Collaboration Web - Social Computing Technology for Emergency Data Interoperability

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***Abstract*— This paper discusses the use of social media for data interoperability and sharing between agencies during emergency situations, natural disasters, and disruptions of critical infrastructure. The work presented is ongoing in the context of the Emergency Responders Data Interoperability Network (REDIRNET) research project. The project's purpose is to provide a decentralized framework for interoperability between emergency agencies' systems, based on a public meta-data gateway controlled by the agencies through a socio-professional web interface. A major problem during crisis situations is sharing data from various sources between the agencies involved. These data are often heterogeneous and distributed between many organisations with different access rights, and may have little or no security level protection. This paper focuses on the shared platform, which collects information from a variety of sensor nodes and presents it in a user-friendly manner. This is a new approach to using social networks actively in the field of Public Protection and Disaster Relief by addressing the technological challenge through an open-sourced metadata gateway combined with social computing technology.**

Keywords-Collaboration web; Data interoperability; Social computing technologies.

I. CONTEXT AND MOTIVATION

In recent years, First Responder organizations across Europe have considerably improved their communications and IT systems through the deployment of new technologies, including such innovations as unmanned surveillance and sensor systems that assist in preventative actions and enhance responses to major crisis events. Nevertheless, a number of recent major incidents have highlighted the challenges first responders face, most notably concerning barriers to interoperability [1], [2]. These challenges must be faced despite the current economic and financial situation, which places agencies under considerable budgetary pressure, leaving them unable to invest significant sums in enhancing their interoperability capabilities – particularly when such cooperation between agencies is thankfully not required frequently. This leads to the conclusion that if we are to enhance agency interoperability, this must be achieved through cost-effective solutions. Interoperability is especially important during major incidents, when many agencies are involved. In addition to the core responder agencies, major crisis events invariably involve public utilities, technical rescue, the coastguard, search & rescue, highway management, hazmat and other disaster relief teams. As a consequence, several command posts and crisis management centres are in operation and need to inter-operate. The need for interoperability between different agencies has often led to the development of one-to-one interconnection solutions, which suffer from maintenance issues as the connected systems evolve. Moreover, such ad hoc solutions often fail to consider emerging concerns related to security and privacy.

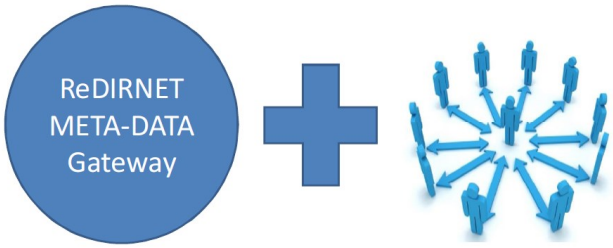

Figure 1. Metadata gateway combined with socio-professional networking.

Two main technologies are combined in our project: a *common metadata gateway* and a *socio-professional networking system* [3], [4], [5], [6], [7], allowing each agency to set the visibility and controllability of its data for each partner agency and each data field, as shown in Figure 1. The project introduces a system that provides seamless interoperability for participating agencies at virtually zero cost, while still offering great flexibility as regards what data can be available to partner agencies via the socio-professional web. This level of interoperability offers emergency service agencies a more effective response to major crisis incidents that may ultimately lead to enhanced safety and security for the public across Europe.

In the remainder of this paper, we first discuss related work in Section II, before moving in Section III to a presentation of the REDIRNET components used to implement the collaboration web described in Section IV. Our conclusion is presented in Section V.

II. RELATED WORK

The idea of the Collaboration Web took shape in 2012, with the launch of the Free Secure Interoperable Communication (FREESIC) project [8]. Its goal was to

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"allow highly secure and cost effective interoperability between communication infrastructures over the entire Europe". The approach chosen was to leverage existing interoperability solutions such as gateways, simplifying FREESICs adoption by agencies, and, in return, opening broader possibilities for them. The service operated free of charge and offered open source gateway code, documentation and operational guidelines for others to use. Provision was made to continue the free-of-charge operation after the project's end. The architecture took into account ongoing standardization research (e.g., the **Network Centric Operations Industry Consortium** (NCOIC) Interoperability Framework [9]) to reduce integration time and costs. The integration process was simple: the system integrator took the gateway equipment and modified it as needed. While the gateway remained the property of the integrator, the integrator did not have to worry about disclosing any know-how or information. Communication between gateways was end-to-end encrypted and each gateway was under the full control of the end user, so as to avoid security concerns2. The project was successful in showing that the initial concept of the Collaboration Web was workable.

III. REDIRNET COMPONENTS

The main focus of the current project [10] is to create possibilities for interagency communication and the sharing of first responders' data. Our system allows an agency to access a partner's shared sensor data. Based on the sensor and its capability, two kinds of connection can be set up: a request/response connection is used for batched data, while a stream connection is established for a continuous data flow. It is assumed that the partner agency consuming the data is capable processing the incoming data. As an example, in Figure 2, Agency B is offering data streams from Sensor 4 and Camera 1 to Agency A. This arrangement has been previously agreed between the two agencies and configured using the REDIRNET socio-professional network. The network's seamless interoperability means that Agency B's Sensor 4 and Camera 1 can be displayed in agency A's control center beside its own Sensor 6 and Camera 3. The same is true for data displayed on Agency A field officers' handheld devices.

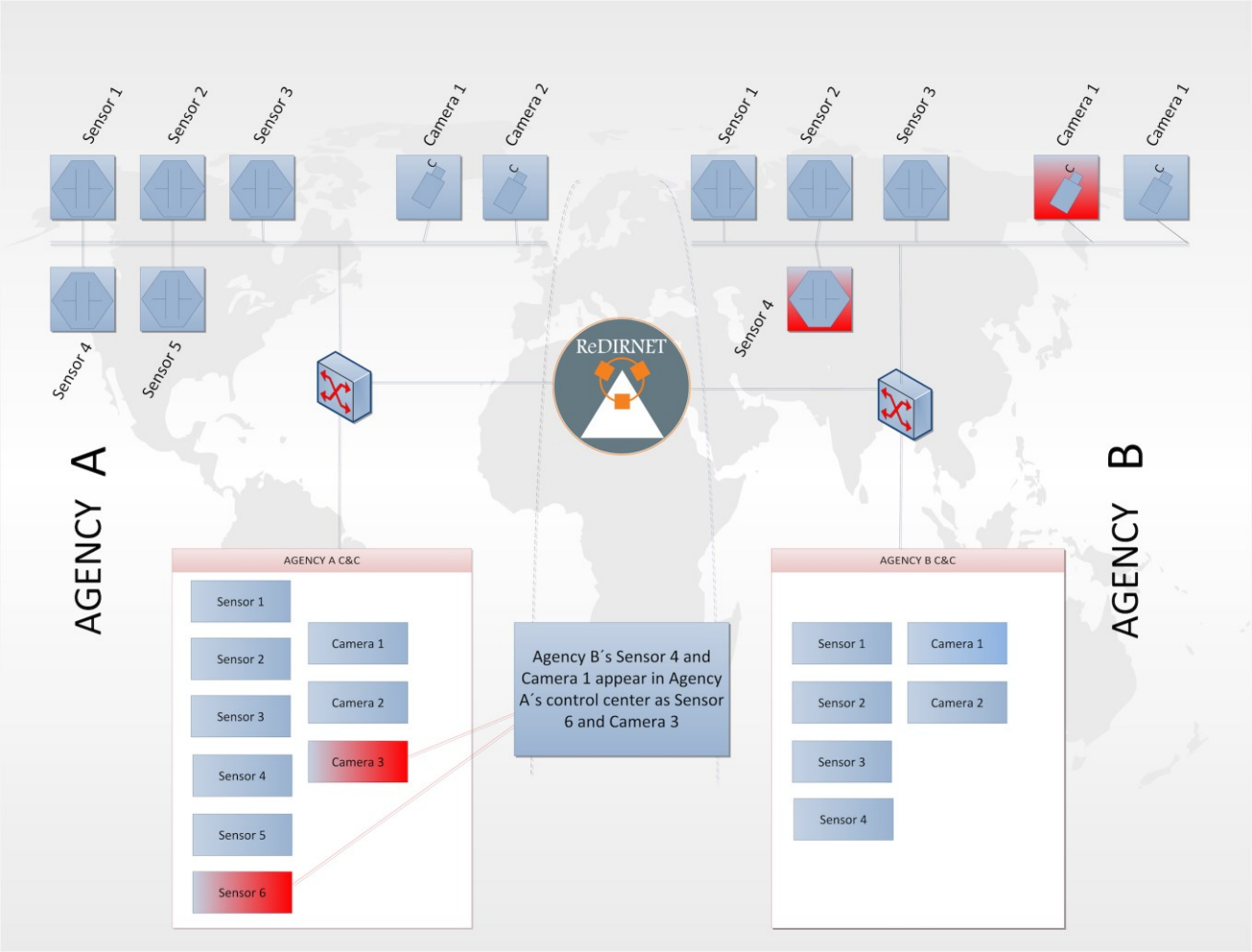

Figure 2. REDIRNET components.

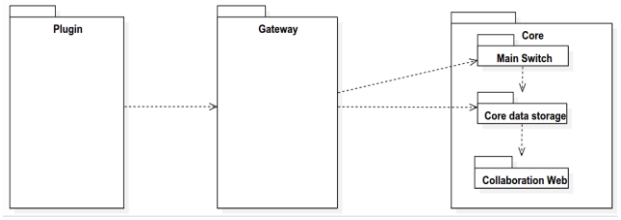

Figure 3. Class diagram showing REDIRNET components.

In order to provide agencies with the ability to share their data resources, some preliminary steps are required. The data-producing resource must be connected to some sort of translator, which can encode the data stream into a common transport protocol, and provide the correct command interface. This translator is then connected to a transport network, which can verify permissions for each user and route the stream to its destination, where it is translated into a protocol native to the data consumer and subsequently displayed.

This workflow, shown in Figure 3, can be achieved by a system consisting of five components:

- ***Main Switch***, redirecting the communication, checking permissions and providing a logging facility,
- ***Core Data Storage*****,** supplemented by an ontological search engine, providing database services for all data requiring storage,
- ***Collaboration Web***, the user interface for the system, allowing resources to be registered and their permissions to be managed,
- ***Gateways***, a client at each agency client, taking the role of mediator between the Main Switch and the plug-ins,
- Plug-ins, drivers providing interfaces for the endpoint resources.

IV. COLLABORATION WEB

The socio-professional networking component provides a decentralized opportunity for an interoperability network to be built and configured by its users. It also allows the interoperability network to be run without major operational costs, since the collaboration rules are set by the agencies themselves by following basic guidelines. Collaboration rules are set according mutual agreements between the agencies involved and should cover issues that include the visibility and controllability of data fields, data streams and switches. The algorithms and keys used for end-to-end encryption of the data are also set up by the agencies.

The Collaboration Web handles the use cases related to getting in touch with other agencies and the high-level configuration of the inter-connection based on abstract roles. Typical use cases are the creation of an agency profile, registration of a data resource, and configuration of permissions. The agency's authorized users can perform all

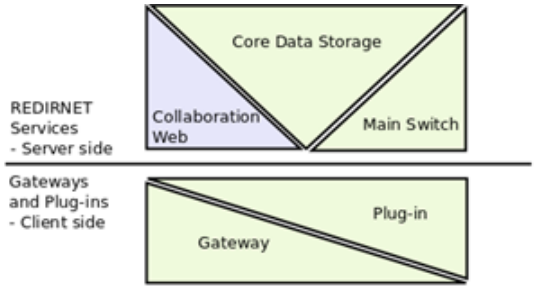

Figure 4. Collaboration Web system in relation to other components.

these actions through a web browser. The web interface will initially provide all of the essential collaboration capabilities mentioned above, but, should the need arise, it can be extended to provide additional functionalities of the type found today in commercial applications.

In line with modern approaches to the development of web applications, we are using the Model-View-Controller programming paradigm for enhanced robustness and modularity, as shown in Figure 4. The services of the REDIRNET Core, particularly its Core Data Storage component, will implement the Model and Controller functions of the paradigm, while the Collaboration Web itself will provide the View role.

Figure 5 shows the operations allowed by the collaboration web, an example screen for which appears as figure 6. These operations will allow each agency's authorized users to:

- register users and maintain profiles;
- enter name, short-name, description, and contact information;
- establish partnerships between agencies;
- search for a partner agency, propose/approve a partnership, display the partners of an agency and whether a partnership was mutually approved;
- search for the data resources of other registered agencies;

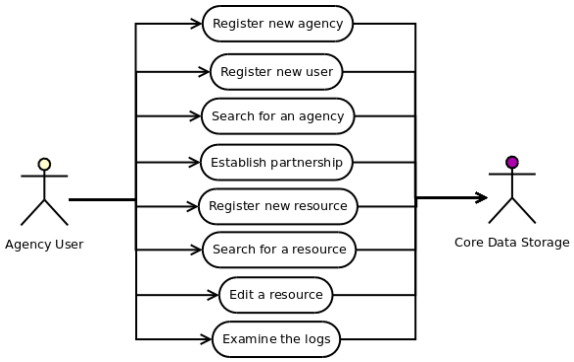

Figure 5. Collaboration Web system operations.

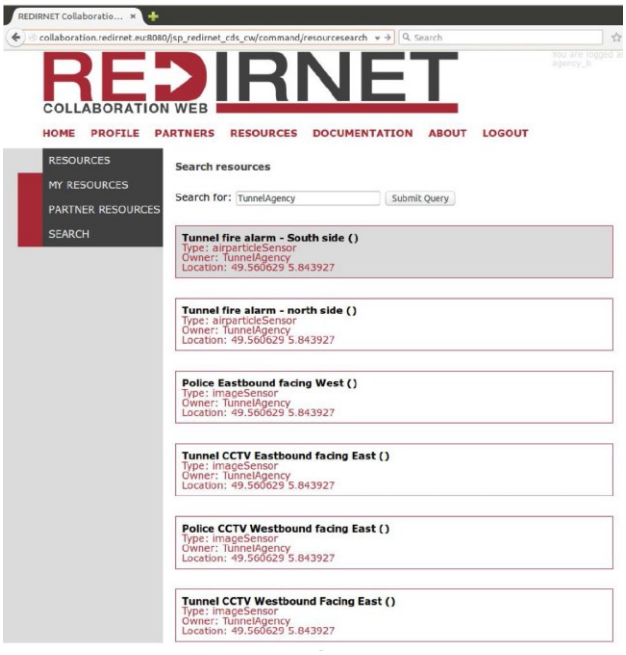

Figure 6. Collaboration Web ontology search (detail).

- set up interoperability for resources with the help of the ontology subsystem, which allows the user to use the terminology native to their region or domain; and
- examine log events and set the correct permissions on each resource.

The Collaboration Web should also be able to initiate a crisis event, which makes it possible to override some of the permissions. (This possibility of overriding existing resource permissions will be of course based on agreement between the respective agencies.) A major issue in such collaborative systems is data privacy, especially where international cooperation is involved. To solve such concerns, the collaboration system will be available only to agencies in the field of Public Public Protection and Disaster Relief, and subject to bi- or multilateral agreements based on trust relationships estabished before each agency joins the system.

V. CONCLUSION

The core features of the REDIRNET system have already been tested and the system is being prepared for integration by the first test users. These core features are related to data transfer from the producing plug-in and gateway, via the main switch, to the consuming gateway and plug-in. The system also supports a limited set of social networking features, semantic search and agent-assisted resource polling. The system remains under development, and we expect to implement other features defined in the system requirements in the coming months. The whole system will be evaluated in the final demonstration, which will include both emergency agencies and end users. The usability of the system must satisfy both technical (functional) and non–technical requirements, such as process/culture, financial & commercial, legal & regulatory, and data privacy, which will be developed in cooperation with end users at the beginning of the research project.

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