

Study on the Use of Pervasive Technology to Improve the Emergency Response to Mass Casualty Incidents

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Introduction & Motivation

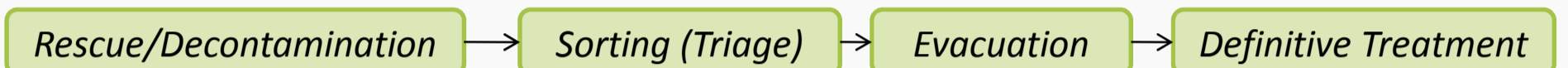
- **Cost from transportation attacks in the world - last 10 years:**
 - 1.125 incidents, 7.037 injuries and 2.333 fatalities 35 thousand deaths; (*Prevention of Terrorism Incident Database – RAND Corporation*)
 - 32% of the attacks to public surface transportation, from 1997 to 2000, were subways, trains and/or train stations. (*Mineta Transportation Institute*)

“It is virtually impossible to defend against attack, due to the very nature of their design and operations”

- **Design and operations:**
 - Scheduled stops along fixed routes;
 - Operations depend on people having quick and easy access to stations and trains;
 - The number of access points and volume of ridership make it impractical to subject all rail passengers to the type of screening that airline passengers undergo.

Emergency Response Process

- **Casualty Sequence Flow**



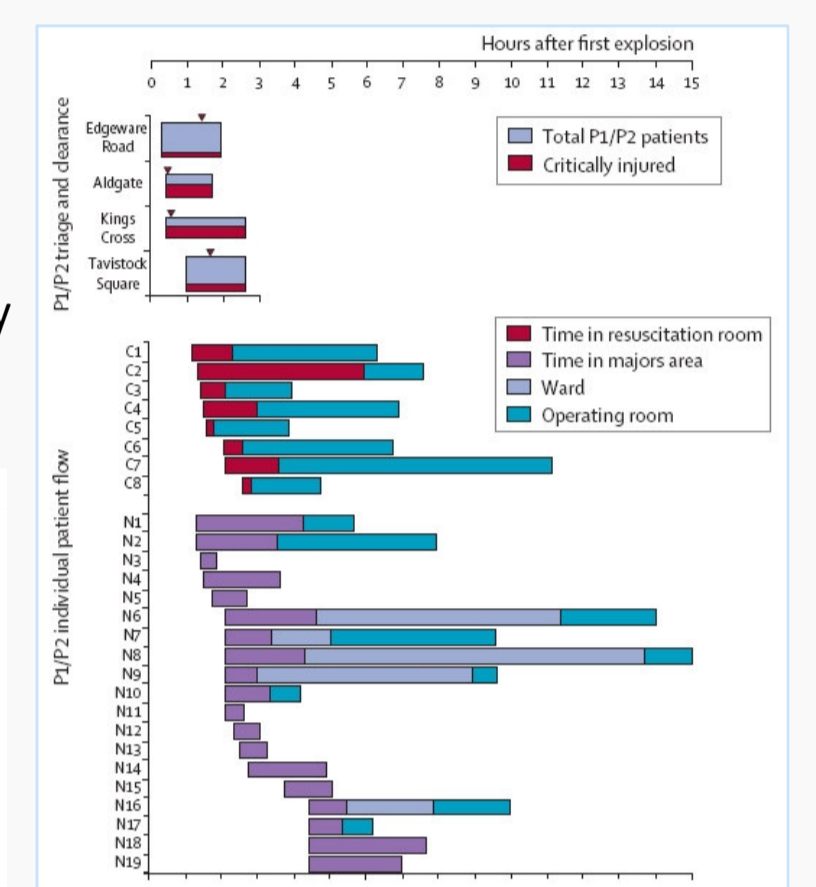
- **Key Concepts:**

- **Triage:** sorting victims according to priorities;
- **Overtriage:** noncritical sorted as high priority;
- **Critical Mortality Rate:** deaths among critically injured.

	Aldgate	King's Cross	Edgware Road	Tavistock Square	Total
Dead at scene	7	25	7	14	53 (7%)*
Priority 1 or 2	11	10	17	17	55 (8%)*
Critically injured	8	6	2	4	20 (3%)*
Overtriage, n (%)	3 (27%)	4 (40%)	15 (88%)	13 (77%)	35 (64%)*
Critical mortality	1	2	0	0	3 (15%)*

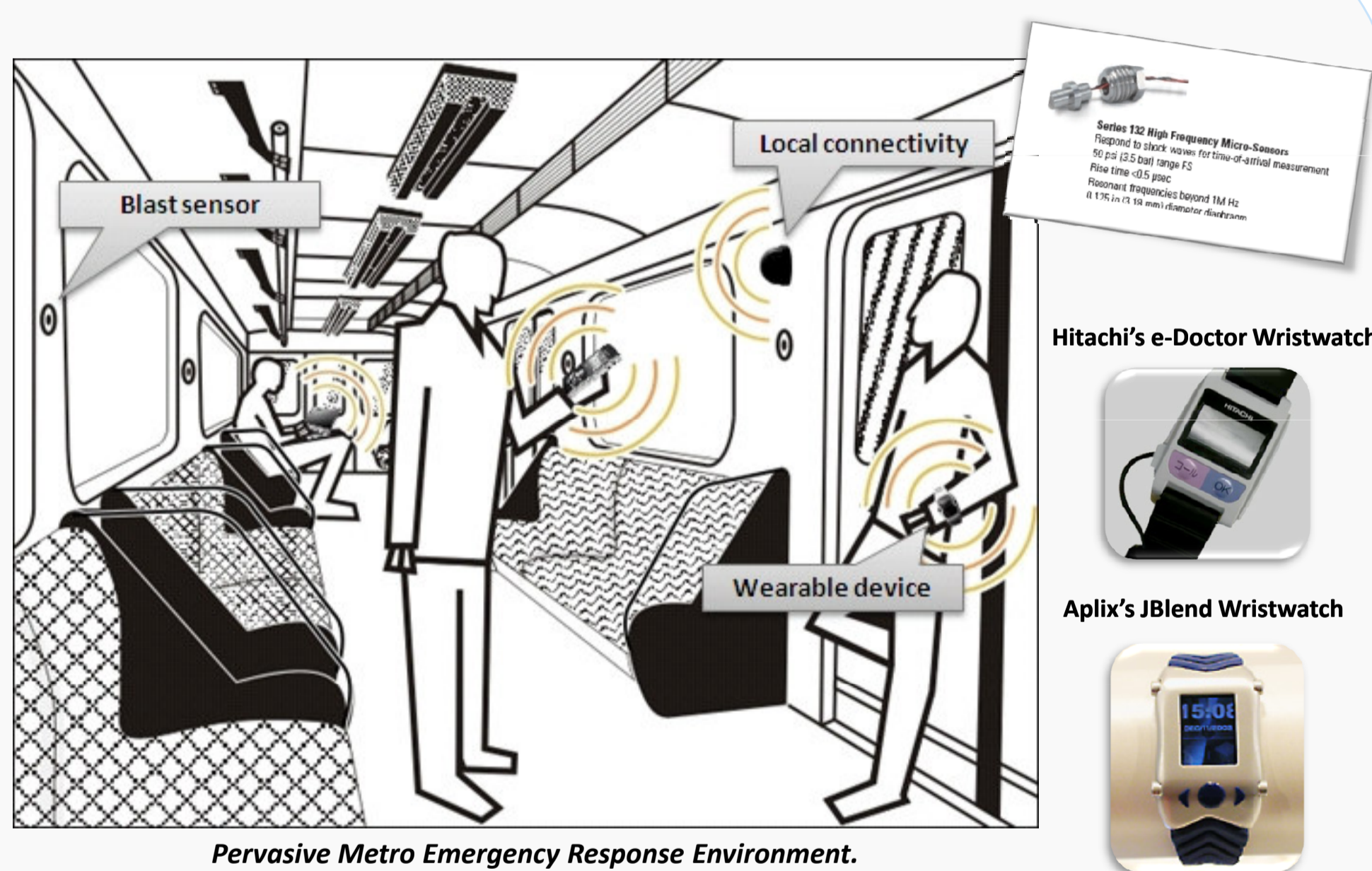
*Of 775 total casualties. †Of 722 immediate survivors. ‡Of 20 critically injured patients.

Table 1: Prehospital response, triage categories, and mortality



London Bombings July 7th 2005: mortality, triage and medical resource consumption.

Pervasive Metro Emergency Environment

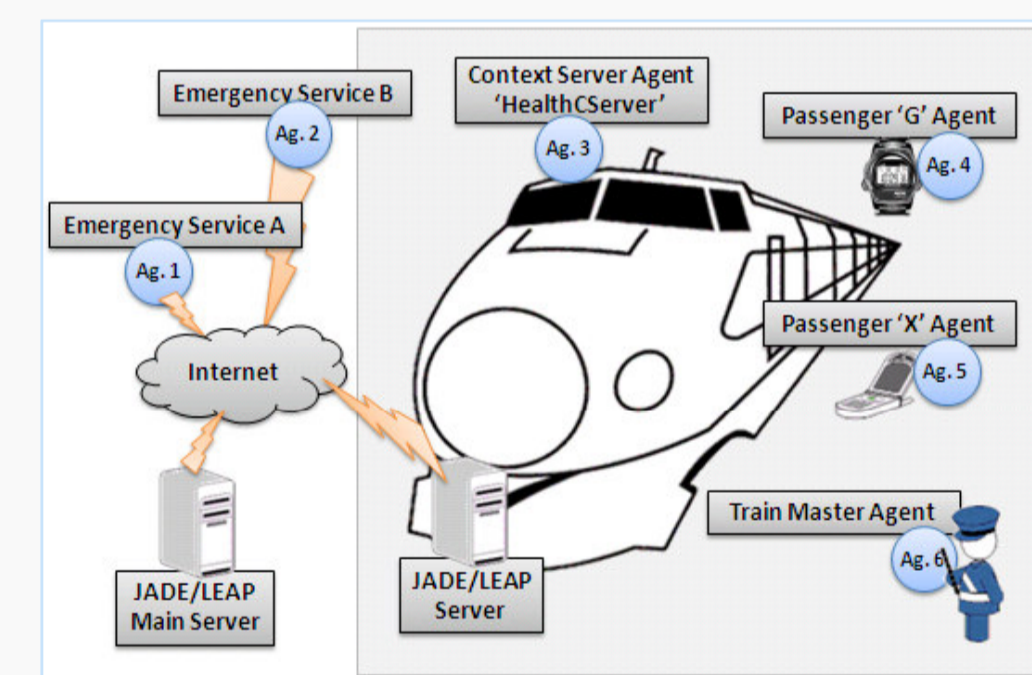


Pervasive Metro Emergency Response Environment.

Architecture

- **Agents are divided into the following categories:**

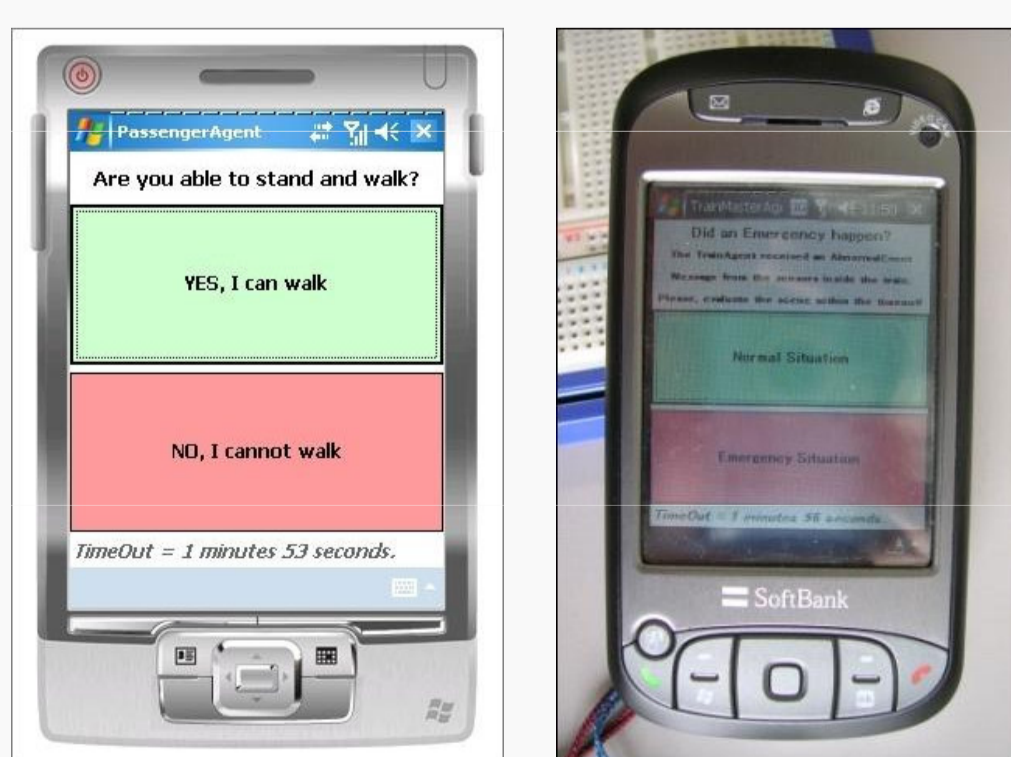
- **Personal agents:** on mobile devices carried by passengers/train master;
- **Environmental agents:** responsible for managing the train schedule stops, for aggregating, estimating and interpreting data gathered from sensors, etc;
- **Emergency service agents:** interfaces with the ambulance service center system, hospital systems, etc;



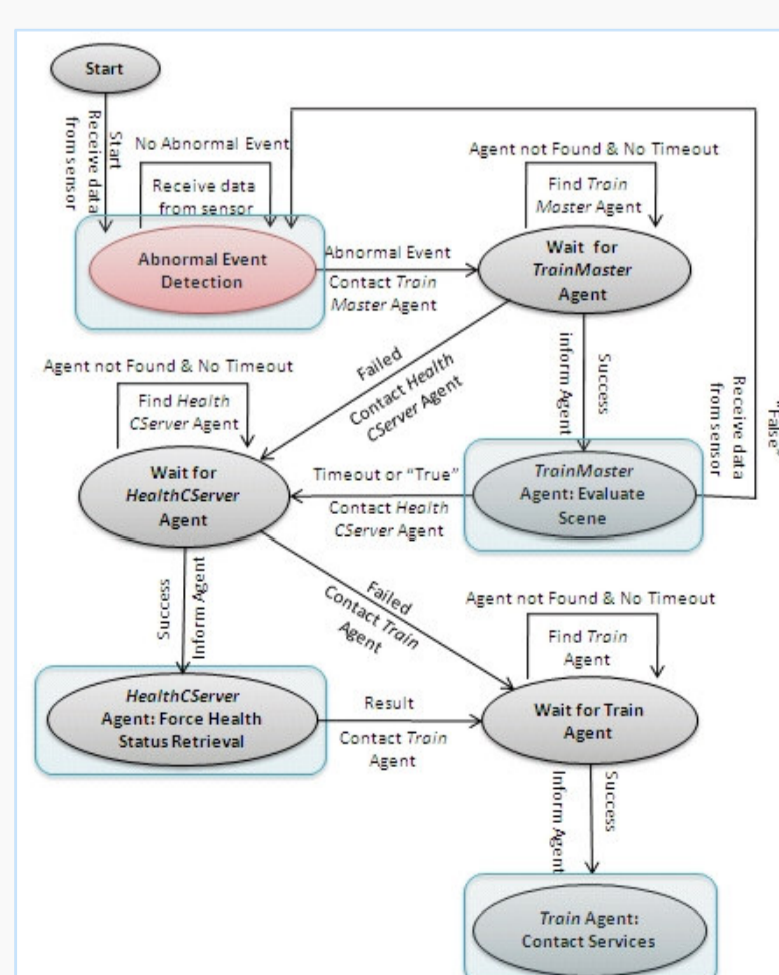
Metro emergency response system employing a multi-agent architecture.

Prototype

- **Personal agents:** JADE/LEAP, J2ME CDC over IBM's WEME J9 VM.
- **Environmental agents:** JADE platform, hosted on a main-container.



(left) PassengerAgent GUI running on a PocketPC emulator and (right) TrainMasterAgent GUI on a Softbank X01HT cell phone.

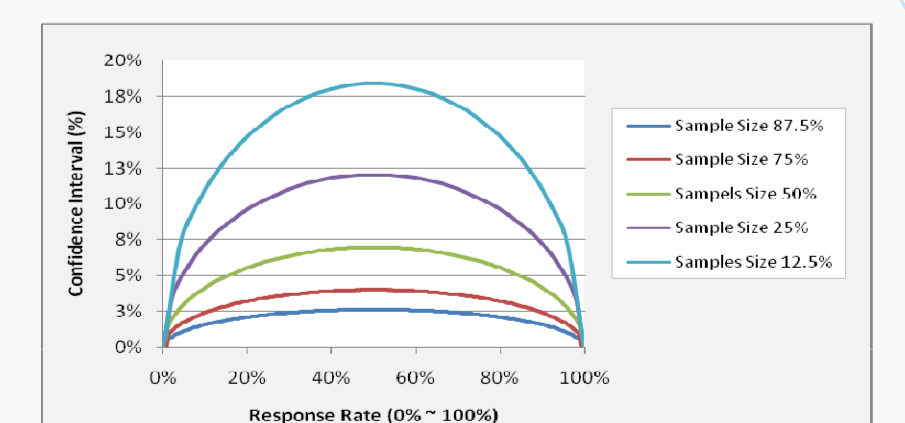


Communication Flow Diagram.

Evaluation & Conclusion

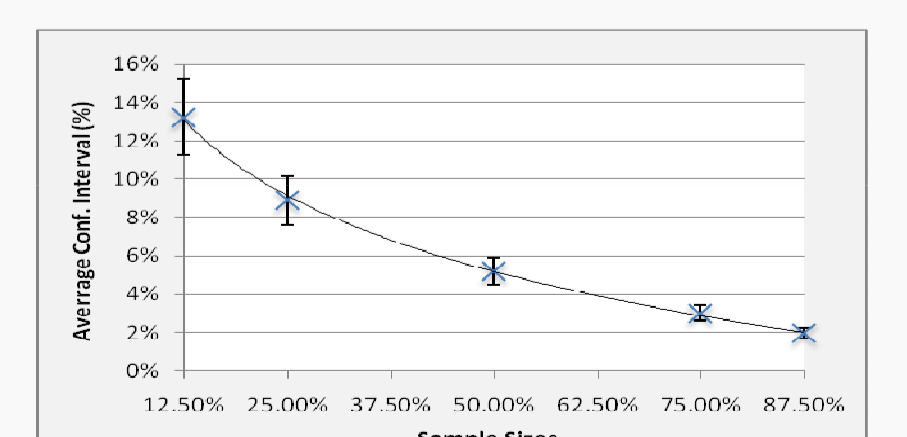
- **Specification of the necessary parameters for achieving accurate estimations:**

- each carriage has 200 passengers;
- passengers carrying mobile devices are distributed uniformly, their number is the **sample size**;
- after an emergency occurs, a portion of passengers possessing mobile devices may respond, thus defining the **response rate**;
- each response, representing the victim's condition, can be one of the categories: OK, GREEN, YELLOW or RED;



Confidence interval versus response rates for a single category (e.g., #GREEN).

- **Conclusion**
- Although the error margin may increase according to the response rate, keeping to higher sample sizes shorten the error margin slide window, and thus increases the overall accuracy.



Average confidence interval versus sample sizes over an average of all response rates.

- If percentages of each category are distributed relatively evenly, the accuracy of our system is compromised. On the other hand, should there be one category with most passengers (e.g. OK), then the accuracy of our system is strengthened.