

---

# **FUSION TECHNOLOGY INFORMATION ANALYSIS CENTER**

Concept for

**FUSION INFORMATION CENTER (FIC)**

---

---

May, 2002

---

---

**FUSION STAKEHOLDERS GROUP RECOMMENDATION**

---

---

**VISION**

*A central point of access for information on fusion technologies,  
systems and operations to support the cost-effective*

***development and operation of multi-sensor/multi-source  
information systems***

Tactical and strategic decision-makers now face growing problems of exploiting massive quantities of diverse, and often low-confidence, information. To address these problems cost-effectively, the Fusion Stakeholders throughout the DoD and National Intelligence communities have identified the need for a single focal point for coordinating engineering and operational information related to data fusion. These Fusion Stakeholders recognize that such a program can:

- Facilitate the development and use of techniques for combining and understanding diverse data; thereby improving the performance, reliability and trustiness of multi-sensor/multi-source information systems for defense, national intelligence and other missions directly serving the security and interests of the United States
- Maintain and develop methods for collection and analysis of data related to fusion technology, systems and operations
- Transfer fusion technology information within the U.S. Government and from the U.S. Government to authorized agencies and individuals
- Promote standardization, technology re-use and interoperability of fusion processes; thereby improving the cost-effective development and operation of multi-sensor/multi-source systems

## BACKGROUND

Data fusion in the broadest sense involves the synergistic use of multiple pieces of data.<sup>[1]</sup> Data fusion includes processes for aligning, associating and combining data and information in estimating and predicting the state of objects, their relationships, and characterizing situations and their significance. In a broader sense, fusion is concerned with coordinating the exploitation of multiple information sources (e.g. sensors) and processing resources in support of mission operations.

Fusion is a function of most weapon systems, all C3I programs, all Intelligence collection and exploitation activities and, indeed, in virtually all information processing, whether human or automated.

The systematic development and use of fusion techniques are particularly critical in applications requiring data that is massive, diverse, ambiguous or noisy, or time-critical:

- Massive Data – large amount of background data (e.g. in wide-area surveillance), or large number of objects (e.g. in battlespace awareness, littoral tracking, or meteorology)
- Diverse Data – from a number of different kinds of sensors or other sources (e.g. multisensor/multispectral target recognition, geopolitical analysis) or with complex relationships among objects (e.g. in force structure analysis, geopolitical and economic analysis)
- Ambiguous or Noisy Data – e.g. closely-spaced targets, high clutter backgrounds, low-confidence target or situation models (e.g. in situations with minimal prior intelligence), or sources of low or unknown confidence (e.g. in Open-Source Intelligence, or operations in countermeasure or Information Operations scenarios)

Such conditions are characteristic of new emerging requirements; e.g.

- Network-Centric and Information-Centric Warfare
- Low Intensity Conflicts such as Special Operations, Counter Narcotics, Anti-terrorism, Information operations and CALOW (Conventional Arms, Limited Objectives Warfare)
- Economic and political intelligence

The diversity of threats and tactics reflected in these requirements requires the flexibility enabled by Data Fusion to synergistically exploit all possible information sources, despite the quantity, quality and diversity of data.<sup>[1,2,6]</sup>

Currently fusion concerns and efforts exist across a diverse community throughout a variety of Government departments and agencies. There are significant fusion technology development efforts underway in each of the military services, in each of the Intelligence agencies and in diverse activities throughout the Government. The latter range from law enforcement, counter-narcotics and counter terrorism, to system fault diagnosis, to international economic analysis, environmental and meteorological

---

<sup>[1]</sup> For the sake of this discussion, 'data' is used in the broadest sense, to include *information*, *knowledge*, etc. Accordingly, *data fusion* (or simply *fusion*) encompasses *information fusion*, *sensor fusion*, correlation, etc. Also, *information sources* can include traditional sensors, as well as sources of raw or processed information – human sources, documents, multimedia, etc. – as appropriate to a given mission application.

analysis. Additionally there is a large body of technology, skill and capabilities within the supporting industry and in academia. The commercial sector also has fusion needs in such diverse areas as news gathering, factory automation and robotics, market analysis and competitive intelligence in a competitive environment, and medical diagnosis.

The national security requirements for fusion have changed significantly since the end of Cold War. Instead of dealing with a few adversaries with fairly rigid doctrine and for which a large amount of intelligence has been collected, fusion has to supply information on many more countries with less rigid doctrine, and targets that are more variable and covert in nature. Furthermore, in addition to conventional warfare, fusion has to support non-traditional missions such as peace keeping, humanitarian relief, and counter-terrorism.

More sensors and sources have been developed/identified to provide data on objects or situations of interest. Advanced sensor systems are capable of providing large amounts of data that will overwhelm the most capable analysts using today's largely manual processing techniques. In addition to DoD and Intelligence sensors, databases, and other sources, information supporting the Nation's diverse needs can frequently be attained from open sources. All this data has to be exploited with decreasing manpower.

Over the years many fusion systems – including a multitude of trackers, correlators, multi-mode/multi-sensor targeting systems, and analysis systems – have been developed to support the needs of different missions. In 1996, an Air Force Tactical Exploitation of National Capabilities (AFTENCAP)-sponsored survey of tactical data processors counted over 400 systems, all employing data fusion to some degree. Currently, there is no easy way for the Government user to determine whether his fusion needs can be satisfied by the existing technology. Thus, multiple programs may address the same issues, and any programs, resulting in inefficient use of resources may not address some critical issues. Furthermore, there is inadequate attention given to problems of aligning, comparing and combining information from different fusion systems.<sup>[3,4,5]</sup>

Each service and agency element tends to view fusion from its own perspective and focuses its attention on techniques and tools to solve its particular problems. Thus, there exists a wide diversity of potential consumers for emerging technology information related to fusion techniques and for associated decision analysis tools, models, comparative analyses and focused studies. The broad nature of the fusion problem also encompasses a wide diversity of technologies, many of which have been developed or evaluated under the auspices of other programs not directly targeted specifically at fusion problems.

The efforts of all of these developmental and user organizations generate a considerable body of data stored in widely dispersed areas. There is no central body specifically constituted to:

- Serve as a central repository/pointer of Fusion emerging technology data;
- Identify appropriate sources of fusion scientific and technical information and point requesters to those sources
- Provide analytical support to analysis and development efforts;
- Research background data and information to avoid unnecessary duplication of research, development, test, or evaluation activities

- Coordinate fusion related activities of other IACs, military services and agencies; or
- Serve as point of contact to interface with enterprises outside the Government (academia, commercial, etc.)

The Joint Directors of Laboratories (JDL) Command, Control, and Communications (C3) Research and Technology Program was established in FY83 to perform broad-based, multi-service research and technology demonstrations in C3. Sub-panels and Groups were formed to plan, monitor and coordinate C3 research and development among the military services, and other Government activities.

The JDL Data Fusion Subgroup – subsequently re-chartered under Director Defense Research & Engineering (DDRE) as the Data Fusion Group (DFG) – was established to guide research and development in the area of data fusion. Operating as a volunteer organization, the DFG has had some effect in defining a widely used functional model and taxonomy for fusion. This has proven to be valuable framework for comparing and contrasting diverse problems and techniques in data fusion. By maintaining cognizance of fusion-related activities across DoD and other Government activities, the DFG has promoted commonality and interoperability among fusion developments. A Data Fusion Symposium and a National Symposium on Sensor Fusion, both founded in 1987, were merged in 1996 to create a single DoD-sponsored conference on these topics at classified/restricted levels.

Nonetheless, the lack of adequate funding or charter has prevented the DFG from achieving significant effects in improving the cost-effective development and operation of data fusion technology or of multiple-sensor systems. Service/agency specific activities – such as the Naval Ocean Surveillance Correlation (NOSC) Handbook (1987) and the Data Fusion System Engineering Guidelines developed under AFTENCAP Project Correlation (1997) – have been valuable in proposing coordination and standardization of the development, acquisition and integration of such systems. However, lack of joint sponsorships and lack of an on-going proponenty and upkeep once the specific projects were completed have hampered the acceptance of these results by the broader community.

## **REQUIREMENT**

Developing cost-effective multi-source information systems requires an infrastructure of common methods and tools, as well as accessible and coordinated documentation of developmental and operational activities, of organizations and experts in the field, and of designs and test/validation findings. The lack of common engineering standards for data fusion systems, and the lack of a common repository of technical and programmatic information, are major impediments to integration and re-use of available technology. This deficiency has been cited in studies performed by NRL (1980), DARO (1986), and the AFTENCAP Program (1997), among others, and in the Final Report resulting from 1998 Congressionally Directed Action regarding Fusion in the Intelligence Community. In short, current developments do not lend themselves to objective evaluation, comparison or re-use<sup>[3,4,5]</sup>

Additionally, the effective exploitation of multiple information sources often involves problems of

- Interoperability (deconfliction, connectivity, data formatting, spatio/temporal alignment, consistent confidence assessment)
- Multi-level security
- Performance, assuredness and trust (i.e. the confidence in the accuracy, availability and trust-worthiness of the fused information)
- Cross-organizational knowledge, coordination, and trust

## **FIC CONCEPT**

To these ends, a Fusion Information Center (FIC) has been established under the direction of the Information Assurance Technology Analysis (IATAC) and the integrated sponsorship of:

- Carolyn Sheaff, Mike Welch, AFRL/IFEA Rome, NY and,
- Dave Wilcox, Neil Brophy, Booz Allen Hamilton, Rome, NY and,
- Office of Deputy Under Secretary of Defense (Science and Technology) and,
- Office of the Assistant Secretary of Defense (Command, Control and Communications) (ASD/C<sup>3</sup>I)

The mission of the Fusion Information Center (FIC) is to act as the central point for fusion information and knowledge across the U.S. Government. In this role, FIC will support the execution of coordinated fusion technology development, acquisition and operation. The FIC will facilitate the interchange of ideas and improve the utilization of data fusion research among the military services and Intelligence Community.

Specific objectives and responsibilities of FIC may include:

- Support identification of critical data fusion issues, deficiencies and overlapping efforts
- Recommend high payoff areas of fusion research and technology for multi-service/ multi-agency attention
- Assist in the coordination of joint program plans
- Expedite the transfer of data fusion technologies among U.S. Government services and agencies
- Support special interest groups (SIGs) to focus technology functions
- Identify new opportunities for technology re-use and interoperability on a continuing basis
- Develop and maintain a database of on-going theoretical, developmental, T&E and operational fusion-related activities
- Develop and maintain a database of subject matter experts
- Perform quick-reaction, short-term technical analyses on an as-needed basis, to support theoretical, engineering, T&E, system integration and operational needs of DoD and other U.S. Government subscribers
- Coordinate with other organizations as appropriate, to include other Technical Panels and coordination bodies in the U.S. Government, industry, academia, and in allied/coalition countries
- Coordinate establishment of metrics and methodologies for assessing fusion systems

- Support DISA, DMSO, IEEE, and other standards groups in their establishment of standards for specifying, documenting, testing, and integrating fusion system functions

The FIC will serve as the repository for information on fusion methodologies, models, and analyses of emerging technologies relating to the information systems critical to the nation's defense.

This effort will directly benefit the government by providing a central point of access for fusion technologies, research and development, models and analysis to support the development and implementation of effective information systems. This effort will also benefit the government by such activities as the following:

- Facilitate the utilization of existing fusion-related scientific and technical information through coordination of the existing bodies of knowledge currently maintained by IATAC and IRIA and other IACs, and other organizations
- Conduct focused analyses pertinent to all aspects of historical, technical, scientific, and other fusion related areas. Specific emphasis is placed on multi-spectral/multisensor target and sensor/source modeling, fusion methodologies, technologies and performance analytic and prediction methods and tools
- Establish a comprehensive knowledge base collected on a worldwide basis, which includes historical, technical, scientific, and other fusion information that supports technology solutions
- Provide support for the development and maintenance of standards and specifications for design, development, test and integration
- Support refinement of the taxonomy, functional model, technique applicability guidelines, interface and documentation standards, and engineering methodology as developed by the Data Fusion Group and under AFTENCAP Project Correlation<sup>[1,2,5,6]</sup>
- Collect, develop and maintain a database of information describing tools for test and evaluation of fusion technologies, techniques and systems with embedded fusion functions. The database will include descriptions of test beds; test data sets; performance metrics; modeling, simulation and analytic tools; sensor/source data reduction, storage and retrieval; and exercise/experiment support
- Develop evaluation and screening efforts to create the authoritative source of evaluated fusion data concerning state-of-the-art of fusion systems
- Evaluate commercial information processing and communication technologies for potential use
- Establish memoranda of agreement with industry to obtain descriptions of state-of-the-art technology and technological data related to fusion
- Develop and provide information products to include software, databases, handbooks, state-of-the-art reports, critical reviews; technology assessments, research directories, abstracts, and indexes
- Conduct focused fusion studies and analytical efforts concerning all aspects of historical, technical, scientific, and other information

- Sponsor/support symposia, workshops, conferences, and short courses and other activities to apprise the selected audience of important fusion developments
- Provide information regarding available fusion-related training to include, classroom, computer-based-instruction, videotape, distance learning, and other forms of instruction, and to augment other training programs and systems
- Collect, archive, and distribute fusion-related academic curricula

By coordinating and unifying such activities for U.S. Government activities, the FIC will enable an appreciable improvement in the cost-effective development, integration, operation, and support of multi-sensor/multi-source systems for military, intelligence, and commercial applications.

### **TECHNICAL STEERING COMMITTEE MEMBERS (SCM) ROLE**

The potential FIC SCM have been selected for their roles and responsibilities in developing fusion policies; coordinating, planning, and conducting analyses and tests; evaluating technology issues; developing criteria and standards for fusion activities; and conducting joint projects to identify and leverage technology and enhance fusion capabilities. The operating relationships envisioned for the FIC Technical Steering Committee are depicted in Figure 2.

An SCM role is to propose and advocate utilization of FIC. Each SCM sponsor shall provide a representative to serve as a voting member on the FIC Technical Steering Committee. Non-voting members of the SCM may include advisors from Industry & Academia. Non-voting members provide advice and may lobby for the FIC to support specific interests. The Steering Committee will debate and provide consensus guidance from the voting members to the Technical Monitor assigned by DDR&E in accordance with DoD Instruction 3200.14 dated 7 May 1997. The SCM interprets fusion community policy, prioritizes FIC technical objectives, review of technical focus, and guidance of for evolving technical focus areas. The Steering Committee chaired by the TM will meet formally on a semiannual basis, and on an ad-hoc basis as needed to address time sensitive issues. Technical Sponsors may establish specific technical subgroups as needed for more in-depth issue analysis and the development of short- and long-term FIC technical objectives.

Technical Sponsorship by the leading U.S. Government activities involved in fusion will ensure that the FIC concentrates its efforts on the most important emerging technologies and critical challenges to our nation's strategic and tactical information exploitation requirements.

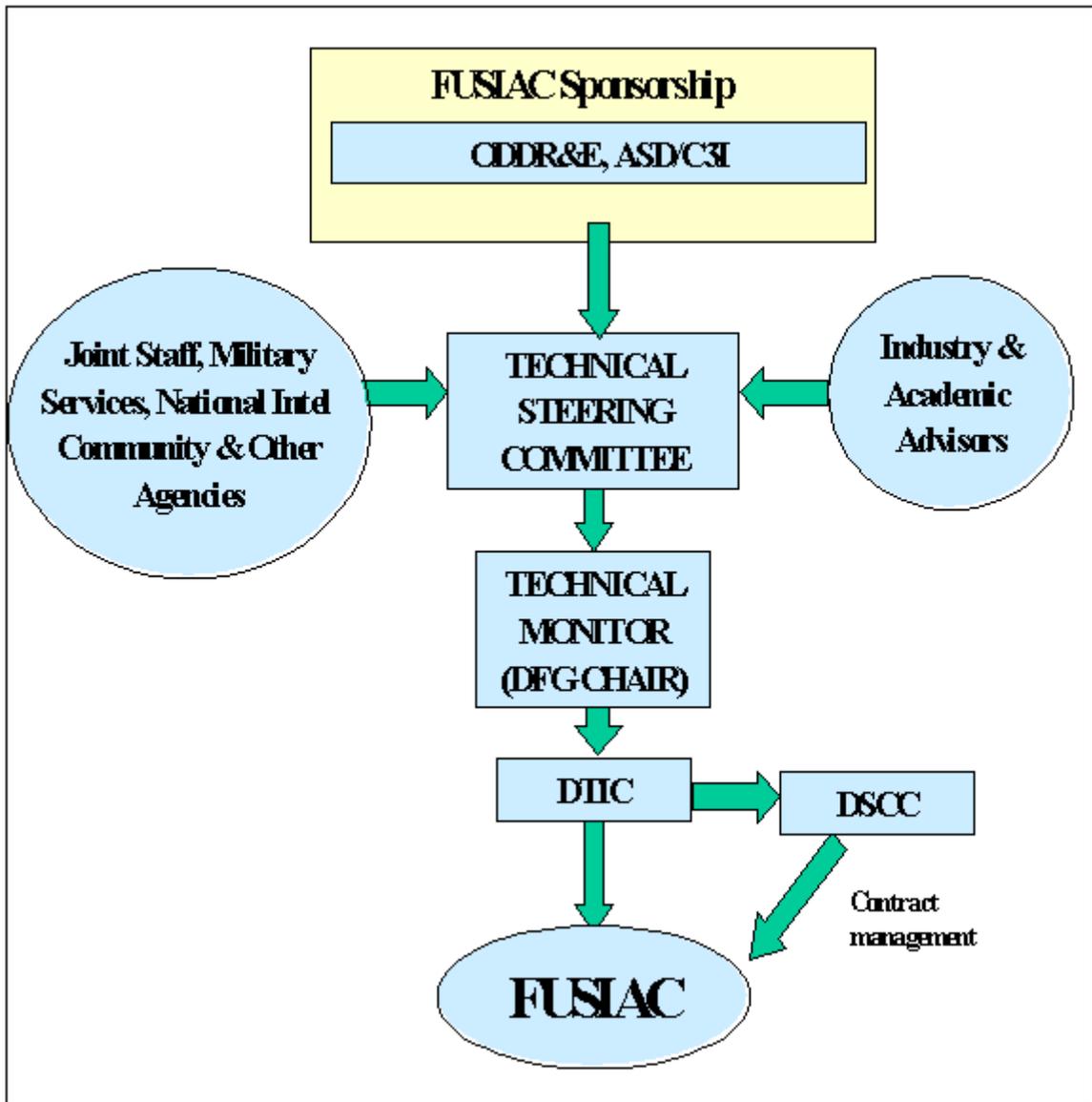


Figure 1 Operating relationships envisioned for the FIC Team and Co-Technical Sponsors

## **DTIC ROLE**

The Defense Technical Information Center contributes to the management, conduct, and productivity enhancement of DoD Research & Development efforts by providing access to, and transfer of, scientific and technical information for DoD and other US Government agency personnel, as well as their associated authorized contractors. DTIC is the DoD organization responsible for implementing the DoD Scientific and Technical Information Program. DTIC provides a wide range of both demand and subscription services from databases of planned, ongoing, and completed research activities.

DTIC provides leadership for the DoD IAC Program through the IAC Program Management Office (PMO). The IAC PMO serves two primary functions. First, it oversees, regulates, and fosters the growth of the IAC programs for OSD. Second, it is the focal point for organizations requiring IAC services. The IAC PMO develops and promotes the IAC program, initiates procurements, reviews tasks, and oversees contracts. The types of efforts overseen by the PMO and conducted within the individual IACs include producing technology assessments, empirical data sets, and state-of-the-art reports; finding information and providing answers; and conducting special needs studies. Additional efforts include the planning and execution of symposia or special meetings, focused on increasing awareness and sharing scientific and technical information on topics of interest. In the most technical sense, DTIC's IACs conduct workshops for training and for the introduction of new technologies and techniques.

The DoD IAC PMO is responsible for the day-to-day administration and oversight for the FIC. The DoD IAC PMO supports the Steering Committee by establishing Memoranda of Agreement (MOA) with selected industries/companies involved in the development of fusion related technologies, and inviting them to provide advisors to the Steering Committee to assist in lending focus for the Team. The DoD IAC PMO also coordinates studies requested by the Steering Committee to help clarify policy questions, technology issues, and technical focus areas.

The establishment of a FIC will provide the foundation to ensure continued success in solving the growing problems of exploiting massive quantities of diverse, and often low-confidence, information relevant to tactical and strategic decision-making. The development of a FIC will provide a core focal point for the establishment and maintenance of a comprehensive fusion knowledge base that would include historical, technical, and scientific data and information. It will provide a central repository and authoritative source for fusion emerging technology information needs and ensure that previous research is considered in current efforts. It will be able to develop and distribute fusion/ technical publications to include handbooks, state-of-the-art fusion technology reports, critical technology assessments, bibliographies, research directories, and assist in developing and evaluating fusion training programs. Another important capability a FIC Team will provide is to ensure their information products are distributed within appropriate limits established by Directives and Instructions with regard to information security.

The complexity of the problems faced within the fusion community lends itself to the structure of the Technical Area Task (TAT). TATs, who are designed to bring solutions to complex problems requiring extensive technical analysis or significant data collection, will allow the concentration of efforts on specific problems. The FIC will make use of TAT efforts in conducting extensive analyses; data collection in support of fusion research; engineering documentation reviews; developing extensive technical reports;

and developing, evaluating, and presenting fusion emerging technology training programs.

## REFERENCES

- [1] Franklin E. White, Jr., *Data Fusion Lexicon*, Joint Directors of Laboratories, Technical Panel for C<sup>3</sup>, Data Fusion Sub-Panel, Naval Ocean Systems Center, San Diego, 1987.
  - [2] Franklin E. White, Jr., "A model for data fusion," *Proc. 1st National Symposium on Sensor Fusion*, vol. 2, 1988.
  - [3] Naval Ocean-Surveillance Correlation Handbook, NRL report 8402, 17 September 1987.
  - [4] *Airborne Reconnaissance Technology Program Plan*, Defense Airborne Reconnaissance Office, February 1995.
  - [5] *Data Fusion System Engineering Guidelines*, SWC Talon-Command Technical Report 96-11/4, vol. 2, 1997.
  - [6] Alan N. Steinberg, Christopher L. Bowman, Franklin E. White, "Revisions to the JDL Data Fusion Model," *Proc. Third NATO/IRIS Conference*, Quebec City, October 1998.
-