Experiences from a Transportation Security Sensor Network Field Trial

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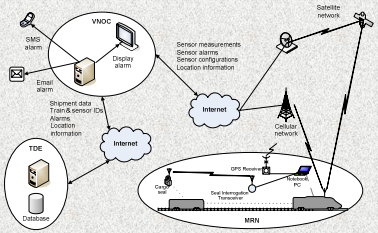
Introduction

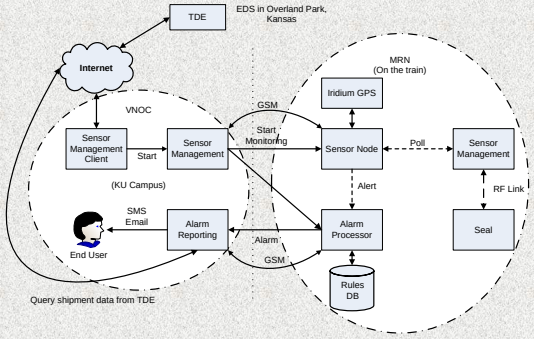
- Cargo theft estimated to cost the US economy $15–$30 billion
  - Cargo theft affects originators, shippers, and receivers.
- Most non-bulk cargo travels in shipping containers.
  - Container transport is characterized by complex interactions.
- Deficiencies in container transport chain expose the system to attacks such as:
  - Trojan Horse
  - Hijack or theft of goods
- Insufficiencies in these areas can be overcome by creating secure trade lanes, especially at intermodal points.
- Transportation Security Sensor Network (TSSN), based on Service-oriented architecture principles, has been developed for monitoring integrity of cargo shipments.
- TSSN has been implemented and a field trial conducted to evaluate its effectiveness and performance.

System Architecture



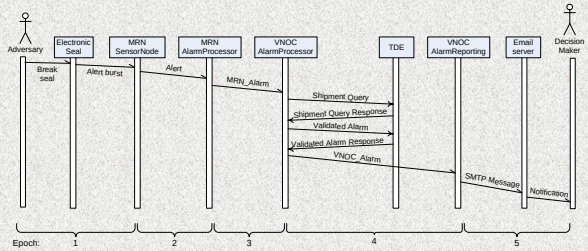
- TSSN is composed of Trade Data Exchange (TDE), Virtual Network Operations Center (VNOC), and Mobile Rail Network (MRN).
- Using commercial off-the-shelf hardware and networks combined with middleware developed in-house the TSSN is able to detect events and report those relevant to shippers and other decision makers.

Experiment and Analysis



Short-haul Rail Trial Configuration

- Field trail carried out on train making a ~35 km trip from intermodal facility to rail yard.
- Field trail objectives:
  - Determine performance of TSSN system when detecting events on intermodal containers in a rail environment.
  - Investigate if decision makers could be informed of events in a timely manner using SMS messages and email.
  - Collect data that will be used in a model to investigate system trade-offs for monitoring rail-borne cargo.
- During experiment events were created by breaking and closing a seal kept in the locomotive.



Sequence Diagram with Messages Involved in Decision Maker Notification

Results

Epoch	Description	Median/s	Max/s
1	Event occurrence to alert generation	2.13	8.75
2	Alert generation to MRN AlarmProcessor service	0.01	0.08
3	One-way delay from MRN AlarmProcessor to VNOC AlarmProcessor service	1.94	2.90
4	MRN_Alarm arrival at VNOC to AlarmReporting service	0.05	3.01
5	Elapsed time from VNOC AlarmReporting service to decision maker's phone	9.8	58.7

TSSN Collector Node mounted in locomotive

Antenna assembly mounted on locomotive

Seal mounted on container

Refinements, Conclusions & Selected References

- Refinements:
  - Redesign MRN hardware for TSSN collector node to have redundant backhaul communications capabilities.
  - Enhanced sensor capabilities to enable whole-train monitoring.
- Conclusions:
  - Based on our experiments and evaluations TSSN is viable for monitoring rail-borne cargo.
  - Based on experimental results it can take just over one minute to notify decision makers of events. Where most of time is spent delivering an SMS message to decision maker.
  - Decision makers desire notification within 15 minutes. We have successfully demonstrated that events can be detected and decision makers notified within decision maker threshold.
- Selected References:
  - M. Kuehnhausen, "Service Oriented Architecture for Monitoring Cargo in Motion along Trusted Corridors," Master's thesis, University of Kansas, July 2009.
  - D. T. Fokum *et al.*, "Experiences from a Transportation Security Sensor Network Field Trial," University of Kansas, Lawrence, KS, ITTC Tech. Rep. ITTC-FY2009-TR-41420-11, June 2009.

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