worldwide for over 35 years™

Executive Summary

Regulatory efforts to promote Data Communications (Data Comm) enabled capability, establish equipage mandates, and further develop Communication, Navigation and Surveillance / Air Traffic Management (CNS/ATM) systems have been ongoing for years. It is accurate to say that Data Comm is one of the most complex system developments undertaken by domestic and international air traffic control organizations and their associated regulatory agencies in the history of aviation.

The technology of Data Comm has been utilized in the North Atlantic for over three decades, originally rolled out as a cost saving feature from aircraft OEMs. Recently, U.S. and Canadian authorities have established Future Air Navigation System (FANS) 1/A+ requirements in certain North Atlantic airspaces, and Aeronautical Telecommunications Network, Level B1 (ATN B1) capability in European airspace. In the United States, the Federal Aviation Administration (FAA) is implementing FANS Domestic functions by initially implementing Controller-Pilot Data Link Communications Departure Clearance (CPDLC DCL) capability in order to more effectively manage airspace, address communication frequency congestion, and improve safety. Concurrently, the feasibility and necessity of Data Comm as both a forward fit and retrofit installation for business jets has become a reality, and a requirement in a growing number of airspaces worldwide.

Let's Break It Down: What Are the Elements of Data Comm?

Data Comm is a term that is applicable to a growing set of data communication elements and systems, which may be neatly integrated into a single system for flight crew transparency. In this case, you may have multiple CPDLC type systems with significantly differing ground infrastructure that will largely look and operate the same on the flight deck. Some elements of Data Comm are almost completely transparent to the flight crew.

Key elements of Data Comm primarily consist of:

- CPDLC or Controller-Pilot Data Link Communications
- ADS–C or Automatic Dependent Surveillance–Contract (required for FANS Oceanic)
- VDL Mode 2 data link radio and/or appropriate SATCOM
- ADS–B Out or Automatic Dependent Surveillance–Broadcast Out (for FANS/ATN B1 Domestic operations)

The FANS capability embedded in the UniLink® UL-800/801 Communications Management Unit (CMU) consists of both CPDLC and ADS–C functionality and provides a means for direct communication between the pilot and Air Traffic Control (ATC) through CPDLC technology. Very High Frequency (VHF) data link radio or satellite communication (SATCOM) systems are used to enable digital transmission of short, relatively simple messages between the aircraft and ATC. FANS 1/A+ is a requirement in the North Atlantic in the core tracks and is expanding to additional tracks and airspaces.

The ADS–C capability is largely a transparent capability that allows ATC to independently negotiate a periodic transmission of aircraft information to the responsible air traffic center for monitoring and management of traffic in remote areas of operation. ADS–B automatically transmits aircraft position data once per second and is primarily intended for support of domestic ATC operations in the near future in both the U.S. and Europe. Please see Universal Avionics' White Paper, "Understanding Compliance with Automatic Dependent Surveillance–Broadcast (ADS–B) Out" for additional information if desired.

FANS Domestic is an evolving capability and currently supports CPDLC DCL or CPDLC Departure Clearance. At the end of 2016, this capability had been successfully deployed to 56 major airports across the United States. Additional airports are being evaluated for Phase II of this project. The intention is to make CPDLC DCL the method of choice for clearance delivery at all major airports.

Improved Communications

The goal of Data Comm is to improve safety and performance related to Communication, Navigation and Surveillance (CNS) / Air Traffic Management (ATM) activities within the operating environment.

- HF traffic is reduced, clearing the channel
- Poor quality of HF is no longer an issue
- Standardized message set removes language barrier
- No impact from solar flares like HF

Development of Data Comm and FANS 1/A+

In order for aircraft to fly across oceanic/remote areas of airspace, a method of communication and surveillance had to be established to manage aircraft out of range of traditional ground-based VHF radio and radar systems for an extended period of time.

For decades, the only means of communication in remote/oceanic airspace had been a High Frequency (HF) radio system that uses line of sight or the atmosphere to bounce the transmissions to the recipient. The pilots report their position to a radio operator who, in turn, relays the aircraft position report over a telephone line to the responsible Oceanic Center. HF Radio is known to be problematic due to noisy transmissions caused by atmospheric conditions, and language barriers.

FANS provided an improvement to HF Radio communication in these areas by using data link communication through satellite communications. The existing satellite-based Aircraft Communications Addressing and Reporting System (ACARS) was used during the first implementation of Data Comm FANS systems.

As far back as 1983, industry officials concerned about the rise in air traffic sought to address an aging infrastructure, unable to effectively handle increasing congestion. Responding to the issue, the International Civil Aviation Organization (ICAO) established the Special Committee on Data Comm FANS, which was tasked with identifying new technologies for the future development of communication and surveillance that would aid in the management of air traffic under the Data Comm FANS infrastructure.

The initial FANS report was published in 1988, laying the basis for the industry's future strategy for the CNS/ATM concept; Air Traffic Management (ATM) through digital Communication, Navigation and Surveillance (CNS). Work then started on the development of the technical standards needed to realize the Data Comm FANS concept.

The Boeing Company, reportedly seeking the cost saving benefit that Data Comm FANS technology provides, announced the first implementation of FANS in the early 1990s, known as FANS-1. It used existing satellite-based ACARS communications, targeting operations in the remote South Pacific Oceanic region. The deployment of FANS-1 was to improve route choice available to operators, and thereby reduce fuel burn.

Later on, a similar product was developed by Airbus, known as "FANS A." Today, the two technologies are collectively known as "FANS 1/A." With the addition of minor enhancements, it has now become known as FANS 1/A+. Data Comm FANS systems today use automatic position reporting and Controller Pilot Data Link Communications (CPDLC) to directly communicate to ATC over VHF using VDL Mode 2 or SATCOM (Inmarsat or Iridium) in lieu of ACARS, to enable more efficient communications between the aircraft and ATC.

Data Comm FANS in the North Atlantic Track System

ATC services are now provided to FANS 1/A+ equipped aircraft in other oceanic airspaces, and is required in parts of the North Atlantic Track System (NATS). The North Atlantic airspace utilizes a constantly changing 12 hour track system (NAT) designed around the high altitude winds and weather to optimize flights each day. Since there are over 1,400 aircraft crossing the North Atlantic each day (and growing), ATC needed a technology to increase airspace capacity on the North Atlantic Tracks and subsequently, providing a higher level of safety for all aircraft operating in that airspace.

Mandates for FANS 1/A+ began in 2013 for the most efficient tracks in the North Atlantic. In 2015, this was expanded and all of the NATS required FANS 1/A+ technology at optimum altitudes, increasing to most of the North Atlantic airspace between FL350 and FL390 in 2017.

This requirement allows ATC in the North Atlantic regions to reduce required separation standard to half degree tracks and dramatically increases the limited capacity in the region.

Operators not equipped for FANS 1/A+ capabilities will be excluded from airspace which requires it, increasing total trip distance, time, emissions and ultimately more money. The fact is that some business jets simply do not have the range to get across the Atlantic without operating on the NAT at optimum altitudes. Operating outside of those optimum altitude may mean not being able to make the trip nonstop.

Data Comm FANS 1/A+ Benefits

Reduced Separation Between Aircraft

In non-Data Comm aircraft, procedural aircraft separation, errors in navigation and potential errors in voice communication between the flight crew and ATC are considered when determining the necessary airspace separation between aircraft. Through a satellite data link, aircraft equipped with Data Comm FANS can transmit required ADS–C reports with actual position and intent information at specified time intervals automatically. The position report is based on the accuracy of the GPS position sensing, which is typically accurate to within a few meters.

CPDLC between the flight crew and the ATC drastically reduces the possibility of communication error, and allows for reduced aircraft separations in airspace. Increased airspace capacity means a greater availability of desired routes for the aircraft operating within that airspace.

Digital data communication between the flight crew and the ATC drastically reduces the possibility of error, and allows for reduced aircraft separations in airspace. Increased airspace capacity means a greater availability of desired routes for the aircraft operating within that airspace.

FANS Benefits

- Reduced separation between aircraft
- Data link communication
- No altitude loss when crossing tracks
- More direct routings

Data Link Communication

The VHF Datalink (VDL) is a means of sending information between aircraft and VHF ground stations. The new VDL Mode 2 network, a high-speed and high-capacity digital communications network, provides roughly 20 times the message capacity than today's commonly used ACARS. Use of VDL Mode 2 tends to be more cost efficient than traditional VHF and service providers are encouraging its users to transition to the VDL Mode 2 network.

Elimination of HF Radio Requirements

As noted, FANS requires a SATCOM system to support CPDLC. Some SATCOM systems support both voice and data, while other systems are limited to voice only. Aircraft with the ability to tune and communicate via SATCOM voice (when meeting the system design requirements for Safety Services Communications) can eliminate the use of HF Radio communication equipment while utilizing the SATCOM voice capability as a primary means of communicating with ATC in lieu of HF.

More Direct Routings

By 2017, even aircraft that would normally fly a random route across the Atlantic will not be allowed to transition through the North Atlantic Track System (NATS) if they are not equipped for FANS, resulting is less-than-optimal routing. This trend will continue as equipage rises and demand for more operations in the airspace increases.

Worldwide Requirements and Mandates

North Atlantic FANS 1/A+ Mandates

Date	Mandate	Details
February 2013	Phase 1 FANS 1/A+ in the NATS	Two center (most desirable) tracks, FL360-FL390 inclusive (no exemptions)
January 2014	European Data Link Services (DLC–CRO) Implementing Rule (EC DLS IR) Exemption	Aircraft that are FANS equipped and have operational approval are exempt from the DLS IR mandate for the lifetime of the aircraft
February 2015	"Phase 2a" Expanded FANS 1/A+ Airspace (determined June 2013)	All Organized Track System (OTS) FL350-FL390 inclusive (no exemptions)
November 2015	Reduced Lateral Separation Minimums (RLatSM) in NATS	Two center (most desirable) tracks will have a 1/2 degree between the tracks
December 2017	"Phase 2b"	FANS 1/A+ required in all Minimum Navigation Performance Standards (MNPS) airspace FL350-FL390, inclusive
January 2020	"Phase 2c"	FANS 1/A+ required in all MNPS airspace FL290 and above

European Mandate: DLS–CRO – Data Link Services Central Reporting Office

The program previously associated with this capability was called Link 2000+, however that has been superseded by the Data Link Services–Central Reporting Office (DLS–CRO) at Eurocontrol. Data link communications is a key element of the Single European Sky ATM Research (SESAR) initiative and equipage for ATN B1 CPDLC. This can be accomplished via the Universal Avionics UniLink UL-800/801 CMU with Software Control Number (SCN) 31.0 with the ATN option. This will provide compliance with European CPDLC initiatives.

The European implementation of ATN B1 CPDLC in upper airspace is outlined in the SESAR Data Link Services Implementing Rule (DLS IR) legislation published in January 2009 (EC Reg. 29/2009). The original IR had required all existing aircraft operating above FL285 in European airspace to be retrofitted for ATN B1 CPDLC by now, but this has been pushed to February 2020 for both retrofit and forward fit installations. The participating ATC services should be ready to provide CPDLC services by February 2018 (as of this writing).

The FANS 1/A+ CPDLC message set existing in Universal Avionics UniLink UL-800/801 CMU is different than what is required for ATN B1 CPDLC, and will be usable in European airspace with the upgrade to SCN 31.0 with the ATN Option.

EASA does require a Letter of Authorization (LOA) to utilize ATN B1 services in European airspace. Please check the EASA website for further information.

U.S. FANS Domestic and CPDLC DCL

The FAA has extensive plans to implement CPDLC DCL capabilities in the domestic U.S. airspace. The first of those capabilities has been fully deployed in the first 56 major airports in the U.S., where CPDLC DCL data link will be used for clearances over a VHF Data Link Mode 2 system that is about 20 times faster than the existing VHF network. Most importantly, CPDLC DCL will allow you to obtain your clearance rapidly and begin start and pushback much faster than using standard departure clearance voice protocol. Information regarding CPDLC DCL capabilities and airports can be found at: www.nbaa.org/ops/cns/datalink/20151105-faa-introduces-controller-pilot-data-link-communications-departure-clearance.php.

It should be noted that as the system is rolled out, there are issues with certain flight planning services and limitations at certain towers with CPDLC DCL. Some web based services may or may not support the necessary transmission of information to the FAA so that CPDLC DCL delivery can be accomplished. Also, individual towers may delete your CPDLC DCL if they require the clearance to be modified for any reason. In those cases, flight crews should revert to basic voice protocol as done today. This capability will expand rapidly over time, and flight crews should educate themselves on using CPDLC DCL.

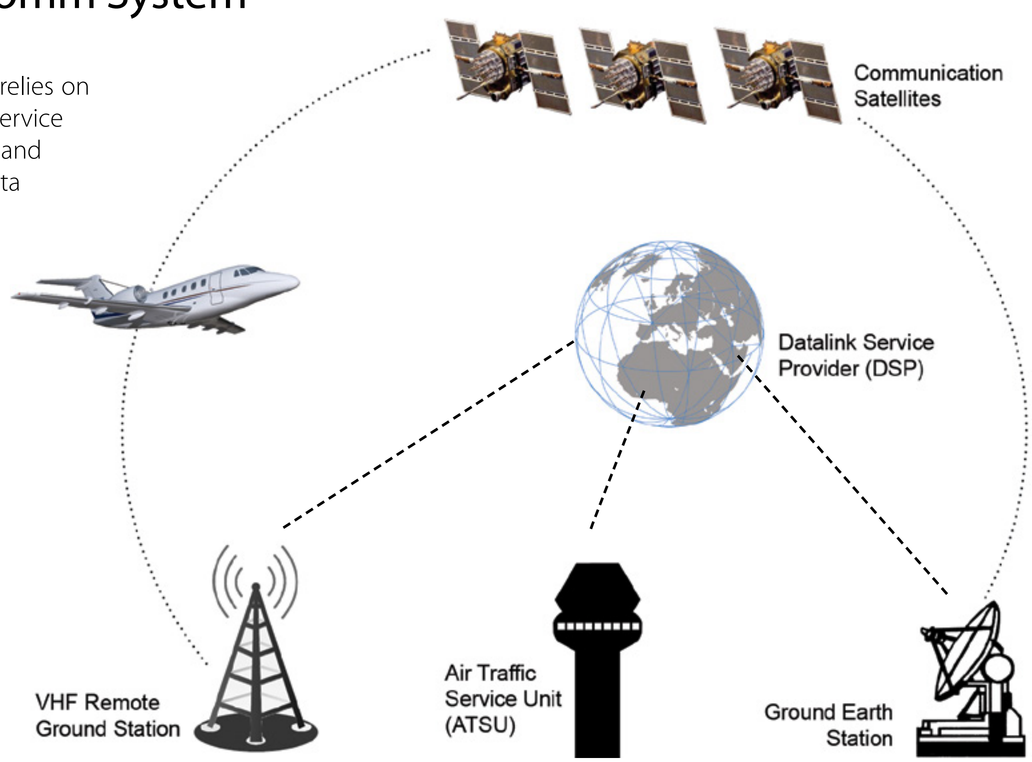
Flight crews should also test their preferred flight planning services, set aircraft capabilities correctly in their aircraft profiles, and verify the CPDLC DCL is available at the tower during initial utilization of the CPDLC DCL system to assure proper operation overall. There are many parts that must work in harmony to provide this capability, but once operational on your aircraft, CPDLC DCL can provide the flight crew with a departure clearance in a matter of seconds instead of potentially waiting many minutes just for an opening on the voice channel.

CPDLC DCL does not require an LOA for operational approval for Part 91 operators. Amendments to air carrier Ops Specs will be required for Part 135 or 121 operators, and may be accommodated using the same process as any other Ops Spec amendment.

How the Data Comm System Pieces Work

The current data link system relies on the networks of Data Link Service Providers (DSP), such as SITA and ARINC, for the delivery of data link messages.

Also referred to as Communication Service Providers (CSP), the DSPs are commercial entities that offer similar services, but run their networks in different configurations.



Controller-Pilot Data Link Communications

CPDLC is a method by which the ATC can communicate with pilots over a data link system, increasing the effective capacity and improving the availability of the communications channel. Data link communication permits the exchange of text-based messages between ATC ground systems and the aircraft. It is intended to supplement traditional voice over VHF and HF radio frequencies, and free up voice radio channels.

CPDLC has two effective forms, a predefined message set and free text. The CPDLC message set provides a fixed set of responses to clearances, information, or request message elements which correspond to standard ATC voice phraseology (such as "climb and maintain FL350"). The controller is provided with the ability to issue standard instructions or requests for information. The pilot is provided with a standard set of responses to these instructions or requests. "Free Text" messages are used when information needs to be exchanged that is not conforming to these pre-defined formats.

Automatic Dependent Surveillance–Contract

Automatic Dependent Surveillance–Contract (ADS–C) reports the current flight position via SATCOM or VHF data link to ATC which also improves the surveillance capability of the airline's operational control center. It improves the surveillance of enroute aircraft participating in the North Atlantic tracks. ADS–C requires a peer-to-peer relationship with a ground facility (aircraft to the controlling ATC facility) to acknowledge receipt of ADS–C messages. This capability is embedded within the Universal Avionics UniLink UL-800/801 CMU and is largely transparent to the flight crew.

Equipment Installation for Data Link Systems

Aircraft approval for FANS Oceanic operations require an LOA from the FAA and equipment installation under a Supplemental Type Certificate (STC) or OEM Service Bulletin in accordance with AC 20-140 (as amended), to include:

- Flight Management System (FMS), i.e. Universal Avionics SBAS-FMS, Software Control Number (SCN) 1000.5/1100.5 or later
- Communications Management Unit (CMU), i.e. Universal Avionics UniLink UL-800 or UL-801
- A DO -178B Level 'D' software SATCOM system, i.e. Inmarsat or Iridium
- External "ATC" annunciator "cube" or installation integrated into flight displays
- Aural Alert - a sonalert or some other means to provide a "Signature" aural advisory to alert the flight crew of incoming CPDLC messages
- Data Capable Cockpit Voice Recorder (CVR) (AC 20-160), i.e. Universal Avionics CVR/Flight Data Recorder (FDR)

Systems limited to CPDLC DCL do not require SATCOM capability.

SATCOM Considerations

FANS 1/A+ data link operations in remote oceanic airspace are transmitted via SATCOM or VDL Mode 2 if within range. Verify with the SATCOM manufacturer that it is an ARINC 741-compliant system.

Per AC 20-140 (as amended) the SATCOM Technical Standard Order (TSO) requirements are as follows:

- Inmarsat's SATCOM (Inmarsat Data 2)-TSO-C132
- Iridium's SATCOM (i.e. Short Burst Data, SBD)-TSO-C159a

Currently there are SATCOM systems on the market that either have or are in the process of receiving TSO certification. For those that do not, the FAA has stated that an Alternate Means Of Compliance (AMOC) will be accepted for the short term for capable SATCOM systems without TSO approval. Please contact the SATCOM manufacturer regarding TSO approvals and Universal Avionics for the latest SATCOM/UniLink compatible interfaces.

Obtaining FANS Oceanic Operational Approval

Crew Training

In order for the operator to receive an LOA for FANS operations from the FAA, the flight crew must complete an FAA approved training course. Contact Universal Avionics for a list of training providers.

AC 20-140 Considerations

Advisory Circular (AC) 20-140 (as amended), "Guidelines for Design Approval of Aircraft Data link Communication Systems Supporting Air Traffic Services (ATS)" provides one acceptable means of compliance, but not the only means, for type design approval of aircraft that have a data link system installed.

This AC provides airworthiness requirements for aircraft with an installed data link system intended to support air traffic services. It identifies specific configurations of aircraft data link systems for applicants seeking approval for STCs in order to facilitate operational approvals. In addition, Universal Avionics provides compliance reports in support of installation of the UniLink UL-800/801 CMU systems to aid in demonstration of compliance for your aircraft installation.

Summary

Data Comm systems have matured over the past three decades from an aircraft OEM cost saving feature to a necessity for effective worldwide airspace management and communication advancements. Several areas are mandating Data Comm capabilities and excluding non-equipped aircraft from airspaces with the most desirable and cost saving routes. Equipping for FANS 1/A+, CPDLC DCL, or ATN B1 operations can both meet regulatory requirements and provide a substantial return on investment for aircraft dependent upon operating in those airspaces. The addition of FANS Domestic initial capabilities such as CPDLC DCL at major U.S. airports can virtually eliminate wait times for aircraft clearance delivery, potentially reducing operating costs significantly over time. In all cases, the UniLink UL-800/801 CMU Data Comm capabilities can provide compliant operations and reduction of aircraft operating costs.

Reference List

- FAA AC 20-140C, Guidelines for Design Approval of Aircraft Data link Communication Systems Supporting Air Traffic Services (ATS)
- FAA AC 20-160, Onboard Recording of Controller Pilot Data Link Communication in Crash Survivable Memory
- FAA AC 120-70B, Operational Authorization Process for use of Data Link Communication System
- FAA AC 91-70A Oceanic and International Operations
- Global Operational Data Link Document (GOLD), 2nd Edition, 26 April 2013
- FAA TSO-C160, VDL Mode 2 Communications Equipment
- RTCA/DO-258A, Interoperability Requirements for ATS Applications Using ARINC 622 Data Communications (FANS 1/A+) Interoperability Standard
- DO-306 Chg 1, Safety and Performance Standards for Air Traffic Data Link Services in Oceanic and Remote Airspace (Oceanic SPR Standard)
- ED-85A, Data Link Application System Document (DLASD) for the "Departure Clearance" Data Link Service
- ED-89A, Data Link Application System Document (DLASD) for the "ATIS" Data Link Service
- ED-106A, Data Link Application System Document (DLASD) for the "Oceanic Clearance Data Link Service
- RTCA/DO-290, Safety and Performance Requirements Standard for Air Traffic Data Link Services in Continental Airspace (Continental SPR Standard)
- ED-154A, Future Air Navigation System 1/A - Aeronautical Telecommunication Network Interoperability Standard
- www.nbaa.org/ops/cns/datalink/20151105-faa-introduces-controller-pilot-data-link-communications-departure-clearance.php

Acronyms

- AC - Advisory Circular
- ADS–B - Automatic Dependent Surveillance–Broadcast
- ADS–C - Automatic Dependent Surveillance–Contract
- AMOC - Alternate Means of Compliance
- AFN - ATS Facilities Notification
- AOC - Airline Operational Control
- ACARS - Aircraft Communications Addressing and Reporting System
- ATC - Air Traffic Control
- ATM - Air Traffic Management
- ATN - Aeronautical Telecommunications Network
- ATS - Air Traffic Service
- CM - Context Management
- CMU - Communications Management Unit
- CNS - Communication, Navigation and Surveillance
- CPDLC - Controller-Pilot Data Link Communications
- CSP - Communication Service Provider
- CVR - Cockpit Voice Recorder

Acronyms

- DLS IR - Data Link Services Implementing Rule
- DSP - Data Link Service Providers
- FANS - Future Air Navigation System
- FDR - Flight Data Recorder
- FMS - Flight Management System
- GPS - Global Positioning System
- HF - High Frequency
- ICAO - International Civil Aviation Organization
- LOA - Letter of Authorization
- MNPS - Minimum Navigation Performance Specification
- NATS - North Atlantic Track System
- OEM - Original Equipment Manufacturer
- OOOI - Out/Off/On/In
- OTS - Organized Track System
- RLatSM - Reduced Lateral Separation Minimum
- RLongSM - Reduced Longitudinal Separation Minimum
- SBAS - Satellite-Based Augmentation System
- SatCom - Satellite Communications
- SES - Single European Sky
- SCN - Software Control Number
- STC - Supplemental Type Certificate
- TC - Type Certificate
- VDL - VHF Datalink
- VHF - Very High Frequency

About Universal Avionics

Universal Avionics is a leading manufacturer of innovative avionics systems offered as retrofit and forward-fit solutions for the largest diversification of aircraft types in the industry. Markets served include Business, Special Missions, Government/Military, Airline (regional/commercial), Helicopter and OEM.

To learn more about Universal Avionics, visit www.uasc.com/home/contactus/aboutus.

UNIVERSAL® AVIONICS SYSTEMS CORPORATION

Corporate Offices
3260 E. Universal Way
Tucson, Arizona 85756 USA
(520) 295-2300
(800) 321-5253
Fax: (520) 295-2395

Midwest Operations
Wichita, Kansas USA
(316) 524-9500
(800) 255-0282
Fax: (316) 524-9700

European Office
Basel, Switzerland
+41-61-383-7683

Asia Pacific Office
Singapore
+65 6701 8231
Fax: +65 6701 8001

Internet
uasc.com
E-mail: info@uasc.com