Pat Finley, Ebola article
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Writer: Whitney Lacy
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# Transportation Modeling & Global Health

A patient in the United States has been diagnosed with Ebola. Fear and panic kicks in across the country, and hospitals are inundated with hundreds of people, some infected with the highly contagious disease and others not. Blood tests are needed for positive diagnoses, but the diagnostic labs are overwhelmed with blood samples to test, and staff are overworked and stressed. Infected people need to be quarantined and treated, but it's hard to find rooms to quarantine so many patients. Sick people who need triage and regular care for other emergencies are afraid to go to hospitals for fear of Ebola, which has a 50% fatality rate. And since hospitals are so overwhelmed, sick people often stay home, infecting heathy people around them; the U.S. is now in the grips a full-blown Ebola outbreak.

Sandia's high-performance computers simulated such a nightmare scenario recently, and with good reason. An Ebola outbreak in the United States could be devastating if hospitals are not prepared. When an Ebola outbreak in West Africa became a global concern in 2014, health advisers were alarmed at the length of time it took to properly diagnose infected people. In rural areas in Liberia, for example, blood samples from ailing people would be sent to a laboratory for testing, but the closest lab was hundreds of miles away through difficult and sometimes impassable roads. In more urban areas, blood samples would be sent to nearby labs, but those labs were often already overburdened by the sheer volume of samples to test. Staff at some treatment centers were unaware that a lab a little farther away might have the capacity to take in more samples. Meanwhile, undiagnosed infected people were unknowingly spreading the disease to many others around them, worsening the outbreak.

The U.S. Defense Threat Reduction Agency (DTRA) and Centers for Disease Control and Prevention (CDC) posed a serious question: how do we improve blood-sample transportation routes in Liberia to ensure that samples taken from ill people are tested as quickly as possible, ensuring a proper diagnosis and faster treatment? Sandia scientists, already experts in transportation modeling for nuclear materials, quickly swarmed on this problem.

The Sandia Ebola response team immediately set out to collect data from the region using available maps and local information, and transformed the raw data to GIS maps. Then, applying Sandia transportation routing algorithms, the team identified the optimal routes to get blood samples to the best laboratory for testing, even if that lab was not geographically the closest. The models also showed the best possible locations for mobile diagnostic laboratories that would better support the very rural regions that were most affected by the Ebola outbreak.

The team relied on the immense computational power of the Red Sky HPC system to verify that the new sample transport routes were not only fast, but also minimized the chance for transmission of the Ebola virus among Liberian patients in hospitals and communities. After building a computer model of the healthcare system of the entire country, the team used that model to show how many individuals would

contract Ebola under different scenarios. They then ran the model millions of times on Red Sky, using every conceivable combination of disease propagation factors and control measures. The power of this massively parallel parameter study enabled Sandia researchers to define confidence metrics for Ebola cases prevented by the new transport routes, and to ensure that gains would hold up even if the pattern of disease spread had changed dramatically.

Sandia was uniquely suited for this project due to its experience in global health security combined with its computer modeling capabilities, and the efforts of its transportation mapping and validation using Red Sky helped ensure faster diagnoses. When the outbreak was contained, the model also showed which mobile test labs were best to be decommissioned and which would be beneficial to remain in their locations should another outbreak occur.

The outbreak in Africa sent red flags to researchers who were concerned about an outbreak occurring in the United States. Using similar computing models running on Sandia HPC systems, the team studied a simulated outbreak and utilized Veteran's Affairs (VA) hospitals around the country in their simulation. They established which hospitals would best be used for triage, which to use for quarantine, and which to use for regular emergency care. The success of this study led the VA and CDC to re-evaluate crisis management plans for such a scenario. In the years since this HPC-based global health modeling capability was pioneered in Liberia and Sierra Leone, it has been adapted to improve the efficiency of healthcare delivery and infectious disease control in many other developing countries in Africa, the Middle East, and Southeast Asia.

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*Example of near impassable roads in Liberia, 2014*

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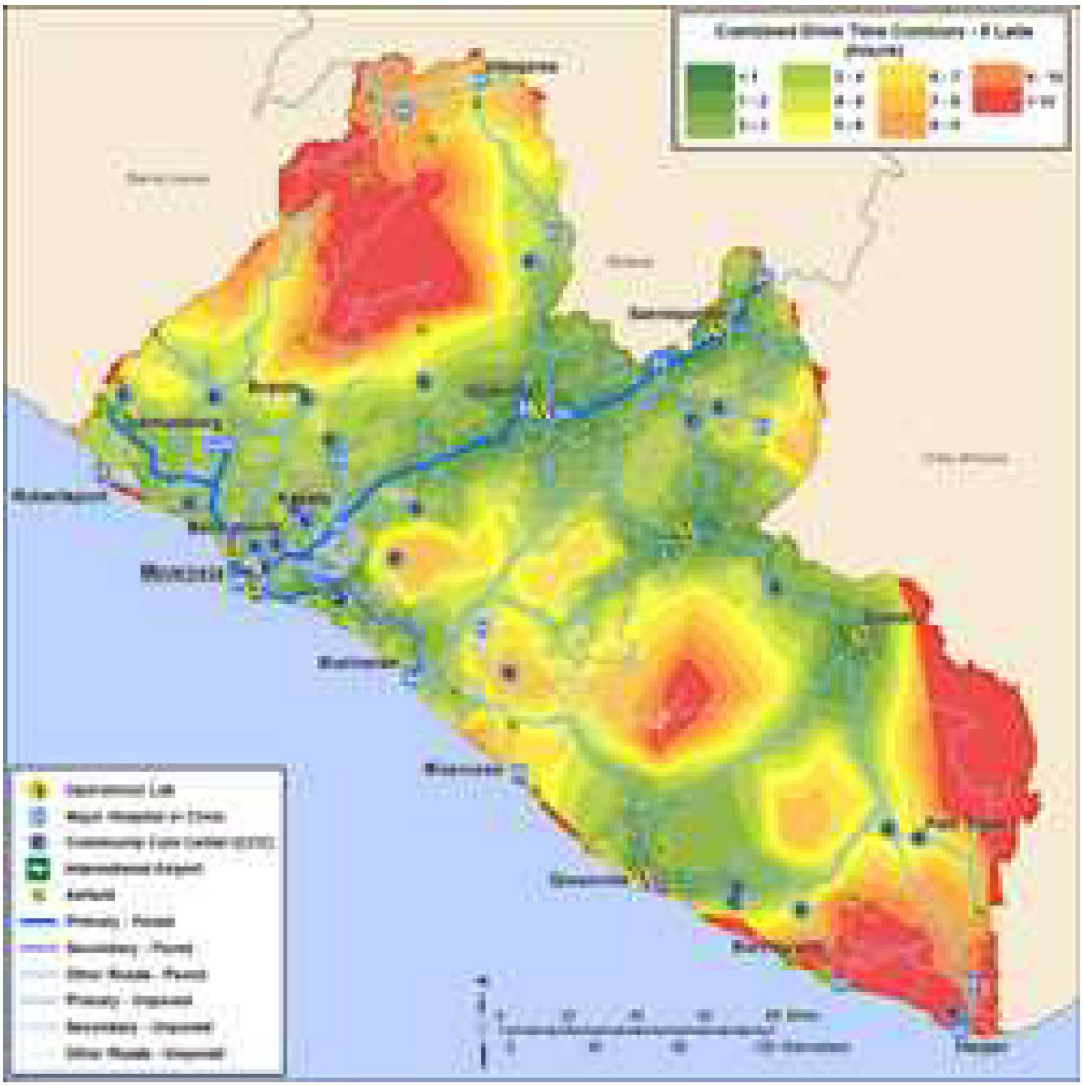

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