Computational modeling of ultrafast digital electronics

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Science Challenge – Computational modeling of ultrafast digital electronics

- To understand how large electric fields, such as those from lightning strikes or electronic countermeasures, affect the performance of new “smart materials” being considered for use in new generations of electronic and telecommunications equipment.

Why is This Important?

- Special materials (called strongly correlated electron materials) hold much promise for creating smart electronic components that can change their physical properties in response to the needs of a particular device or situation. These smart electronics have the potential to lead to entirely new generations of electronic devices—such as military and civilian communications devices—that dynamically adapt to changing conditions and the needs of their users.
- Because of their complexity we are only now beginning to understand the properties of these materials and how to tune their performance in response to changing needs. An important step toward increasing our understanding is in quantifying how reliable these materials are when operating in electrically hostile environments (such as those created by lightning strikes or electronic warfare).

HPC Challenge – Matrix Inversion of Hundreds of Thousands of Complex Dense Matrices

- While their theoretical base has been established for over 40 years, little is known about how these devices will respond in the real world because the equations have been too complex to solve with high precision.
- The calculations require the matrix inversion of hundreds of thousands of large matrices that are general complex dense matrices. Each run takes on the order of 50,000 hours of computer time. In order to evaluate a number of cases to try and understand the behavior of the system, hundreds of thousands of hours of computer time is required.
- With the resources in today’s newest, largest supercomputers we are, for the first time, able to exactly solve the theoretical equations governing the behavior of these devices in electrically hostile environments

The Cray XT3™ System Helps Form the First Exact Solution

- Leveraging the power of the Cray XT3 system has allowed for the study of the non-linear effects of large electric fields and more accurate validation of the original theoretical equation, improving the understanding of how these effects can cause communications devices to perform poorly or even fail in certain situations.
- The superior scalability of the Cray XT3 system allowed researchers to apply more than 1,000 processors on each of the calculations performed during the analysis. Over 600,000 hours were used in six weeks to establish important new characteristics of these materials and to validate new numerical tools that will enable even more in-depth analysis in future studies.

For Additional Information, please contact:

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