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Final Copy of Case Study

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STATUS:
Laureate

Organization:
Virginia Tech Transportation Institute

Organization URL:
http://www.vtti.vt.edu/

Project Name:
Driving Road Safety with HPC Technology

What social/humanitarian issue was the project designed to address?
What specific metrics did you use to measure the project's success?

America's highway system is critical to meeting the mobility and economic needs of our nation as a whole, as well as regional and local communities. With more than 30,000 fatal crashes occurring on our nation's roadways each year, our transportation infrastructure is in dire need of research and technology to update ailing infrastructure and improve driver safety. The Virginia Tech Transportation Institute (VTTI) naturalistic driving studies observe driver behavior in the real world, using vehicles instrumented to collect video and sensor data (see Appendix 1). As part of this research, studies of unprecedented scale, notably the Strategic Highway Research Program (SHRP2) Naturalistic Driving Study, have been undertaken to better understand driving behavior relative to safety critical events. SHRP 2 has an intense, large-scale focus, integrates multiple fields of research and technology, and is fundamentally different from the broad, mission-oriented, discipline-based research programs that have been the mainstay of the highway research industry for half a century. SHRP 2 focuses on applied research in four areas: safety, to prevent or reduce the severity of highway crashes by understanding driver behavior; renewal, to address the aging infrastructure through rapid design and construction

methods that cause minimal disruptions and produce lasting facilities; reliability, to reduce congestion through incident reduction, management, response, and mitigation; and capacity, to integrate mobility, economic, environmental, and community needs in the planning and designing of new transportation capacity. VTTI has been tasked with the design and execution of the in-vehicle field study required for the SHRP 2. The resulting naturalistic driving study (NDS) involves more than 3,000 volunteer drivers to learn more about how individual driver behavior interacts with vehicle and roadway characteristics.

Please describe the technologies used and how those technologies were deployed in an innovative way. Also, please include any technical or other challenges that were overcome for the successful implementation of the project.

The SHRP 2 study is a significant example of data-intensive scientific investigation, harvesting on the order of a petabyte of video data and several tens of terabytes of sensor data from over 3,000 instrumented passenger vehicles. In addition to SHRP 2, VTTI also conducts naturalistic driving studies on teen drivers, freight vehicles and motorcycles. VTTI harnesses state-of-the-art high-performance computing (HPC) technologies, including cluster management by Platform HPC, Dell PowerEdge C Series compute cluster, IBM's GPFS parallel file system, and IBM's InfoSphere Data Warehouse parallel relational database environment, as integral parts of Virginia Tech's Scientific Data Warehouse environment (see Appendix 2). VTTI's research scientists perform data analysis and data mining using VTTI's custom visualization application and parallel SQL queries, as well as the MATLAB, R, and SAS analysis environments. This environment forms the foundation of VTTI's data-intensive scientific research, and is fundamental throughout the data life cycle of VTTI's research program. Without the use of HPC resources, the scale of VTTI's data acquisition would be infeasible, as up to 2 terabytes per day of sensor and video data must be decrypted, re-encoded, summarized and ingested into the parallel database infrastructure. Moving VTTI's data mining queries to large-scale data management resources has increased analysis performance up to 1,000-fold. In VTTI's legacy file-based infrastructure, a simple query (such as the average speed of vehicles across a data set with over 200,000 trips) could take up to three weeks to complete. With the high throughput enabled by parallel HPC databases, that same query takes only minutes. Increased productivity has enabled VTTI to deliver the intensive data needed to address critical road infrastructure and safety issues on a markedly accelerated timetable.

Please list the specific humanitarian benefits the project has yielded so far.

HPC technology is enabling the landmark collection of data for the Strategic Highway Research Program (SHRP 2) naturalistic driving study. The resulting data set is expected to be a cornerstone in the transportation safety research industry for at least the next 20 years, helping to minimize the number of fatalities on our roadways by identifying the behaviors and infrastructure pain points that lead to crashes and near-crashes. In one specific example, VTTI's innovation is working to reduce the number of fatalities and injuries associated with inattention while driving, including use of handheld devices and other distractions. According to NHTSA, in 2009, 5,474 people were killed in crashes

involving driver distraction, and an estimated 448,000 were injured. VTTI is developing machine-vision-based techniques to enable automated glance-related scoring, as opposed to a manual frame-by-frame video reduction. Our national highways are the lifeline of our local, regional and national economies. Without the ability to efficiently move goods and human resources from point A to point B, local economies and quality of life would deteriorate. The SHRP 2 data set will aid in reducing congestion and inform planning to dramatically improve a national highway system that has been largely unaltered since its establishment in the 1950s. The Department of Transportation, Department of Commerce, freight planners, automobile manufacturers, and insurance companies use naturalistic driving data as a baseline to improve transportation safety by learning from the driver experience.

Please provide the best example of how the project has benefited a specific individual, enterprise or organization. Feel free to include personal quotes from individuals who have directly benefited from the work.

The data collected for the SHRP 2 study is expected to be the cornerstone of transportation research for years (decades) to come, helping the U.S. Department of Transportation and related agencies to conduct transportation research and planning to inform the national policies and funding that will dramatically increase roadway efficiency and safety. While expected to grow as the data analysis and its implications evolve, the SHRP 2 naturalistic driving study will address questions such as the following: How do driver distraction; driver fatigue; the influence of driver impairment (e.g., alcohol); driver interactions with intersection features; and driver support systems influence crash likelihood? How do driver interactions with roadway features influence the likelihood of lane departure crashes? What variables or pre-event factors are the most effective crash surrogate measures? According to the U.S. DOT report, "An Analysis of Driver Inattention Using a Case-Crossover Approach On 100-Car Data," the power of the naturalistic driving study data, such as the SHRP 2 and the previous 100-Car Naturalistic study collected by VTTI and managed with HPC technology, "primarily resides in the detailed driving behavior data recorded in the seconds leading up to crashes and near-crashes as compared to data from normal, baseline driving. These assessments allow safety researchers to calculate which of those behaviors actually increase risk of crash/near-crash involvement as well as assess the frequency, duration, and impact on eye glance behavior for each of these tasks. Use of these new and unique data sources is a critical step not only towards furthering our knowledge of the types of behaviors that actually increase drivers' crash/near-crash risk but also in directing research towards the mitigation of these behaviors to most effectively save lives."