



Decision and Information Sciences Division



Information Sciences Group

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Information Sciences

The expertise of staff members in Argonne's Information Sciences Group (ISG) encompasses a wide spectrum of information technology systems that store, organize, and structure large-scale, complex information sources to support analysis, decision-making, modeling, simulation, and dissemination. ISG uses an interactive, rapid-prototyping process that involves customers in the production of the final system. This approach helps to ensure that the system meets the needs of the end user.

ISG, a pioneer in creating prototype systems, continues to develop advanced and innovative information technology solutions that help address the complex challenges faced by government and industry. These systems focus on both current and future challenges in information technology, including complexity, scale, wide area information dissemination, and information protection and security. ISG-developed information systems provide customers with the architectures, interfaces, access mechanisms, and servers they need to harness the power of large-scale and varied data sources.

These disciplines provide the foundations for large-scale data management, data warehousing, mining, visualization, analysis, mapping, modeling, and simulation.

ISG Expertise

Internet Technologies and Digital Libraries

Internet technologies provide real-time information to worldwide users through the World Wide Web. Web pages provide information, e-business, advertisement, news, and access to digital libraries. Search engines that provide thousands (or perhaps hundreds of thousands) of results to a query are not useful. Large-scale digital libraries need to be structured in ways that allow users to locate not only the information, but the context and background of the information so that it can be accurately interpreted.

However, the challenge remains to organize the information so that users not familiar with the information and its structure can locate the information they are seeking precisely and in a timely and efficient fashion.

These full-text information systems and digital libraries have been built for large-scale data repositories in connection with U.S. Department of Energy (DOE) information dissemination projects.

Data Warehousing

ISG's information scientists research, develop, and apply technology and also leverage processes to bring disparate databases and information sources together in integrated systems that house corporate knowledge bases. These leveraged processes focus on capturing metadata—information about information—from the source systems (Fig. 1), which, in turn, help us identify the context, purpose, and limitations of the data sources and understand why these sources were created.

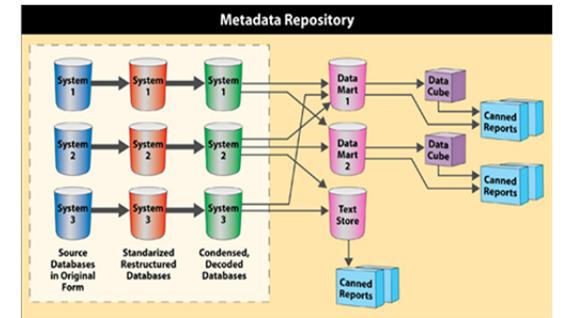


Fig. 1. Metadata Repository Architecture

Cyber security is a critical area of information security and protection. ISG projects include:

- *Network analysis.* ISG has examined networks for traffic analysis, performance, and architecture validation.
- *Sensor integration networks.* ISG integrated distributed chemical-biological sensor systems in secured networks to provide warnings in subway systems, at national events, and for urban monitoring.
- *Large-scale data mining for security applications.* ISG determined the origins of inquiries, patterns of access, and general data discovery from tracked information.
- *Networks for scientific data acquisition.* ISG has designed and implemented a large-scale network for the Atmospheric Radiation Measurement (ARM) Program.
- *Vulnerability assessments and penetration testing.* ISG helped conduct these assessments and "white hat" penetration tests of government and energy-related industrial systems.
- *Certification and accreditation (C&A).* ISG has extensive experience in conducting C&A assessments and in performing evaluations of systems required by A123 and the Federal Information Security Management Act. Our evaluation-related activities include preparing systems documentation and performing the testing on these systems.

Worldwide Data Acquisition Systems

The ARM Program is the largest global climate change research program supported by DOE's Office of Science. Argonne's ISG provides technical support to the ARM Program by:

- Designing and implementing the worldwide communications infrastructure required to operate the measurement network, including on-site local area networks and instrument communications, as well as wide area communications.
- Developing procedures that ensure recovery of high-quality data in a cost-effective and timely manner.
- Managing the network infrastructure and cyber security at these facilities.



Fig. 2. Technical Support Process for ARM

The scientific infrastructure created as part of the ARM Program is a valuable national and international asset for advancing scientific knowledge of earth systems (Fig. 3).

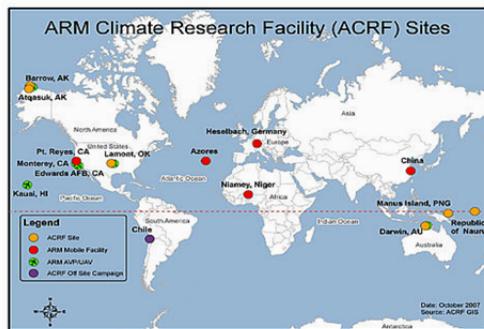


Fig. 3. Worldwide ARM Sites

Systems and Network Engineering

ISG computer and network engineers provide sponsoring organizations with the hardware and software foundation required to support their local and remote (worldwide) systems. Services include:

- Evaluation, selection, implementation, and integration of advanced computer architectures, high-speed networking systems, and supporting components.
- Requirements analysis, needs definition, and system selection and justification—while also factoring in requirements for security, reliability, ease of use, life-cycle cost, and performance.
- Development of prototype and testbed systems and networks to ensure quality and ease of implementation.
- Designed, specified, and engineered worldwide data networks and mobile data collection and communication systems for the ARM Program and urban sensor network.
- Consolidation of military installation networks.

Very Large-Scale Data Management

Scientists involved in the Argonne Tandem Linear Accelerator System (ATLAS) experiment at the Large Hadron Collider (LHC) at CERN—the European Organization for Nuclear Research—in Geneva, Switzerland, are seeking to understand the fundamental forces that have shaped the universe since the beginning of time.

- ISG leads an international team of developers who are providing the data store architecture and designing the navigational infrastructure, ATLAS control framework input/output infrastructure, and multi-terabyte (TB) metadata system. Argonne also provides support for distributed database servers and services.
- The data store and its supporting services

operate in globally distributed grid- and cloud-based computing environments and at laptop scales, with performance and functionality tuned to specific high-energy physics access patterns and tool suites.



Fig. 4. CERN (inset: Beamline)

Independent Verification and Validation

The risks associated with the development of a software system are the product of the severity of the consequences of failure and the likelihood that the failure will occur. Such risks include marginal to catastrophic consequences (e.g., software causes treaty violations) when safety or security is at stake. The ISG uses flexible independent verification and validation, commonly referred to as IV&V; tailors tasks to meet customers' needs; and applies IV&V at the system level to include hardware and software interactions. A key component of ISG's approach to IV&V is the concept that early detection of risks and deficiencies leads to more efficient, less costly, and more accurate systems. By stressing the "practical" aspects of IV&V, Argonne's team adjusts the tasks to match the level of consequence involved. Performing IV&V minimizes risk and instills confidence in the final product. IV&V works best when it is incorporated into the entire life cycle.

Software Quality Assurance

Argonne has conducted assessments and audits of software quality and provided instruction on software quality engineering.

Geographic Information Systems

In connection with infrastructure assessments, ISG has more than 10 TB of geospatial data in data holdings. Highlights include:

- Digital Ortho Quarter Quads of the entire United States at a 1-meter resolution level.
- Imagery in many urban areas at a 6-in./1-foot level of resolution.
- U.S. coverage of vector data for numerous domain areas.

Sync Matrix Emergency Management Information Systems

Sync Matrix Enterprise is an innovative planning tool that combines the power of mass collaboration technology for emergency planning. The software serves as a collaborative workspace, allowing the planning team to work individually or as a team. It enables planners to visualize how the actions of all participating organizations and locations relate to each other, to the hazard, and to the operation's goals and objectives.

Energy Economics and Investment Analysis Information Systems

ISG has developed modular computer software, AMIGA, to assess energy transitions over the coming decades, including economic and environmental impacts. An electricity supply model, MARS, is used to select cost-effective and feasible energy solutions.

Medical Computer Imagery

ISG applied image analysis, statistical modeling, and machine learning to discover image-based features for characterizing the visual appearance of lung nodules used by radiologists in their visual diagnosis task. This capability was applied to predict the ratings of diagnostic characteristics.