DATA-FUSION MODEL FOR FORENSIC IDENTIFICATION OF ILLICIT CHEMICALS

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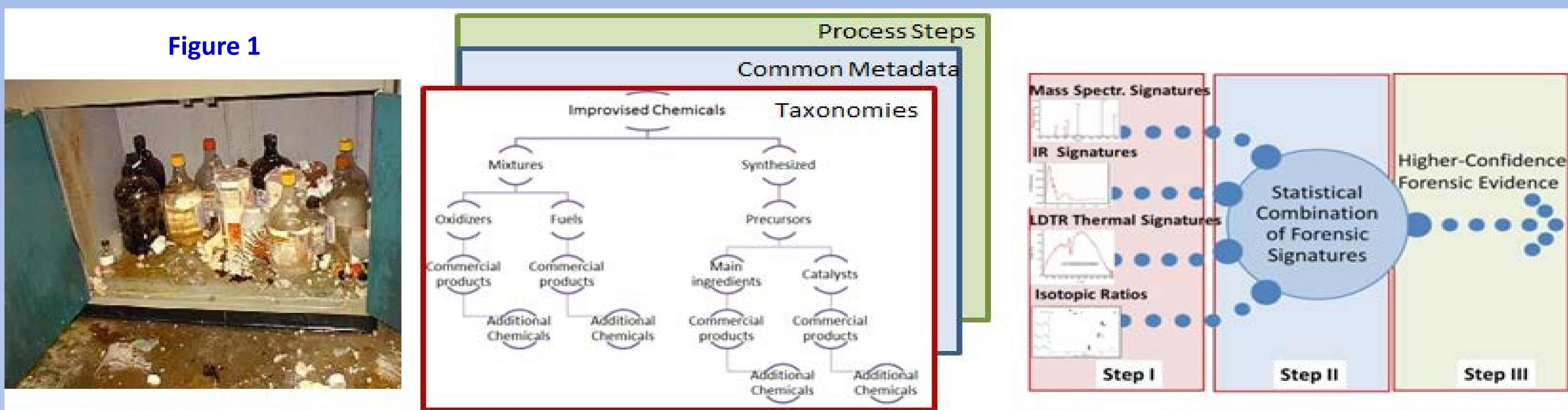
Figure 1

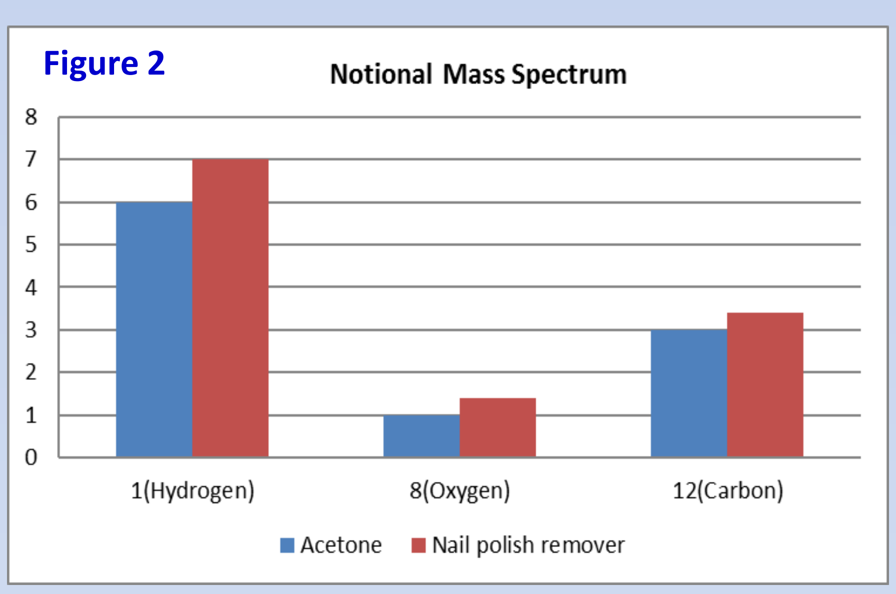


Site collected data + additional available data + signatures = heterogeneous data fusion

Objectives

- **Statistically combining heterogeneous forensic data, including both sample signatures and analyzed collected evidence, can enhance the overall confidence level of identifying the composition of improvised and precursor chemicals. Figure 1 presents an approach for combining heterogeneous forensic data, i.e., collected data, chemical-signature measurements, commercial sources for precursors and additives/additional chemicals, and process information.**
- **The presence of precursors (i.e., everyday household chemicals) with a significant number of additives, act as "confusers" that make existing reference data (mostly for pure chemicals) unusable (Fig. 2). This results in limiting detection accuracy (often to below 50 %), making the evidence inadmissible in court. Our innovation is based on a novel data-fusion model approach (currently using Bayesian networks) that combines all relevant heterogeneous data in a way that transforms "confusers" into "markers" and increases detection accuracy and confidence beyond 95 %.**

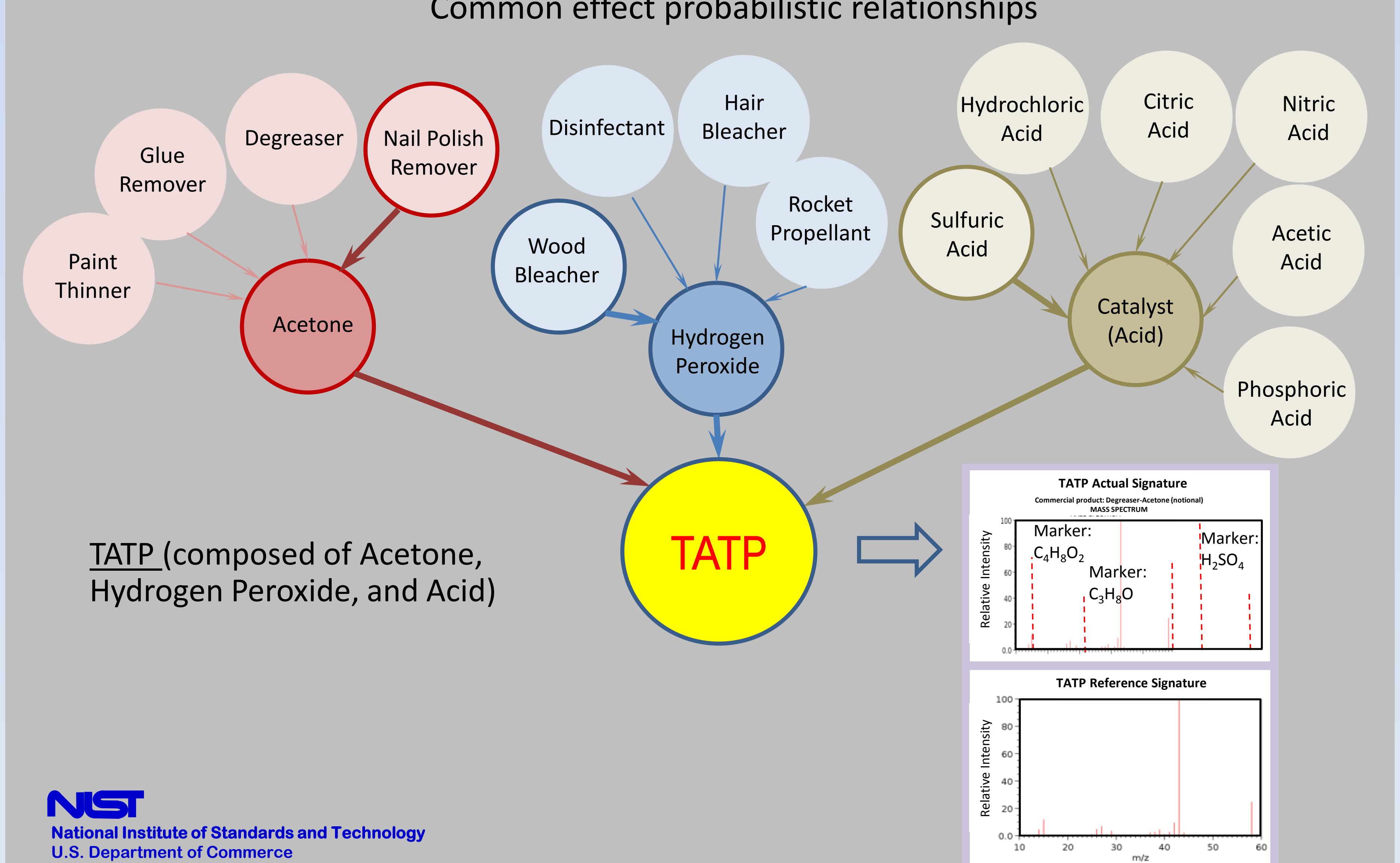
Figure 2



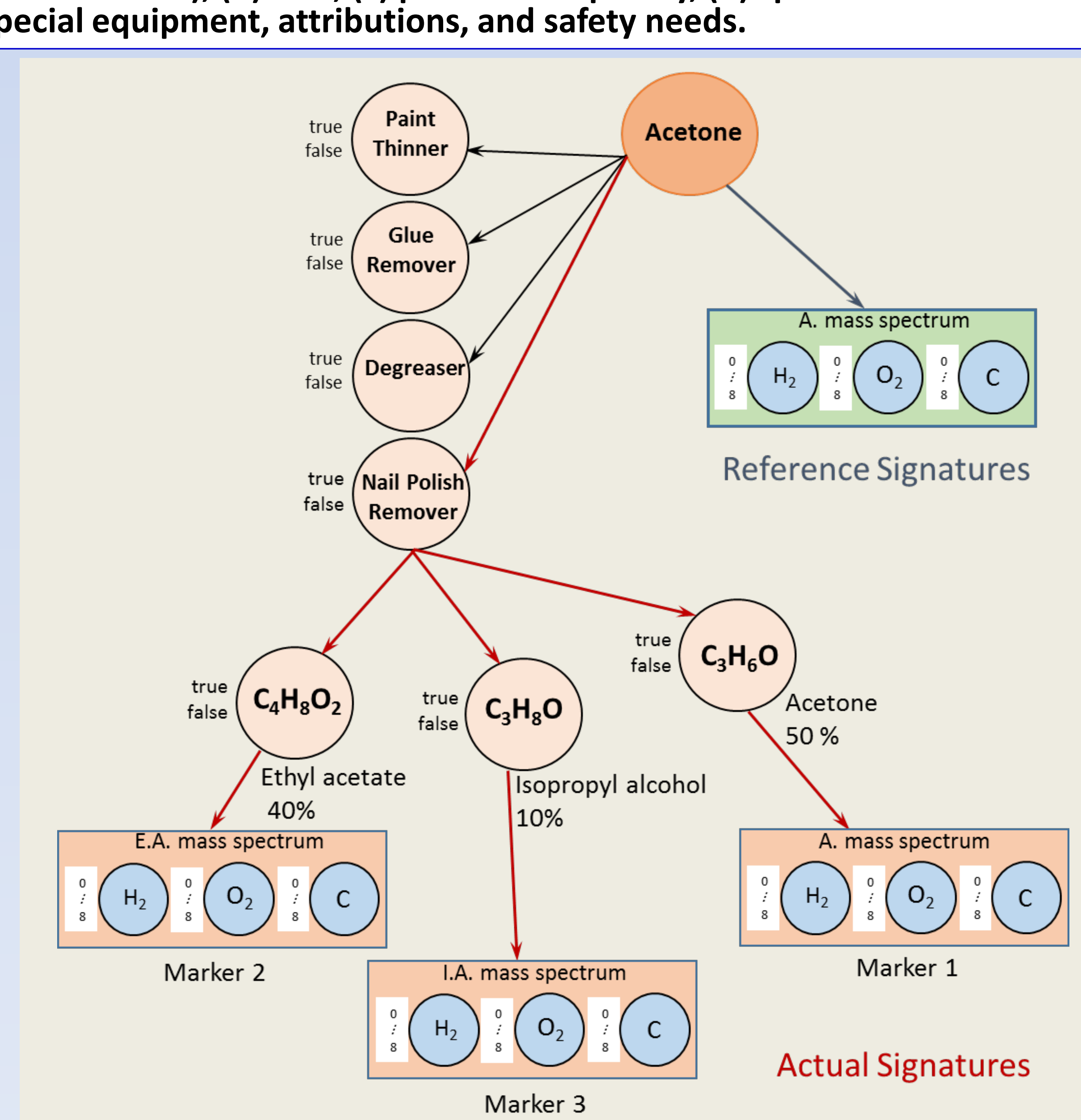
Scenario

- **Consider TATP (triacetone triperoxide), which is the most commonly used improvised explosive material; i.e., recent terrorist events in the UK (Oct. 22), NY (Sept. 18), NJ (Sep. 17), France (Jul. 14), Belgium (Mar. 22).**
- **Suppose that after collecting and analyzing samples, forensic teams discover that the certainty of identifying the explosive material is in question due to the presence of "confusers" (other secondary chemical compounds) in measured signatures.**
- **To address this issue, our data fusion model will use reference processes, data, and analytical signatures, along with on-site observables and collected signatures to better infer the identity of the improvised substance.**
- **For example, TATP is synthesized by mixing acetone, hydrogen peroxide, and an acid (e.g., sulfuric acid) that serves as a catalyst. One of commercial sources for acetone is a nail polish remover which may include acetone, ethyl acetate, and isopropyl alcohol. Similarly, hydrogen peroxide is commercially available in wood bleach products that also contain a number of other ingredients. Thus, measured signatures of the trace substance is likely to contain numerous features attributed to the TATP, sulfuric acid, and others ancillary substances.**
- **To better understand the challenge for conventional forensic analysis, criminals and terrorists have available a variety of commercial sources for acetone (with additional additives), hydrogen peroxide, and different acids, which can result in many different possible outcomes. Criminals and terrorist are adaptive and evolve by using different alternatives.**
- **However, our system captures these various possibilities ('limitations') and vulnerabilities though statistical data-fusion metrics that account for: (a) materials/ingredients availability (at specific locations), (b) cost, (c) process complexity, (d) special skills requirements, (e) special equipment, attributions, and safety needs.**

Common effect probabilistic relationships



TATP (composed of Acetone, Hydrogen Peroxide, and Acid)



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