The University of Kansas

Technical Report

Summary of Status: A Unified Architecture for SensorNet with Multiple Owners: Supplement to Advance SensorNet Technologies to Monitor Trusted Corridors

University of Kansas, ITTC
V.S. Frost, G.J. Minden,J.B. Evans, L. Searl,
D.T. Fokum, D. Deavours, E. Komp, A. Oguna,
M. Zeets, M. Kuehnhausen, D. Depardo

EDS
J. Walther, L. Sackman, M. Gatewood,
J. Spector, S. Hill, J. Strand

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1.0 Introduction

This effort is aimed at monitoring cargo movements along a trusted corridor, e.g., rail facilities, in association with an integrated data-oriented methodology to increase efficiency and security. This goal is being achieved by performing research and deployment of an associated testbed focused on rail transportation issues. The results of this effort will lay the foundation for enhancing the ability of the private sector to efficiently embed security that provides business value such as safety, faster transport and reduced theft while supporting law enforcement and national security. In the end, the benefit of the combination of real-time sensor data with trade data exchange information will be demonstrated through field tests on a deployed rail testbed. (For background and definition of terms see [1] V.S. Frost, G.J. Minden, J.B. Evans, L. Searl and D.T. Fokum, T. Terrell, L. Sackman, M. Gatewood, J. Spector, S. Hill, and J. Strand, "Status Update : A Unified Architecture for SensorNet with Multiple Owners: Supplement to Advance Sensor Technologies to Monitor Trusted Corridors", ITTC-FY2009-TR-41420-10 August 2008).

2.0 Status on Technology Proof of Concept and Integration of the SmartPort Trade Data Exchange and Transportation Security SensorNet Technologies

In preparation for rail trials of the integration of the Smartport trade data exchange and transportation security sensornet technologies, trains at a rail yard in Kansas City, Mo. were visited on August 27, 2008. Initially a short haul rail trial will be conducted which will run from the rail yards in downtown Kansas City, Mo. to the intermodal facility in south Kansas City. Information gathered from this visit lead to the construction of the hardware required for the trail trials. The construction and testing of the required hardware has been completed.

A mobile integration test of the communications and interactions between the TDE at EDS, MRN, and the VNOC has been successfully completed (December 4, 2008). This mobile integration test was conducted using two pickup trucks to emulate the train. The mobile component (the MRN) of the integration test was conducted in driving around Lawrence, Ks.; the VNOC was located in ITTC on the KU campus, and the TDE was located at the EDS facilities in Overland Park, Ks.. This successful mobile integration test was preceded by several field experiments of components of the system.

With the successful completion of the mobile integration test, the short haul rail test is being scheduled with a target of before the end of 2008.

3.0 Status of the Development of Transportation Security SensorNet (TSSN) Technologies

The development of the TSSN takes an SOA approach, building upon the original ideas of ACE but utilizing current technology and widely accepted open Web Service specifications and publicly available implementations which are suitable for Sensor

Networks. Some of the Web Service specifications in use are SOAP, the WS-X specifications, and UDDIv3.

The TSSN is being implemented in three phases. The first phase will be used in the field trials described above.

Phase 1 – Simple service messages based on OGC specifications (used in trials).
Phase 2 – Use full OGC specification interface messages.
Phase 3 – Use lessons learned from Phases 1 and 2 to make improvements.

Phase 1 is now complete.

4.0 Status of System Architecture, Modeling, and Optimization

This task is focused on developing models of the Transportation Security SensorNet (TSSN) and Trade Data Exchange environment that can be used to articulate trade-offs and enable system optimization. In order to model the container placement and sensor assignment problem efficiently a new method has been devised for indexing the containers and the locations (slots) that they occupy on the train as well as the location of sensors and elements of the communication network. We developed a new concept of object visibility and defined a visibility space as the set of system costs such that customer requirements for probability of detection, probability of false alarm and event reporting deadlines are met. The problem can now be formally stated as: Given a collection of objects with different values and end-to-end information systems (including sensors, seals, readers, and networks) with different capabilities: how do we design a system that allows "visibility" (meeting given constraints) while minimizing overall system cost? Small train based and trackside systems have been analyzed to confirm our approach. Sample results are given below (Table 1). (A full description of the current system model is in [2] Daniel T. Fokum, "Optimal Communications Systems and Network Design for Cargo Monitoring" Proposal for Ph.D. dissertation research Department of Electrical Engineering & Computer Science, University of Kansas, December 2008.)

Case	Number of Sensors	Normalized Cost Metric	Average Time to Record Event/s
Rail-mounted Scenario	5	1,555	6
	4	1,581	49,685
	3	3,145	99,363
	2	4,795	149,042
	1	7,300	198,721

	0	11,400	248,400
Trackside Case	5	1,895	556

Table 1 Example results from system trade-off study

Further work is needed on the model, objective function, and obtaining realistic model parameters. The framework will then be applied to study system trade-offs.

5.0 Status of Communications System Evaluation

Research is continuing on radio technologies for TSSN. As part of evaluating the current active container seal technology, it was discovered that the communication range for the devices selected for this research was more limited than expected. The active seals we are using operate in the 916 MHz band. A vendor of bidirection RF amplifiers in the 916 MHz band made custom modifications to their device based on our specification. With those modifications we were able to expand the communications range of the system. In the course of conducting the mobile integration tests we determined that the communications range is now on the order of a quarter of a mile. This expanded range will enhance the rail field tests. Note with all the elements (MRN, VNOC, and TDE) of the system in operation in a mobile environment exact range measurements are difficult to obtain.

6.0 Status RFID Technology Evaluation and Development

The combination of the new ITTC/KU on-metal RFID tag technology and the Mojix system was deployed and tested in a warehouse environment. While this initial testing focused on the suitability of the system on an MES (manufacturing and execution system, i.e., an assembly line) and for scanning entering and exiting a dock door, the results of this testing lead to conclusions concerning applicability in an intermodal environment. Additional experiments have been conducted and a technical report is in preparation.

7.0 Associated Efforts

KC SmartPort has continued to coordinate meetings for the groups involved in TSSN, CTIP and EFM. These meeting are creating a common, open environment with low entry barriers to enable broader access by stakeholders while contributing a venue to commercialization. The KU/ITTC and EDS teams are supporting the interactions between these efforts. KU/ITTC and EDS teams participated in KC SmartPort coordination meetings on August 27, September 30 and October 28, 2008. The next meeting is scheduled for December 16, 2008.

8.0 Project Timeline

Figure 1 is the current project timeline. The short haul field trial is targeted for completion by the end of 2008; a long haul field trial in Mexico is anticipated in spring 2009. The efforts associated with the system modeling, communications, and RFID are planned to be completed by the end of spring 2009 and an interim report describing these activities delivered by end of summer 2009. Activities associated with SmartPort, EFM, and CTIP will continue until June 2010. The current date of completion for the effort is June 15, 2010.

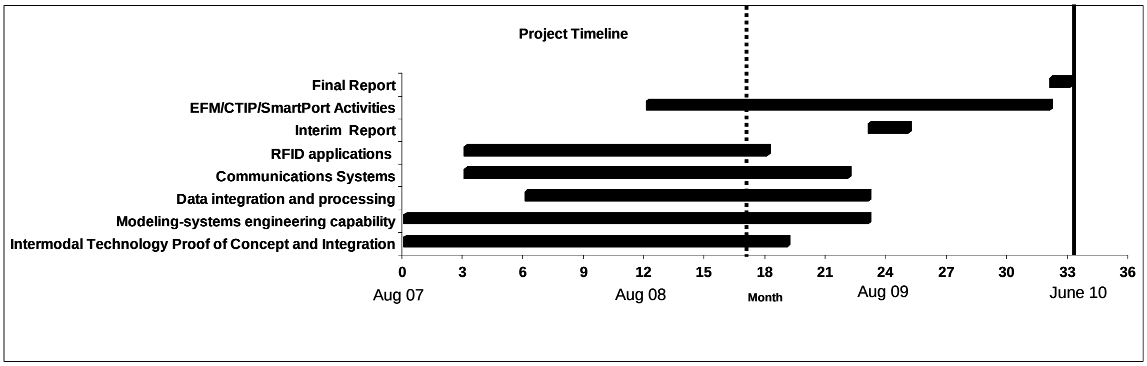

Figure 1 Project Timeline

9.0 References

[1] V.S. Frost, G.J. Minden, J.B. Evans, L. Searl and D.T. Fokum, T. Terrell, L. Sackman, M. Gatewood, J. Spector, S. Hill, and J. Strand, “Status Update : A Unified Architecture for SensorNet with Multiple Owners: Supplement to Advance Sensor Technologies to Monitor Trusted Corridors”, ITTC-FY2009-TR-41420-10 August 2008.

[2] Daniel T. Fokum “Optimal Communications Systems and Network Design for Cargo Monitoring”, Proposal for Ph.D. dissertation research, Department of Electrical Engineering & Computer Science, University of Kansas, December 2008.