Title: **Data Resources and Sample Applications
for Information Analysis in CW and BW
Defense**

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2. Importance to LANL's Science and Technology Base and National R&D Needs

Research in the detection, prediction, and attribution of epidemics builds LANL's analysis and assessment core competency and our general capabilities in information science and technology.

3. Scientific Approach and Accomplishments

The initial work in this project consisted of examining conventional, simplified disease models in the literature (e.g., [1] and [2]) to determine their shortcomings and to examine their structure. These models typically assume that the population is homogeneously mixing; that is, all members of the population are in contact with one another. (Such an assumption is valid within a confined space such as an aircraft, but, as discussed later, this assumption is not appropriate for most environments.) By using system-theoretic analysis, we found that most of these models can be expressed in a common form. Also, there is a canonical transformation to an input-output form that enables such a model to be efficiently simulated to predict the evolution of the disease and that permits the parameters of the model to be estimated in an on-line fashion. Details of this work are presented in a LANL technical report (1).

In an open environment such as a city, the spread of disease is most likely dominated by spatial effects such as transportation routes, food delivery mechanisms, ambulance coverage patterns, weather, etc. However, other than some very simplified treatments of the subject (e.g., as in [3]), these effects are generally not accounted for in epidemiological models. This is an area that is ripe for further research and one that is well-suited to LANL's capabilities in simulation and modeling. An obstacle to implementing a disease model that incorporates such "transport" mechanisms is the lack of data needed to characterize a particular outbreak. Although there are an increasing number of specialized sensors and analytic techniques (e.g., genetic sequencing) that could be used to gather the data needed for a spatial disease model, such information is likely prohibitively expensive and too invasive to gather in an ongoing fashion. This represents an opportunity to use LANL's expertise in data mining and data fusion to examine passive data sources, such as data gathered by the Center for Disease Control or medical facilities, with the goal of identifying similar cases that indicate an emerging disease or an attack. Such a system could determine when to trigger or where to focus the more sophisticated, active data sources.

Publications:

- (1) Howse, J. and Buescher, K., "A Preliminary Study of Simulation and Identification for Epidemiological Models," Los Alamos technical report LA-UR-96-3541.

References:

- [1] Bailey, N., "The Mathematical Theory of Infectious Diseases," Charles Griffin & Co., London, England, 1975.
- [2] Capasso, V., "Mathematical Structures of Epidemic Systems," Vol. 97 of *Lecture Notes in Biomathematics*, Springer-Verlag, Berlin, Germany, 1993.
- [3] Gould, P. and Wallace, R., "Spatial Structures and Scientific Paradoxes in the Aids Pandemic," *Geografiska Annaler*, **76B**, #2, pp. 105-116 (1994).