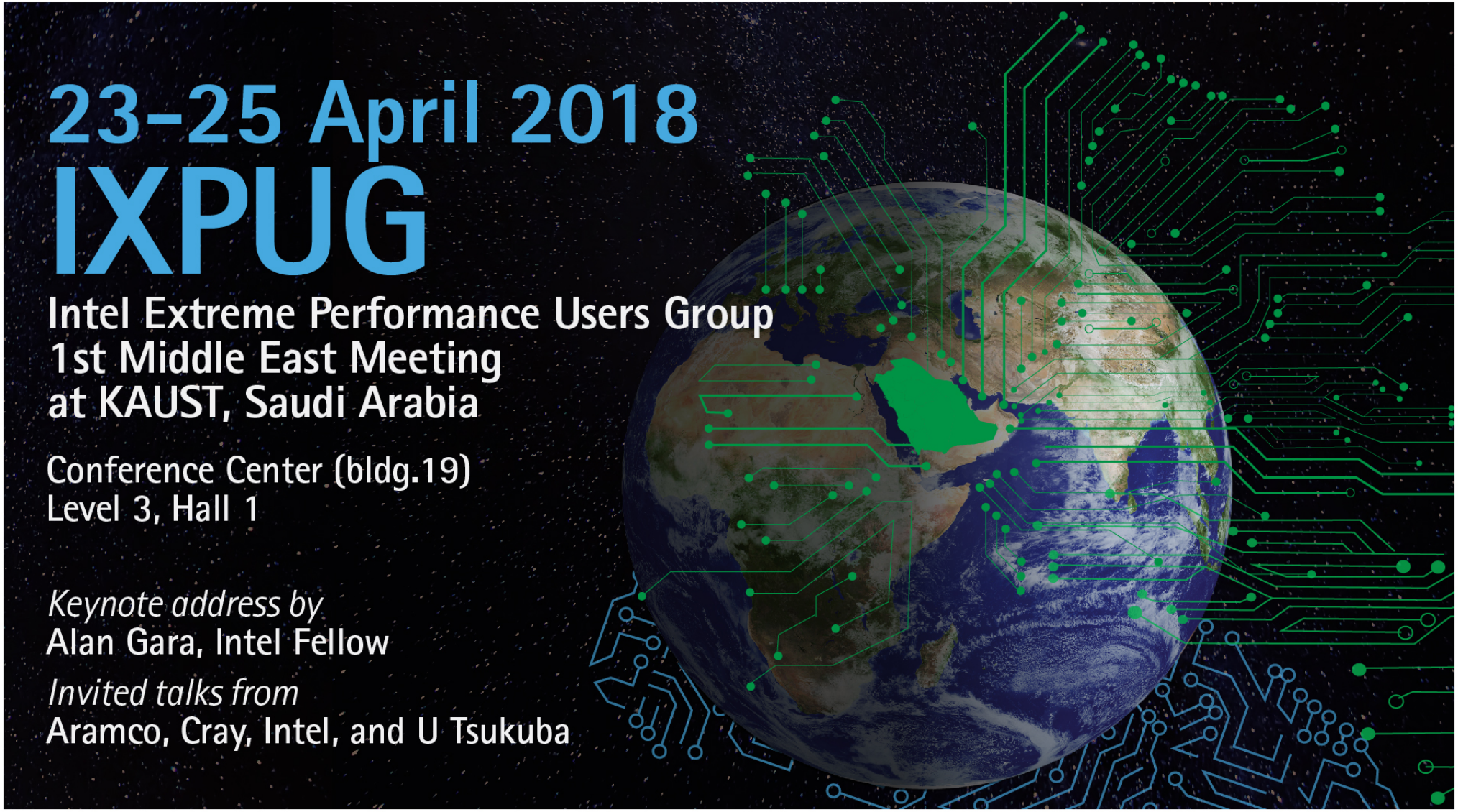
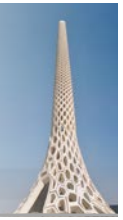
HPC in Industry: Introductory Tales



Haiku for industry session



H·P·C offers

An awe·some ren·dez·vous for

in·dus·try and KAUST!

HPC in Industry, Agencies & Business

Industrial Outreach

Industrial Outreach

David MARTIN

High Performance Computing in Industry, Agencies, and Small Business

High performance computing (HPC) in industry includes simulation and data analytics. Today, "HPC" means more than the speed of numerical processing. It refers as well to the vast storage resources and high-bandwidth communication that come proportionally with fast processing resources. This program on the impact of HPC in industry will contain with a keynote, a series of short contributed talks, and a closing panel. The workshop is intended to be interactive and allow time for discussion and sharing experiences. Industries that are established in HPC are encouraged to present a short case study of a foray into HPC – either positive or negative. Industries that are only exploring the potential of HPC are welcome to raise questions. Topics to be addressed include:

- How industry uses HPC to increase competitiveness
- Examples of HPC driving innovation and improving product cycles
- Models for how academia and national laboratories collaborate through computing
- Strategies for increasing pre-competitive collaboration among like industries
- Strategies for increasing collaboration between complementary industries
- Ideas about how exascale computing will impact industry

Biosketch

David Martin is Manager, Industry Partnerships and Outreach at the Argonne Leadership Computing Facility at Argonne National Laboratory, where he works with industrial users to harness high performance computing and take advantage of the transformational capabilities of modeling and simulation. David brings broad industry and research experience to ALCF. Prior to joining ALCF, David led IBM's integration of internet standards, grid and cloud computing into offerings from IBM's Systems and Technology Group. Before IBM, David managed networks and built network services for the worldwide high-energy physics community at Fermilab. David began his career at AT&T Bell Laboratories, doing paradigm-changing work in software engineering and high-speed networking. David has a BS from Purdue and an MS from the University of Illinois at Urbana-Champaign, both in Computer Science.

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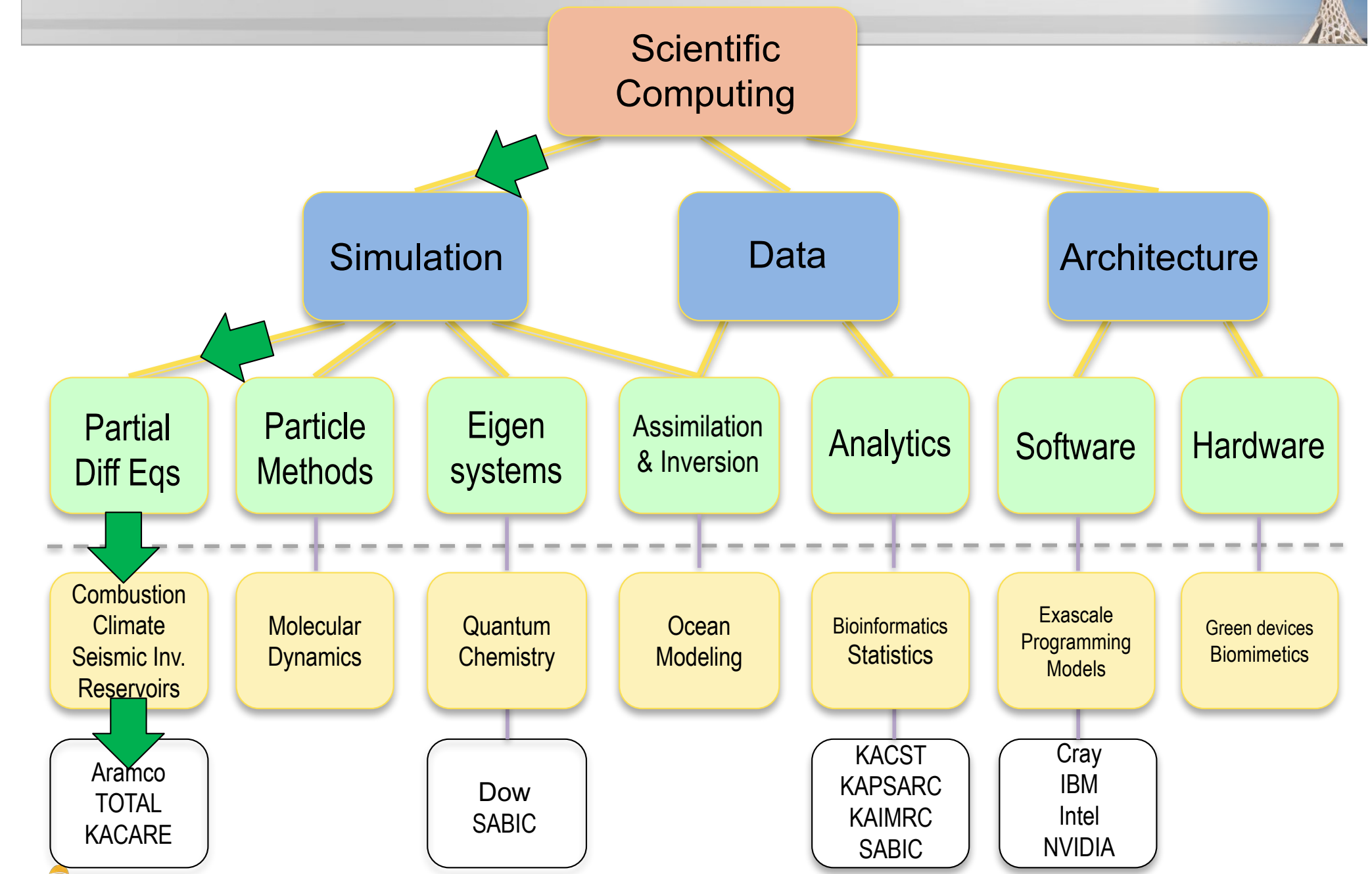
Scientific Computing at KAUST



Three milestones from 2016-2017

- **Full-scale 100 Hz, 7.5m inversion**
  - GeoDrive (in-house)
  - Believed to be highest ever frequency and finest ever resolution
- **Trillion-cell reservoir simulation**
  - GigaPowers (in-house)
  - Believed to be highest ever resolution
- **200,000-core oil-gas separation**
  - ANSYS (commercial)
  - Believed to be highest ever granularity

Seismic Inversion (from "Arabian Sun")

the arabian sun

December 13, 2017 | vol. LXXII, No. 48 — a weekly Saudi Aramco publication

passwords: sharing isn't caring

Passwords are the first line of defense in protecting Saudi Aramco's information systems. And while you may trust your friends, you should never share passwords with them, as that can compromise both you and the company.

see page 10

safety in numbers in Abqaiq

Members of Saudi Aramco senior management praise employees and management in Abqaiq during their trip to the Southern Area, pointing to mostly improved safety numbers during last week's Executive Management Safety Review.

see page 3

BERRI GAS PLANT still going strong at 40

see pages 8 and 9

delighting in the red sands of Shaybah

Saudi Aramco employees and their dependents travel into the heart of the Rub' Al-Khali and behold the wonders of Shaybah — the latest trip offered by the Saudi Aramco Employees Association.

see pages 12 and 13

OPEC basket

five-week price trend 2017

Saudi Aramco by the numbers

88%

of Abqaiq area workers took advantage of mass transportation to the job site, an increase of 13% from the previous year.

GeoDRIVE: Integrated geophysical solution for subsurface model building

Saudi Aramco scientists in EXPEC ARC set a new standard for subsurface mapping and characterization

Ali Al-Momin speaks about the importance of incorporating multidisciplinary data, extreme-performance computing, advanced techniques and user-friendliness with GeoDRIVE. (Photo: Lamees N. Aloboudi/MPD)

> "Achieving this resolution level is imperative for meeting our exploration and development targets. The launch of this in-house developed, advanced tool is timely and represents a significant addition to our subsurface imaging capabilities."
>
> — Ibraheem M. Assa'adan

Dhahran — The Geophysics Technology Division (GTD) at the EXPEC Advanced Research Center (ARC) recently achieved a major breakthrough by unlocking ultra-resolution subsurface mapping and characterization. Saudi Aramco's integrated geophysical solution for dynamic real-time image and velocity estimation (GeoDRIVE) successfully produced a 3-D image of the subsurface geologic layers at a record resolution of 7.5 meters.

"Achieving this resolution level is imperative for meeting our exploration and development targets," said Ibraheem M. Assa'adan, vice president of Exploration for Saudi Aramco. "The launch of this in-house developed, advanced tool is timely and represents a significant addition to our subsurface imaging capabilities."

"The limits of geophysical techniques have historically been behind the engineering needs at reservoir level," said Ali A. Al-Meshari, manager of EXPEC ARC. "The smallest distinguishable features in geophysical methods are of the size of tens of meters, whereas optimal drilling and producing operations require accurate measurements within a few feet.

"We successfully imaged the target reservoir at a resolution that was previously deemed out of reach."

subsurface imaging using seismic at Saudi Aramco

Saudi Aramco's exploration and development targets have historically been very large with simple structures. For such targets, quick and simple geophysical methods were sufficient to provide an overall picture of the geologic settings at the subsurface. However, recent targets have become increasingly more complex in challenging environments such as low-relief structures, stratigraphic traps, subsalt, and fractured reservoir. In such environments, accurately simulating the physical propagation of seismic waves through the subsurface is an essential step to extract subsurface models from seismic data.

While optimal in theory, there are several obstacles that prevent the use of advanced seismic imaging techniques in production workflows. Massive seismic data, typically in the order of petabytes (1015 bytes), is simulated in 3-D models that have several billion cells.

Moreover, each imaging application requires several simulations for each portion of the data, resulting in tens of thousands to hundreds of thousands of simulations. The data volume, model size, and number of simulations render advanced imaging techniques very challenging and inefficient in utilizing computing resources, even when utilizing the world's largest supercomputers. As a result, most conventional applications are restricted to smaller areas with limited resolution, approximated physical properties, and simplified wave propagation physics.

The vast computational cost of accurate seismic simulations created a gap between theoretical advancements in the academic world and practical industrial applications. However, Exploration's continuous search for more ambitious objectives gave Saudi Aramco the perfect environment for accelerating the path of implementing academic frontiers in industry settings. This provided a unique opportunity to build an innovative solution that can satisfy our current needs as well as the future needs of researchers and professionals.

KAUST and EXPEC ARC collaboration

To tackle this multifaceted challenge and to enable and support next-generation depth imaging and model estimation algorithms, GTD worked in collaboration with the Extreme Computing Research Center and Research Computing Core Lab teams at KAUST to develop GeoDRIVE. This fully integrated seismic imaging platform is designed for massively parallel exascale supercomputers with optimized simulators and modular infrastructure.

The first pre-release of GeoDRIVE was successfully applied on *Midyan* 3-D seismic data using the Shaheen II supercomputer at KAUST in collaboration with the Red Sea Department. The in-house, integrated platform efficiently utilized more than 100,000 cores to compute 54,000 seismic simulations. This enormous computing power was made possible thanks to the KAUST Cray supercomputer Shaheen II, which is the 18th-ranked computer system in the world.

Throughout this collaboration, KAUST mobilized its resources to provide EXPEC ARC with seamless access to Shaheen II, as well as specialized personnel for system program support and optimization to ensure the runs went smoothly and efficiently. KAUST's high-performance computing expertise and our geophysical expertise were effectively integrated in this case where the whole became much larger than the sum of the parts.

"This is a long-awaited moment in the history of Saudi Aramco/KAUST collaborations," noted David Keyes, director of KAUST's Extreme Computing Research Center. "It represents more than an academic collaboration — a real production run was performed at a record high frequency. Our collaboration puts to use software developed in the Ph.D. theses of KAUST computer science graduates who were Saudi Aramco sponsored — one of whom now supports Saudi Aramco from Intel's own research center on the efficient use of Intel's multicore processors on every node of Shaheen II."

the future of subsurface characterization

The objective of geophysical methods is to enable geoscientists to interactively and efficiently build high-resolution and high-fidelity Earth models. To achieve this objective, GTD strives to bring the next evolution of geophysical solutions and go beyond providing seismic images. The ultimate goal is to estimate a dynamic Earth model of the whole Kingdom that provides the essential information about the reservoir in real-time. Such fundamental change will require a complete overhaul of the way subsurface characterization in conducted in our industry.

Members of the GeoDRIVE development team are in full agreement that the future leading Upstream solutions need to incorporate multidisciplinary data integration, extreme performance computing, advance techniques, and user-friendliness — all under one umbrella.

A HIGH PERFORMANCE STENCIL FRAMEWORK USING WAFEFRONT DIAMOND TILING

GIRIH

جامعة الملك عبدالله للعلوم والتقنية
King Abdullah University of Science and Technology

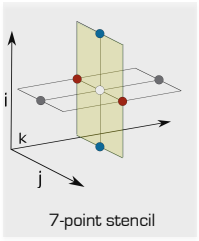
Extreme Computing Research Center

https://github.com/ecrc

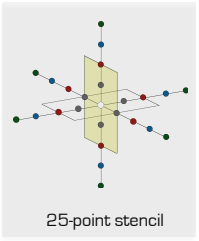
The Girih framework implements a generalized multi-dimensional intra-tile parallelization scheme for shared-cache multicore processors that results in a significant reduction of cache size requirements for temporally blocked stencil codes.. It ensures data access patterns that allow efficient hardware prefetching and TLB utilization across a wide range of architectures. Girih is built on a multicore wavefront diamond tiling approach to reduce horizontal data traffic in favor of locally cached data reuse. The Girih library reduces cache and memory bandwidth pressure, which makes it amenable to current and future cache and bandwidth-starved architectures, while enhancing performance for many applications.

STENCIL COMPUTATIONS

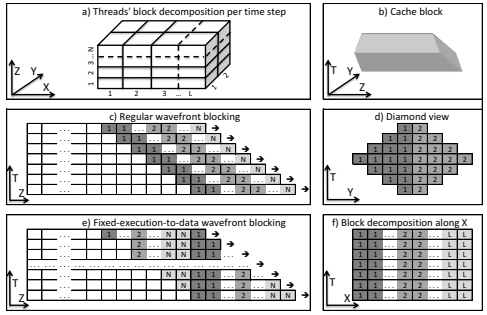
- Hot spot in many scientific codes
- Appear in finite difference, element, and volume discretizations of PDEs
- E.g., 3D wave acoustic wave equation $\frac{1}{c^2}\frac{\partial^2 u}{\partial t^2} = \nabla^2 u$



7-point stencil

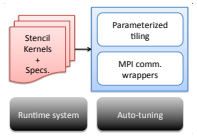

25-point stencil

MULTI-DIMENSIONAL INTRA-TILE PARALLELIZATION



Thread assignment in space-time dimensions

SOFTWARE INFRASTRUCTURE



Girih system components

GIRIH 1.0.0

- MPI + OpenMP
- Single and double precision
- Autotuning
- Short and long stencil ranges in space and time
- Constant/variable coefficients
- LIKWID support for profiling

CURRENT RESEARCH

- Matrix power kernels
- Overlapping domain decomposition
- GPU hardware accelerators:
  - OpenACC / CUDA
- Out-of-core algorithms
- Dynamic runtime systems
- Extension to CFD applications

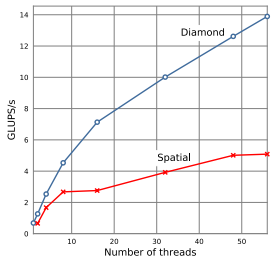
PERFORMANCE RESULTS 8TH ORDER IN SPACE AND 2ND ORDER IN TIME – DOUBLE PRECISION

- Domain size: 512 x 512 x 512
- # of time steps: 500
- 25-point star stencil
- Dirichlet boundary conditions
- Two-socket systems (Mem./L3):

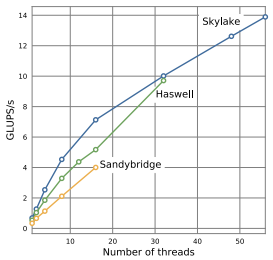
- 8-core Intel SNB (64GB/20MB)
- 16-core Intel HSW (128GB/40MB)
- 28-core Intel SKL (256GB/38MB)

- Intel compiler suite v17 with AVX512 flag enabled
- Memory affinity with `numatcl` command
- Thread binding to cores with `sched_affinity` command

Diamond tiling versus Spatial Blocking on SKL



Diamond tiling performance across Intel x86 generations



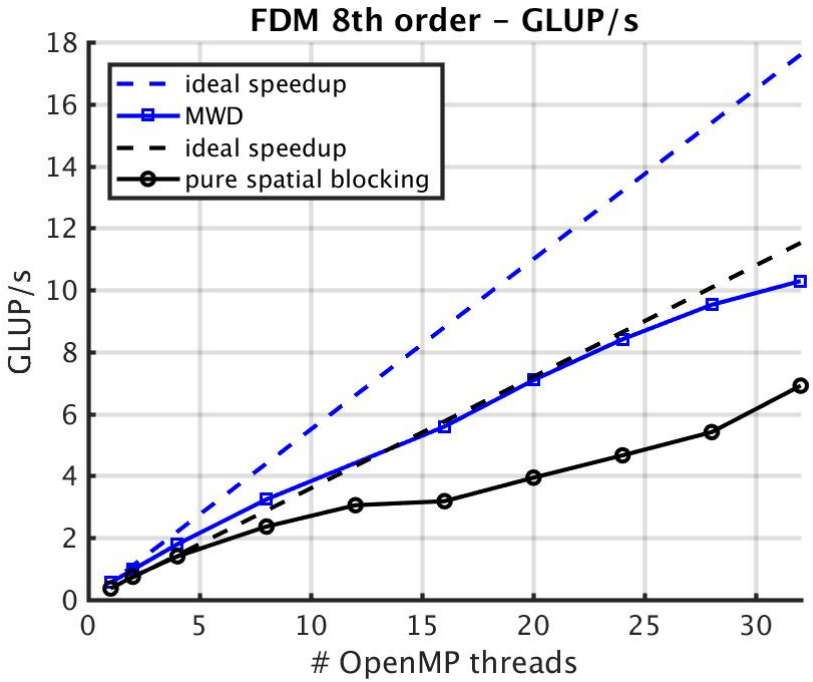
DOWNLOAD THE SOFTWARE AT http://github.com/ecrc/girih

A collaboration of

With support from

Sponsored by

Employed in seismic forward modeling steps in Aramco's next-gen seismic inversion code



Tareq Malas

GIRIH

Many cores learn to share!
Cooperation is good
For limited cache.

Reservoir Simulation (from Cray)

‘Shaheen II’ System Enables World’s First Trillion-Cell Simulation

JANUARY 11, 2017 | BY CRAY | LEAVE A COMMENT

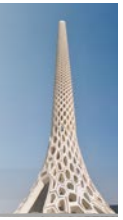
Reservoir Simulation (from Cray)

Saudi Aramco, one of the world's largest oil and gas companies, has set a record for oil and gas reservoir simulations. The achievement was made possible by "Shaheen II," a Cray® XC40™ system at the King Abdullah University of Science and Technology (KAUST) in Saudi Arabia.

"The 'trillion cell' designation refers to how dense and high-resolution the imagery is," explains Saber Feki, KAUST computational scientist lead, in a KAUST report on the breakthrough. "Think of it this way: We all carry megapixel cameras in our pockets. The Saudi Aramco team just simulated subsurface images with six orders of magnitude higher resolution on our machine. It's research that will yield much more reliable information for oil exploration and production."

In order to virtually see the reservoir, we have to "model" or "simulate" the reservoir using production data, special applications and high performance computing. Standard modeling today uses around 10 million to 100 million cells, which could run hundreds of times in order to produce an acceptable model. Only a few companies use models of 100-plus million cells. An example of a large model has around 243 million cells and a reservoir that covers roughly 46 square miles. A larger number of cells allows for modeling of larger reservoirs and also the ability to produce a higher-fidelity picture. It's just like a TV that has gone from HD to 4K. You can get a bigger TV with exceptional fidelity or a smaller one with extreme fidelity. It just depends what you want to accomplish.

Reservoir Simulation (from Cray)



Many companies are looking to go to full-field reservoir modeling, meaning they want to model an entire field in one model. But most current applications, and the need for huge amounts of computing capacity, allow for only a small portion of the reservoir to be modeled. The Cray XC supercomputer system was built to handle this larger scale with reduced modeling times.

So, a trillion-cell model what does that mean? It means we could model huge production basins like the Permian in West Texas (approximately 75,000 square miles), or the Williston in Montana and North Dakota (roughly 200,000 square miles). Or we could model reservoirs down the most minute of cracks and micro-fissures and really begin to understand the workings of the reservoir.

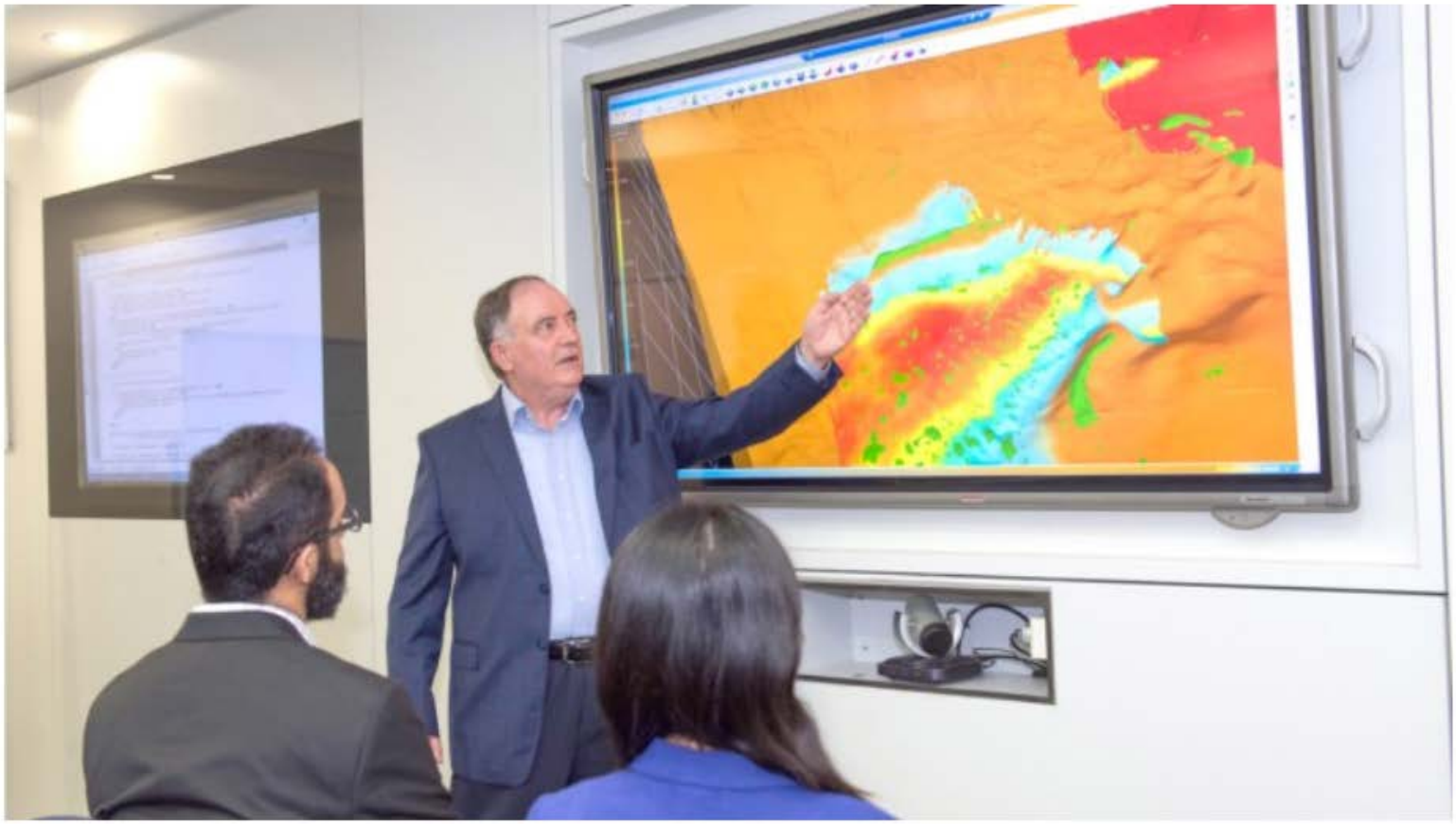
Reservoir modeling can get very complicated very quickly. With the type of work KAUST is doing, these high-density models de-risk the subsurface for exploration and give us added insight into understanding how reservoirs function.

You can read more about Saudi Aramco's work with KAUST and the Cray system here.

Reservoir Simulation (from Aramco)

Saudi Aramco scientists achieve new world record

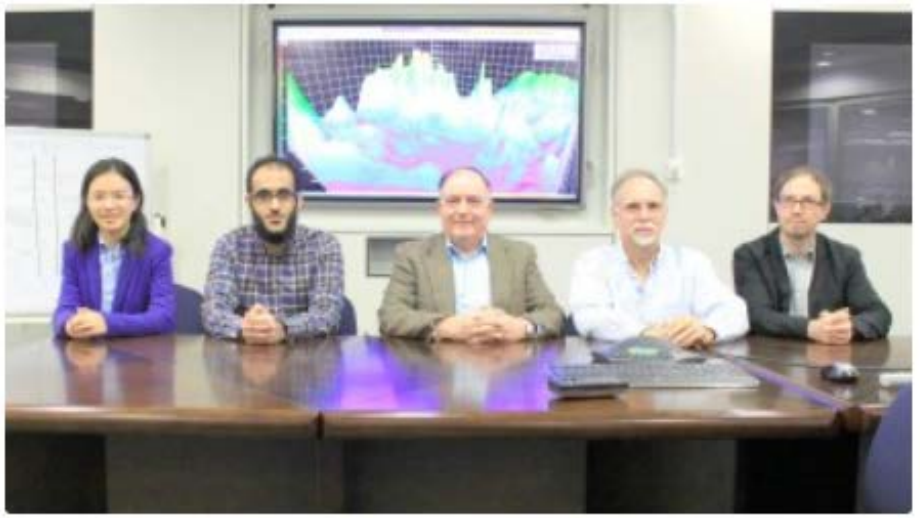
DHAHRAN, November 23, 2016



Reservoir Simulation (from Aramco)

The mission of TeraPOWERS

The mission of TeraPOWERS is twofold: to help increase discovery and recovery. TeraPOWERS will catapult the company much further in reservoir management optimization in visualizing not only all of the fields, but also what is happening between them in one enormous model of the Saudi Arabian basin in its entirety.



Members of the TeraPOWERS team are, from left, Shouhong Du, Abdulrahman Mana, Ali Dogru, Tom Beyer, Florian Manus, and Larry Fung (not shown).

"With this major breakthrough, Saudi Aramco is taking a big leap toward the goal of implementing a basin simulator that will provide a fuller picture of our assets, allowing the company to become an even more efficient steward of the Kingdom's hydrocarbon resources," said Mohammed Y. Al Qahtani, senior vice president of Upstream. "It is also a demonstration of the top talent our company has for managing our oil and gas assets, with great inventive and innovative minds."

Reservoir Simulation (from Aramco)

Our TeraPOWERS team ran the industry's first trillion-cell simulation and hydrocarbon migration algorithm.

We developed POWERS in-house, and at the time of its first deployment in 2000, it was capable of million-cell models. In 2010, we unveiled GigaPOWERS, which ran billion-cell models.

Now, the development of TeraPOWERS will make it possible to model the physics of hydrocarbon reservoirs from their original generation to their final production, from microscopic rock pore scale all the way to giant field and even basin scale.

Reservoir Simulation (from Aramco)

The breakthrough model was made possible through collaboration with the King Abdullah University of Science and Technology (KAUST), located north of Jiddah on the Red Sea.

TeraPOWERS will help prioritize prospects, reduce exploration risks and costs, and enable us to sustainably manage the Kingdom's oil and gas resources for future generations.

The insights generated by TeraPOWERS, combined with data gleaned from core samples, allows for more precise drilling.

Reservoir Simulation (from KAUST)

A millenial pursuit

Drilling for oil is an ancient tradition. Records indicate that the first wells may have been drilled as early as 300 C.E. By the 9th century, Arab and Persian chemists were refining petroleum products for use in lighting and arms. For much of recorded history, the problem was not so much drilling into the earth—although that is often challenging—but where to drill. Saudi Aramco's trillion cell simulation largely solved that.

Computational Scientist Bilel Hadri on the floor of the SC16 supercomputing conference in Salt Lake City, Utah. By Nicholas Demille

"The trillion cell simulation was the level that everyone was trying to achieve," Lee said. "The resolution is so much higher that Aramco can locate things that were not seen before. These pockets of oil and gas were there but could not be seen. What was once a much more random process can now be done in a pinpoint fashion—this is a tremendous difference."

"Using trillions of cells in a reservoir simulation environment was a long-awaited dream for the global petroleum industry and scientific community," noted Dogru in a Saudi Aramco press release. "This achievement opens the door for us to simulate the Saudi Arabian peninsula in its entirety as one model using the reservoir simulation grid. This means that we will be able to examine the peninsula under the microscope for new oil and gas fields."

Reservoir Simulation (from KAUST)

Serving the campus and the Kingdom

A number of Saudi institutions use Shaheen, including King Fahd University of Petroleum and Minerals (KFUPM) and King Saud University (KSU), to develop their work and examine new fields of research. Companies like the Saudi Basic Industries Corporation (SABIC) also use KAUST supercomputing resources to enhance their business in chemistry and chemical catalysis research.

"KAUST has been contributing to the advancement of the Kingdom of Saudi Arabia by educating future leaders in science and technology and by finding technical solutions to problems the Kingdom faces," said Justin Mynar, director of the University's Core Labs. "The KAUST Core Labs have been maintaining world-class, state-of-the-art facilities for the KAUST community, and the University's collaborators and I feel that Shaheen is a national asset that should be further utilized to meet demands from organizations around the Kingdom."

The KAUST Core Labs has been busy promoting the University as an ideal research partner for the Kingdom's institutions. Earlier this year KAUST, signed an agreement with the Aviation Investigation Bureau, an independent governmental organization that needed to decrease dependence on international resources while utilizing expertise and facilities within the Kingdom.

Reservoir Simulation (from "World Oil")

Saudi Aramco in trillion cell reservoir simulation run

11/28/2016

DHAHRAN -- The EXPEC Advanced Research Center (EXPEC ARC) TeraPOWERS Technology Team, under the leadership of Saudi Aramco fellow Ali Dogru, has achieved a major breakthrough with the industry's first trillion cell reservoir simulation run.

Saudi Aramco's cornerstone technology, the parallel oil, gas and water enhanced reservoir simulator (POWERS, deployed 2000) has taken its next evolutionary step from mega-cell to giga-cell (GigaPOWERS, achieved 2010) and now to tera-cell (TeraPOWERS, 2016) simulation capability.

"This is the world's first trillion cell run, as well as a major breakthrough for the global scientific community. Using trillions of cells in a reservoir simulation environment was a long-awaited dream for the global petroleum industry and scientific community," said Dogru.

"We simulated an oil migration problem in the Kingdom from the source rock to the trap with millions of years of history in 10 hours using 1 trillion active computational cells. This achievement opens the door for us to simulate the Saudi Arabian peninsula in its entirety, as one model, using the reservoir simulation grid. This means that we will be able to examine the peninsula under the microscope for new oil and gas fields."

The breakthrough was achieved using the King Abdullah University of Science and Technology (KAUST) Shaheen II supercomputer. EXPEC ARC has supported and collaborated on a range of upstream research programs at KAUST over the years.

Reservoir Simulation (from "World Oil")

Scientists used 150,000 cores—about 75% of the capacity of the entire computer. Since the computing power requirements are so enormous for computational modeling technology development, KAUST provides EXPEC ARC access to the Shaheen II on an arranged basis. During these special requests, KAUST contributes supercomputer run time, as well as specialized personnel for system program support to ensure the runs go smoothly.

"We could not have achieved this incredible milestone without the expertise and resources from KAUST, which provided superb support," said lead TeraPOWERS developer Larry Fung, who was a founding member of the original POWERS and instrumental in the KAUST partnership. "Working on GigaPOWERS over the years—and now TeraPOWERS—has been such an exciting experience. We are driving the industry's leading state-of-the-art technology and working on one of the largest magnitude of clusters in the industry to deliver a most powerful solution."

The simulation of the flow of fluids in the subsurface through and around the reservoir structure requires vast computational power. The more reservoir engineers know about what is going on in and around the reservoirs, the more effectively they can place wells and manage production of hydrocarbons to optimize resources.

Since the giant reservoirs of Saudi Arabia are among the biggest in the world, the company requires extremely powerful modeling and simulation capability to understand the mysteries of the underground. No such capability existed in the industry, so EXPEC ARC embarked upon the arduous journey of pioneering its own in-house technology solution in 1994 with just a small team of scientists. The team grew over the years and achieved the million cell simulation milestone in 2000.

Reservoir Simulation (from "World Oil")

With the greater number of cells in the reservoir models, greater detail is provided on the reservoirs. A giant field such as Ghawar—the largest in the world—was not able to be simulated in its entirety with sufficient resolution until GigaPOWERS came along. Suddenly, reservoir engineers could understand connectivity among the various reservoirs and improve the management of the field.

"GigaPOWERS has proven extremely valuable in providing high-impact return on investment for Reservoir Management and Exploration," said Nasir K. Al Naimi, V.P., Petroleum Engineering and Development. "To be able to model the physics of hydrocarbon reservoirs, from their original generation to their final production, and from the tiny pore-scale all the way to the giant field-scale and even to basin scale used to seem impossible. The TeraPOWERS team is a leading example of the pioneering minds at EXPEC ARC that fuel the dreams and deliver the technologies of tomorrow."

The mission of TeraPOWERS is twofold: to help increase discovery and recovery. TeraPOWERS will catapult the company much further in reservoir management optimization in visualizing not only all of the fields, but also what is happening between them in one enormous model of the Saudi Arabian basin in its entirety.

"With this major breakthrough, Saudi Aramco is taking a big leap toward the goal of implementing a basin simulator that will provide a fuller picture of our assets, allowing the company to become an even more efficient steward of the Kingdom's hydrocarbon resources," said Mohammed Y. Al Qahtani, senior V.P., Upstream. "It is also a demonstration of the top talent our company has for managing our oil and gas assets, with great inventive and innovative minds."

Reservoir Simulation (from "Saudi Gazette")

Saudi Gazette

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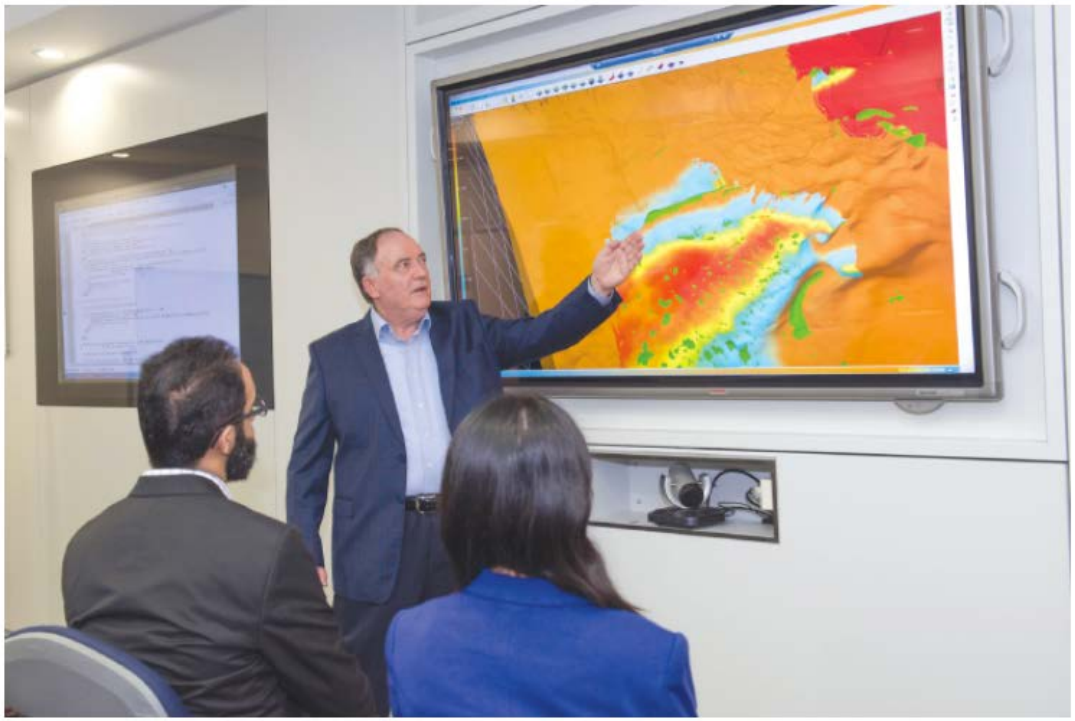
HOME

Saudi Aramco scientists achieve new world record

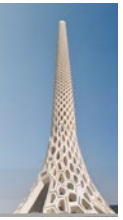
Saudi Aramco scientists achieve new world record

516 days ago



Saudi Aramco fellow Ali Dogru

Oil-Gas Separation (from ANSYS)



ANSYS, Saudi Aramco and KAUST Shatter Supercomputing Record

Record exceeded by over 5x – enabling oil and gas organizations to make critical and cost-effective decisions faster

PITTSBURGH – July 18, 2017 –ANSYS (NASDAQ: ANSS), Saudi Aramco and King Abdullah University of Science and Technology (KAUST) have set a new supercomputing milestone by scaling ANSYS® Fluent® to nearly 200,000 processor cores – enabling organizations to make critical and cost-effective decisions faster and increase the overall efficiency of oil and gas production facilities.

This supercomputing record represents a more than 5x increase over the record set just three years ago, when Fluent first reached the 36,000-core scaling milestone.

The calculations were run on the Shaheen II, a Cray® XC40™ supercomputer, hosted at the KAUST Supercomputing Core Lab (KSL). By leveraging high performance computing (HPC), ANSYS, Saudi Aramco and KSL sped up a complex simulation of a separation vessel from several weeks to an overnight run. This simulation is critical to all oil and gas production facilities – empowering organizations around the world to reduce design development time and better predict equipment performance under varying operational conditions. Saudi Aramco will apply this technology to make more-informed, timely decisions to retrofit separation vessels to optimize operation throughout an oil field's lifetime.

Oil-Gas Separation (from ANSYS)

"Today's regulatory requirements and market expectations mean that manufacturers must develop products that are cleaner, safer, more efficient and more reliable," said Wim Slagter, director of HPC and cloud alliances at ANSYS. "To reach such targets, designers and engineers must understand product performance with higher accuracy than ever before – especially for separation technologies, where an improved separation performance can immediately increase the efficiency and profitability of an oil field. The supercomputing collaboration between ANSYS, Saudi Aramco and KSL enabled enhanced insight in complex gas, water and crude-oil flows inside a separation vessel, which include liquid free-surface, phase mixing and droplets settling phenomena."

"Our oil and gas facilities are among the largest in the world. We selected a complex representative application – a multiphase gravity separation vessel – to confirm the value of HPC in reducing turnover time, which is critical to our industry," said Ehab Elsaadawy, computational modeling specialist and oil treatment team leader at Saudi Aramco's Research and Development Center. "By working with strategic partner, KAUST, we can now run these complex simulations in one day instead of weeks."

KSL's Shaheen II supercomputer is a Cray system composed of 6,174 nodes representing 197,568 processor cores tightly integrated with a richly layered memory hierarchy and interconnection network.

"Multiphase problems are complex and require multiple global synchronizations, making them harder to scale than single phase laminar or turbulent flow simulation. Unstructured mesh and complex geometry add further complexity," said Jysoo Lee, director, KAUST Supercomputing Core Lab. "Our scalability tests are not just designed for the sake of obtaining scalability at scale. This was a typical Aramco separation vessel with typical operation conditions, and larger core counts are added to reduce the time to solution. ANSYS provides a viable tool for Saudi Aramco to solve their design and analysis problems at full capacity of Shaheen. And for KAUST-Aramco R&D collaboration, this is our first development work. There are more projects in the pipeline."

Oil-Gas Separation (from KAUST)

ANSYS, Saudi Aramco and KAUST achieve a new supercomputing milestone

Jul 26, 2017 News

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ANSYS, Saudi Aramco and King Abdullah University of Science and Technology have achieved a new supercomputing milestone by scaling ANSYS Fluent to nearly 200,000 processor cores. This record represents a more than five-fold increase over the record set just three years ago, which will enable organizations to make critical decisions faster and increase the overall efficiency of oil and gas production facilities.

Oil-Gas Separation (from KAUST)

ENGINEERING CODE SCALES ACROSS 200,000 CORES ON CRAY SUPER

July 19, 2017 Nicole Hemsoth

Teams at Saudi Aramco using the Shaheen II supercomputer at King Abdullah University of Science and Technology (KAUST) have managed to scale ANSYS Fluent across 200,000 cores, marking top-end scaling for the commercial engineering code.

The news last year of a code scalability effort that topped out at 36,000 cores on the Blue Waters machine at the National Center for Supercomputing Applications (NCSA) was impressive. That was big news for ANSYS and NCSA, but also a major milestone for Cray. Just as Blue Waters is a Cray system, albeit one at the outer reaches of its lifespan (it was installed in 2012), so is the KAUST machine.

ANSYS, Saudi Aramco and teams from KAUST sped up a complex simulation of a separation vessel from several weeks to an overnight run. This simulation is critical to all oil and gas production facilities as it reduces design development time and better predicts equipment performance under varying operational conditions. Saudi Aramco will apply this technology to make more-informed, timely decisions to retrofit separation vessels to optimize operation throughout an oil field's lifetime.

KAUST Supercomputing Laboratory

Thanks to our royal falcon!

Thanks to our partner!

ارامكو السعودية
Saudi Aramco