

Data Sharing Middleware for INFOrmation Dissemination (INFOD) among Heterogeneous Sources

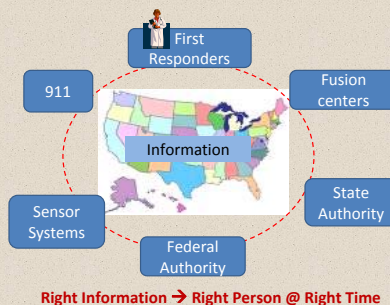
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1. Information Sharing – Objectives, Challenges & Requirements

Objectives: The objective of this project is to develop a data sharing middleware that is able to handle multiple distributed data sources and dynamically changing items, and to assist in real-time information dissemination across multiple agencies for homeland security purposes.

Challenges: The increasing volume, diversity, and complexity of resources and data continue to raise challenges in sharing and retrieval of information. Getting the right information to the right person at the right time becomes the ultimate challenge of the project. Although publish-subscribe systems have enabled communities to exchange information, we argue that these systems have been either restrictive or simplistic, relying on pre-defined channels for data sharing.

Requirements: An efficient and effective information sharing system should 1) foster information sharing across various agencies, 2) enforce policies and constraints for secure information dissemination, 3) support a structured data model for information exchange, such as NIEM (National Information Exchange Model), CAP (Common Alerting Protocol), and 4) plug-n-Play of software services

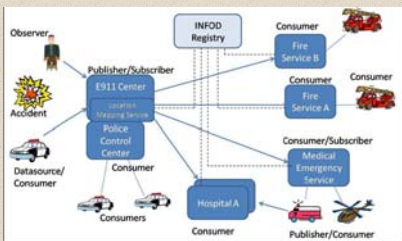


Right Information → Right Person @ Right Time

3. INFOD Application Examples

3.1 First Responder Use Case

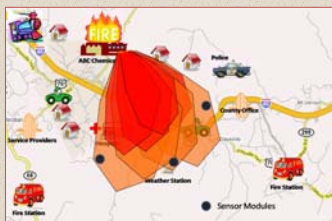
An accident has occurred, and a bystander reports the event to the E911 center, which then requests for police, ambulance and/or fire truck to be dispatched based on the current description of the event. As the first officer arrives at the location, the officer reports more details of the accident to the E911 center and also updates on the states of the incident. If resources in a particular region are not sufficient, the E911 center needs to make a decision in calling for additional resources based on their capabilities and availabilities.



INFOD helps 1) monitor resources, 2) associate services, 3) gain knowledge of the capability/availability of the resource, and 4) define the incident object, structure + policies/ constraints which need to be enforced based on the event description.

3.2 Source Localization & Boundary Tracking and Prediction of Chemical Plumes

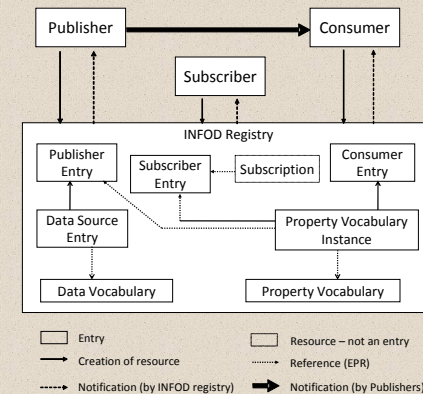
- Accidental gas releases from industrial sites and biological terrorist attacks result in dangerous chemical plumes. To mitigate the effect of these plumes it is necessary to not only **locate** but also **track** their evolution, with the latter problem being more challenging.
- We have proposed effective solutions to both problems using a group of fixed and mobile sensors, which measure the plume concentration at different locations.
- Information is exchanged among mobile sensors and also with information fusion centers through matching conducted by INFOD, where the fusion centers notify the appropriate authority and services.



2. Advancing Information Sharing - The INFOD Middleware

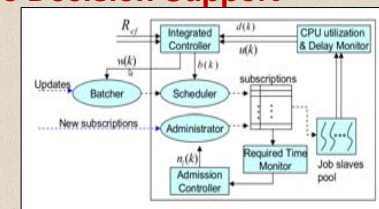
The INFOD model introduces a **flexible** and **dynamic** framework for brokering information between entities. With a number of policies/constraints to be enforced while sharing such critical information, the INFOD system provides the capability to **efficiently communicate the right information to the right person at the right time** with the following capabilities:

- Real-world entities are characterized as Publishers, Consumers and Subscribers.
- Subscriptions enforce policies and constraints for data sharing. Subscriptions define 1) which publisher sends information to which consumer, 2) the event of interest at the publisher, and 3) which message to send to which consumer.
- It establishes a framework for information flow from the publisher directly to the consumer, and the INFOD registry is no longer a data warehouse anymore.
- It provides a structured information model, where user communities are identified by property and data vocabularies. Property vocabularies characterize user entity properties, while data vocabularies describe publisher data semantics. Data Source Entry associate publishers to multiple information sources.
- The INFOD registry matches publishers and consumers based on information needs expressed through subscriptions and limited by properties, after which it ends notification messages to user entities informing them of their associations.
- As user properties or subscriptions change, and/or new users/subscriptions are registered, the system reevaluates granting/limiting associations for information sharing.



4. Potential Impact of INFOD - Real-Time Decision Support

- In time critical applications such as emergency alerting systems, making decision at the right time is as important as making the right decision.
- The INFOD model supports a control based subscription matching mechanism for evaluating high priority policies within a time bound.
- We have explored novel feedback control architecture for INFOD to adaptively control the average response time of metadata matching. Further, we have proposed a Multiple-Input-Multiple-Output (MIMO) control algorithm based on optimal control theory to address the response time and the system throughput in an integrated manner. Empirical results show that our algorithm not only effectively guarantees the real-time requirement but also achieves the maximal system throughput.



Subscription Admission Controller

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