



Space Data Association, Prospective Member Briefing

What is the Space Data Association?

The Space Data Association Limited (“Space Data Association” or “SDA”) is a formal organization of satellite operators, concerned with flight safety and quality of customer services. It is an operational organization which provides operational services to its members. It is not a trade association or lobbying group, although the SDA does intend to foster development and adoption of best operational practices.

The space environment, in all orbital regimes (LEO, MEO and GEO), is becoming increasingly congested, and operators must effectively coordinate and manage their flight operations to minimize the risk of collisions.

To assist in managing flight operations in a congested environment, the SDA provides mission assurance functions to help operators minimize the risks with their satellite operations. Its computing systems provide automated tools and processes to assist satellite operators with their flight operations and quality of service. It accurately analyzes and warns of close approaches between satellites, and allows coordination of avoidance maneuvers. It also improves quality of service with tools to mitigate RF interference (RFI); and provides reliable operational contact information for each of the member satellite operators. In the future, the SDA may offer additional services in support of its members.

Why was the SDA formed?

The space environment is a critical resource, and operators recognize the need to share certain operational data to minimize the risk of collisions and preserve the shared use of this environment.

In 2009, Inmarsat, Intelsat and SES founded the SDA after realizing that accurate orbital position data needs to be formally exchanged to assure the preservation of the space environment for all operators and customers. Up to that time, ad-hoc and informal data exchange had taken place for close approach coordination, or operators relied on third party services. Neither of these methods is completely effective, and so the SDA was formed for satellite operators to share their orbital data in a secure and controlled manner; to convert the different orbital data into a common format; and for automated processes to use that data for conjunction assessment, to improve the safety of operations and availability of the space environment.

What does the SDA do?

The SDA provides three main services to its members:

1. Conjunction Assessment (CA) to analyze and warn of close approaches between a member’s satellite and other space objects;
2. Tools to aid in the mitigation and resolution of RFI and EMI events; and
3. Definitive contacts for each member’s satellite(s), so that coordination of operations, whether CA or RFI mitigation, can be conducted rapidly and accurately.



The SDA can also act as a facilitating interface to share data with other entities, thus relieving third party entities, and the members, from establishing separate data sharing agreements.

How does the SDA support safer satellite operations?

Conjunction Assessment:

CA requires accurate orbital data for all objects which might pose a threat to a member's satellite(s). Existing Space Situational Awareness (SSA) systems provide orbital data generated from observations collected by *non-cooperative* tracking (NCT) systems - typically radars for Low-Earth Orbits (LEO) and telescopes for geosynchronous orbits (GEO) - to ensure the broadest coverage possible. *Non-cooperative* tracking systems collect observations without the active cooperation of the orbiting object.

Unfortunately, since the NCT systems are not dedicated to tracking any particular object, they have difficulty tracking operational satellites, which maneuver regularly to maintain their orbits in support of mission requirements, or even relocate to different orbital locations. This limitation with NCTs can pose significant problems, particularly in GEO, as sensors can be affected by weather for days at a time, preventing the collection of observations immediately following a maneuver. Since these existing SSA systems do not know about maneuvers a priori, the result can be degraded orbital accuracy, cross-tagged satellites, or the inability to associate observations with a known satellite (a *lost* satellite). Fortunately, most satellite operators have their own tracking systems to perform active tracking, either via transponder or beacon ranging, or by GPS tracking, methods which have been shown to be far more accurate than orbits determined from NCT observations. By using these operator-generated orbital data in place of orbits based on NCT, satellite operators can significantly reduce the number of false alarms, providing more confidence in the decision-making process used for collision avoidance.

However, for operators trying to do their own conjunction assessment, even using operator-generated orbital data for both objects, there is a risk that the ephemeris data formats may not be the same, and that a format conversion may not be done correctly, leading to a false analysis and false result.

The SDA addresses these issues by collecting the operator-generated orbital position data for all operational satellites, since this is the most accurate positional information for the operator's satellite(s); performing correct normalization and conversion of all data into the same format; and then analyzing and reporting potential conjunctions.

Radio Frequency Interference:

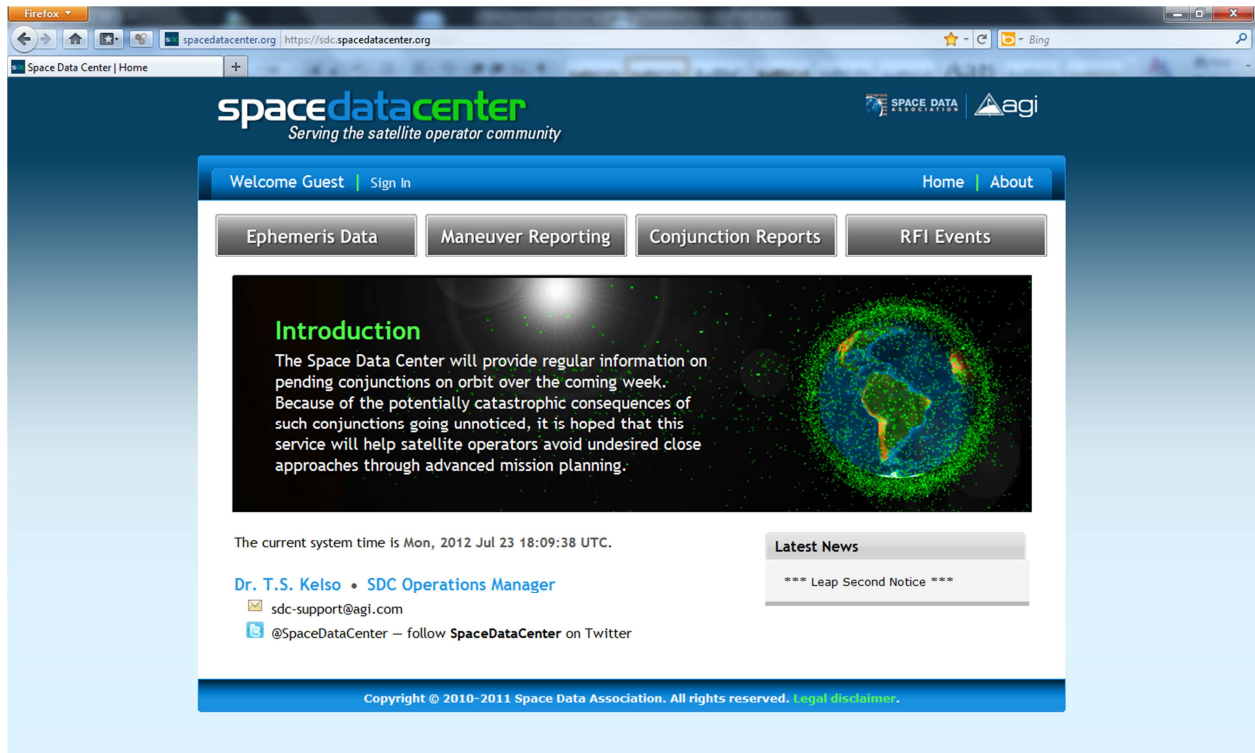
RFI is a major operational problem affecting Quality of Service, and an issue that operators and various industry bodies are continually trying to address. Knowing when these RF interferences occur, understanding where they originate, and learning what other assets they may affect, are a primary concern of SDA members. The SDA provides tools for its members to: share information and seek assistance in investigating RFI events; automatically generate data to more quickly configure geolocation systems and perform interference source analysis; and search historical data for RFI event information.

Authoritative contact information:

The SDA provides a database with reliable operational contact information for each member, which allows quick and accurate communication between members when operational issues or potential conjunctions occur. It minimizes the time to search and find the relevant contact for other operators.

How does the SDA perform its operational services?

The SDA uses a computer system called the Space Data Center (SDC) to perform all data collection, storage, and processing. The SDC was designed and built by Analytical Graphics, Inc. (AGI), under contract to the SDA. AGI is also contracted to operate the SDC and provide technical support for the system and the SDA members.



SDC services and products

Conjunction Assessment:

For CA, the SDC is the operational system following-on from the prototype 'Socrates' system, which was used by a number of satellite operators.

The SDC collects and archives SDA member-provided orbital ephemeris data for use in performing screening of member satellites for close approaches (conjunctions) with other objects, including satellites, rocket bodies, and debris. SDA members upload their most current orbital ephemeris data, incorporating planned maneuvers, on a regular basis whenever they update their orbit determination with new observations or planned maneuvers. For optimum accuracy of the CA, it is recommended that members should update and upload their ephemeris to the SDC, at least every two or three days, and preferably daily or a number of times per day if new orbital calculations are being done by the member at that rate. To ensure high accuracy in the CA process, upon upload of a member's data, the SDC performs data validation and normalizes the ephemeris to a common format and orbital reference frame.

Conjunction analyses are scheduled to run every two or three hours, using the latest data available at the time of the run. This ensures that both you and the other members are using the best data available to make conjunction predictions. When ephemeris data is not available for an object under analysis, the next best data available is used in the conjunction prediction. Currently, this is Two Line Element set (TLE) data.

The CA service also provides a feature called Neighborhood Watch, where you specify satellite pairs you are interested in watching, and reports of the predicted range between the pair of satellites are created on a regular basis.

Notifications are automatically sent via email upon completion of each run, to each member based on the user preferences defined in their profile, notifying them of any circumstances which might pose a threat to their satellites. If a conjunction is predicted between your satellite and another member's satellite, you are both contacted and given the precise ephemerides used to make the conjunction prediction, and each other's contact information. Conjunction analysis results are available online, via the secure SDC web site, or via the SDC web services.

The Conjunction Assessment service provides the following products:

- Conjunctions listed by maximum probability of collision;
- Conjunctions listed by minimum range of the conjuncting satellites; and
- Neighborhood Watch plots for each pair of satellites you specify.

The products are based on your specified thresholds for conjunctions, and other settings as defined in your user profile.

RF Interference:

The RFI service of the SDC provides the following services:

- RFI Alert;
- RFI database;
- RF payload data;
- Geolocation solution sets; and
- Contact details for RFI-related personnel.

The RFI Alert service allows members suffering from RFI to alert other operators who share the same frequency band within the vicinity of the affected satellite to the presence and characteristics of the RFI, and to request their assistance in identifying its cause and removing it.

SDA members submit RFI Alerts via the SDA Web Services interface using a standard format. When submitting an RFI Alert, members are able to indicate its urgency and the impact that it is having on their network, as well as designating who the alert should be sent to (for example: all operators; only operators in the same frequency band and coverage area; or only operators in the same frequency band in the near vicinity of the affected satellite).

In some cases, alerting neighboring satellite operators is adequate to identify errant transmitters and resolve the interference issue. It may also allow the affected operator to obtain useful information and experience from other operators who have dealt with similar events, leading to a speedier resolution.

RFI Alerts and event data can be stored in an SDC database as a historical record. All RFI event data is searchable from within the SDC web site as well as through the SDC web services, allowing members to search for similar events or types of RFI, to aid in troubleshooting interference.

In difficult cases of interference, or where deliberate interference is involved, operators traditionally use a two-satellite geolocation technique to identify the geographical source of the interference. Successful geolocation requires that in addition to having detailed information about the operator's own 'victim' satellite, accurate information is also available for: transponder frequencies, beam coverage, and transponder/beam connectivity parameters for the adjacent satellite; ephemeris for the adjacent satellite; and reliable reference carriers. It can take considerable time to research this information if an operator has to contact other operators.

The SDC can significantly reduce the time required to prepare for a geolocation. SDA members who subscribe to the RFI service are required to provide high level RF details of their satellites (such as frequency bands, transponder connectivity, coverage areas, and reference carriers) in the SDC database. Whenever a member has a problem and wants to perform a geolocation, the RF information in the database will be used to determine the optimum secondary satellite for a geolocation solution, and quickly generate a set of data for use by the member's geolocation system. This will be provided to the member wanting to perform a geolocation, together with the latest ephemeris for the 'victim' and secondary satellites.

Members subscribing to the RFI service also provide contact details and delivery preferences for RFI Alerts, in a similar manner to the conjunction assessment notifications.

Interfacing to the SDC:

Members interact with the SDC via a secure web services interface, for uploading and managing their data, and for receiving alerts and information from the system. AGI provides assistance for the development of the web services interface to upload data to the SDC. The member can continue to use his/her normal orbit determination process and software. It is relatively simple for a member to implement a routine upload of his/her existing ephemeris to the SDC, and the SDC will take care of all validation, conversion, and processing of data.

How does the SDA verify the accuracy of operator-provided orbital data?

To ensure accuracy of member-provided ephemeris data, routine validation is performed in a number of ways:

- During the membership signup process, AGI performs an 'acceptance' of the new member's data, for each satellite, to confirm that the member's data meets certain accuracy requirements and can be used by the SDC;
- With every data upload, a real-time check is made for data consistency against previous data. A comparison is also made against the TLE for the same satellite to ensure reasonable consistency; and



- Quarterly data validations and calibrations are performed by AGI on each member's satellite(s), incorporating the latest tracking observations and station calibration data provided by the member, and a report is produced. This ensures long term accuracy and calibration of the member's orbit determination process.

Who can join the SDA?

The SDA is open to all satellite operators, in all orbital regimes. This includes commercial, civil and military operators. Currently, the SDA has members representing all these types of operators, with satellites in LEO and GEO regimes.

The goal is for all satellite operators to become members and share their data, to maximize flight safety for everyone.

What are the benefits of joining the SDA?

Members will benefit from:

1. Accurate conjunction assessments and notifications; RFI mitigation support; and access to reliable contact information for fellow operators;
2. Reduced workload for conjunction assessment as the SDC does all data conversions, analysis and notifications; so you can focus on real events rather than false warnings;
3. Reduced workload for RFI investigation, as the SDC will send alerts, generate geolocation solution sets, and allow searching of previous RFI events;
4. Participation in a global RFI mitigation community, with fellow operators and access to information, tools and techniques to fight interference;
5. Secure data sharing, since the SDC automatically performs the analysis and does not distribute your data;
6. Minimizing your operating costs for CA and RFI activities; and
7. Technical support 24x7x365 by the SDA's contracted and trusted technical advisor, AGI.

What are my commitments as a member of the SDA?

All members must participate in the CA service and Contacts functions, and contribute data for those services. The RFI service is optional. If you participate in a service, then you must contribute data to that service.

The main data contributions that members agree to provide the SDA (or more explicitly the SDC), are as follows:

Ephemeris data: Routine ephemeris data updates for all satellites that you include in the SDC; and all maneuver plans, so that the SDC knows where your satellites are currently located and when they plan to be moved. Ephemeris data should be uploaded at least every two or three days, and preferably daily or a number of times per day if updated orbit calculations are being done that frequently.

Quarterly orbit data validation: To allow AGI to successfully perform data accuracy checks, on a quarterly basis each member should submit an updated set of fleet observational data (e.g. ranging and



other metric observations as available) and tracking station characteristics, including antenna latitude, longitude, altitude, and calibration data.

Contact information: Accurate contact information for the operations control center(s) and certain technical staff as applicable.

RFI data: If the member also signs-up to use the RFI functions, this requires the member to enter basic payload data (transponder frequencies, polarizations, beam coverage, etc), to allow the SDC to perform automatic comparison with other satellites for distribution of RFI Alert notifications and recommendation of geolocation solution sets.

One other area where the member will need to provide support, at least during the initial setup of user accounts in the SDC, and implementation of data upload, is Information Technology (IT), as follows:

IT support: After joining the SDA, the member will need to provide IT support, to coordinate with AGI, for the installation of user cryptographic certificates and credentials, to allow each of the member's users to access the secure SDC system. Since the handling of security certificates is normally controlled by IT Security staff in many companies, it is recommended that you make arrangements with your IT Department to support this activity. The development of a web services interface for the automated upload of ephemeris data to the SDC, also requires IT skills, and may also need to be referred to your IT Department. The SDA maintains a code repository and example application code that may be reused or modified by you.

What will my data be used for and how will it be protected?

The SDA limits the sharing and provision of member data to other SDA members, except when expressly needed to fulfill the SDA's service objectives. The data to be provided and shared will include:

Contact data: The data will be viewable by all other members, to allow quick and easy contact to be made with other operators if required to solve operational issues. The contact data can only be edited by the member who owns that data.

Ephemeris data: This data is not directly accessible by other members unless a conjunction with that member's satellite is detected by the SDC. The ephemeris data is used by the SDC system for its automated analysis of the relative locations of space objects. Summary results (alerts) from the analysis will be sent to the operators whose satellites are affected by close conjunctions, for them to take action as required.

RF and RFI data: Basic payload data will be provided for each of the member's satellite(s) in SDC. This will include:

- 'RFI Alert' information, describing the characteristics of RFI that is affecting a member, will be distributed to other members who may be able to assist with the identification of the RFI (the actual distribution will be dependent on a selection made by the affected member);
- RF payload data may be used by the SDC system in an automated process, to compute the region where the transmit source is most likely located. It may also be used to generate geolocation solution sets for other members.



As the SDA and SDC evolve, additional functionality may be developed to provide enhanced services for the benefit of the members. This could include services by third parties (for example geolocation service providers). Processes and policies will be developed to accommodate these enhanced functions, while ensuring security of members' data.

The SDC computing infrastructure is designed and built with a high level of security and redundancy (hardware, software and datalinks) to provide high availability and security to protect the members' stored data.

How is the SDA managed and operated?

The SDA is managed by a Board of Directors, consisting of representatives from the Executive Members and Standard Members. The Board makes decisions on membership applications, direction of the SDA, SDC upgrades, budget, contracted services, and other company matters.

Day-to-day administration of the SDA is performed by Mansat, under contract to the SDA.

Analytical Graphics Inc (AGI) is contracted by the SDA as a technical advisor and operator of the Space Data Center (SDC).

All Members are welcome to participate on working committees, which may be established for special purposes, for example to define upgrades to certain SDC functions, or to investigate specific issues of interest or importance to the SDA.

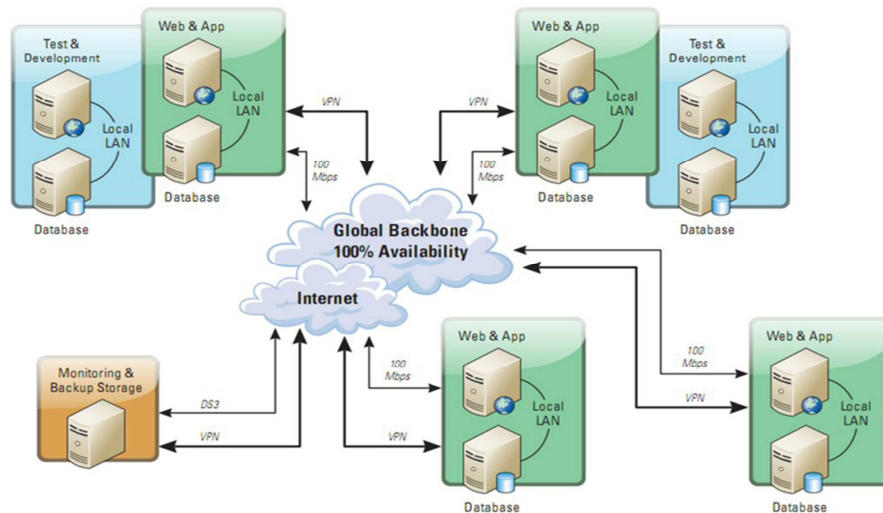
The initial development costs for the SDC were funded by the Executive Members. The ongoing operating costs are expected to be covered by annual membership contributions from all members. The SDA is run as a not-for-profit organization, simply ensuring a cash-positive balance to cover operating expenses and ensure sufficient funds for future development.

The SDA holds regular 'user meetings' to give members the opportunity to hear about SDA activities and plans, and for discussion of members' issues, ideas, and general feedback.

What is the infrastructure of the SDC?

The SDC computing system was designed and built by Analytical Graphics, Inc., under contract to the SDA. AGI is the technical advisor to the SDA and operates the SDC on the SDA's behalf. AGI also provides 24x7x365 technical support to the members.

The SDC infrastructure uses redundant and distributed database servers and redundant datalinks to form a highly available and secure system. Redundant servers are located at each network 'node'. Redundant nodes are located in North America and Europe, and the SDA is planning a third node in Asia. The availability of the overall system is designed for 99.999%.



Secure member access to the SDC is assured by the use of cryptographic security certificates, encrypted access (SSL) and user authentication. Communications between users and the SDC are encrypted, including electronic mail messages generated by the SDC.

Information Technology (IT) support will be required from the member during the user setup process, to install the required user accounts. Data uploads from members to the SDC use a web services interface. AGI provides assistance to new members with the development of the necessary interface software to simplify the setup process. Data uploads (ephemeris) are automated, so that minimal operational effort is required by each member to support ongoing SDC operations.

SDA legal and membership information

The Space Data Association Limited is incorporated in the Isle of Man (UK), and is a 'Company Limited by Guarantee'.

There are three (3) membership categories:

- Executive member: Founder member satellite operator who invested in the development and operation of the SDA organization and SDC system, or other operator who wants a leadership role in the SDA. Executive Members have seats on the Board;
- Standard Member: Satellite operator who is not an Executive Member. Standard Members have up to two Board representatives, elected by the Standard Members; and
- Associate Member: Other organizations such as commercial service providers, research institutes, etc, who are interested in providing or accessing certain data for special purposes.

The cost of membership for a Standard Member is currently US\$10k per year. This will be evaluated annually to ensure that it is set to an amount necessary to cover the Association's operating costs consistent with the Association's non-profit operating philosophy.



The SDA and its categories of membership are governed by SDA's legal formation documents: 1) the 'Certificate of Incorporation'; and 2) 'Memorandum and Articles of Association'.

Use of operator data which is provided to the SDA is governed by a binding legal agreement between each Member and the SDA – the 'Space Data Center Terms and Conditions', which is signed by all members. To discourage misuse of the data, offending members are subject to severe legal penalties. The permitted and non-permitted uses of data are as follows:

Permitted uses:

- Operational support and safety of flight;
- EMI/RFI resolution;
- Insurance underwriting; and
- As required by national regulatory authorities.

Non-Permitted uses:

- Commercial purposes (sales, planning, marketing, etc);
- Securing orbital spectrum rights;
- Transmitting to third parties (unless for a safety of flight issue); and
- Any other use which is not a permitted use.

Where can I get more information about the SDA and SDC?

The SDA website (www.space-data.org) contains general information about the SDA.

The screenshot shows the Space Data Association website in a Firefox browser. The page features a dark blue header with the SDA logo and navigation links: HOME, ABOUT, WHY JOIN, SPACE DATA CENTER, RESOURCES, NEWSROOM, and JOIN SDA. A search bar is also present. The main content area has a background image of Earth with satellite orbits and lists four key benefits:

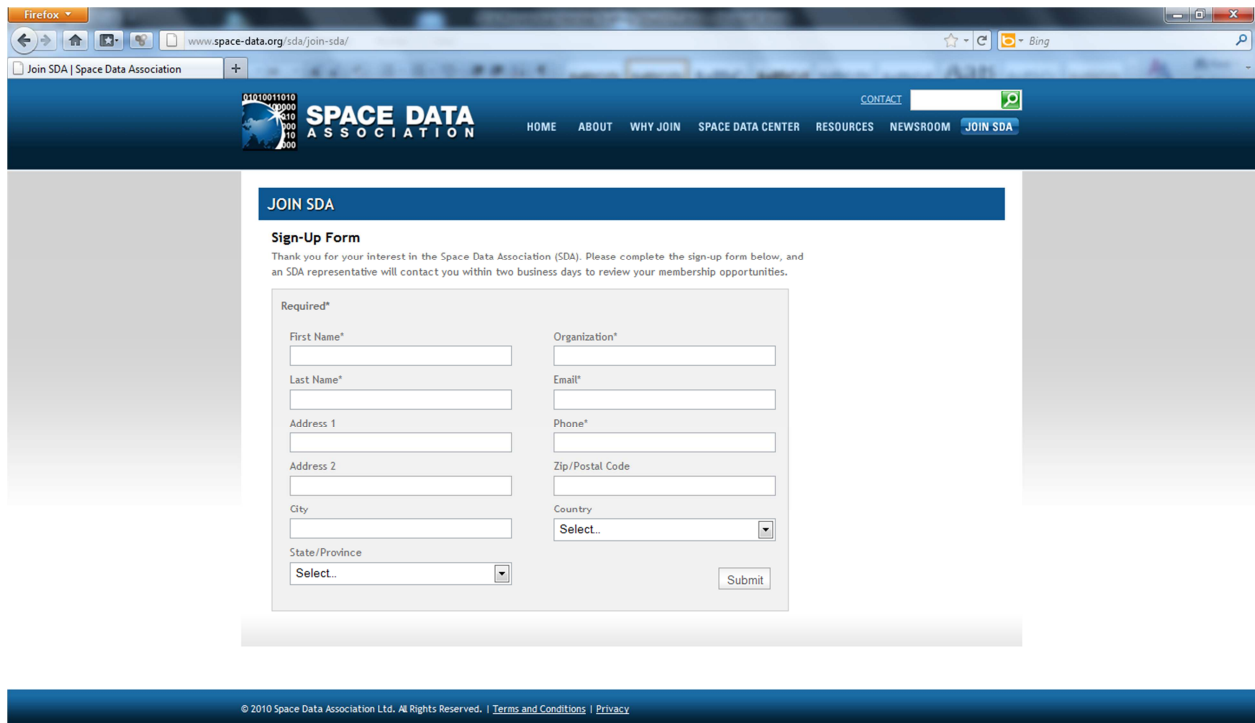
- » Direct support of operations; founded by satellite operators
- » Operational data exchange ensures safety of operations
- » Technical support ensures integrity of your operations
- » Shared costs enables optimal participation

Below this is a 'JOIN SDA TODAY!' section. It describes the SDA as a non-profit association that brings together satellite operators for safe and efficient data-sharing. It lists founding members: Inmarsat, Intelsat, and SES. A 'Learn More' button is provided. A 'WHAT'S NEW' section lists recent updates: 'May 2012: NOAA to Participate in the SDA' and 'March 2012: SDA User Form slides now available!'.

The SDA Directors (see their contact information elsewhere in this document) may also be contacted to request additional information. Technical documentation will be available to provide detail on the SDC, such as a Concept of Operations (CONOPS), membership signup and security instructions, etc.

How do I join the SDA?

The SDA website (www.space-data.org) contains a page for submitting your request to join. You may also contact one of the SDA Directors to express interest in joining and request a membership pack.



The screenshot shows a web browser window displaying the 'JOIN SDA' page on the Space Data Association website. The page features a navigation menu with links for HOME, ABOUT, WHY JOIN, SPACE DATA CENTER, RESOURCES, NEWSROOM, and JOIN SDA. The main content area is titled 'JOIN SDA' and contains a 'Sign-Up Form'. The form includes the following fields:

- First Name*
- Last Name*
- Address 1
- Address 2
- City
- State/Province (dropdown menu)
- Organization*
- Email*
- Phone*
- Zip/Postal Code
- Country (dropdown menu)

A 'Submit' button is located at the bottom right of the form. Below the form, there is a footer with the text: © 2010 Space Data Association Ltd. All Rights Reserved. | [Terms and Conditions](#) | [Privacy](#)

After providing your basic company details and contacts, you will receive SDA legal documents which need to be reviewed by your technical and legal team. These include:

- Space Data Association 'Memorandum and Articles of Association';
- Space Data Association 'Certificate of Incorporation' ;
- Space Data Center 'Terms and Conditions'; and
- 'Letter of Guarantee', a legal formality in the Isle of Man for a company limited by guarantee, in which your organization agrees to be liable for an amount not to exceed ten (10) Pounds Sterling.

Your company will need to sign and return:

- The 'Letter of Guarantee'; and
- The Space Data Center 'Terms and Conditions'.



SDA Contacts

For additional information on the Space Data Association, the following SDA Directors may be contacted:

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