

HPC User Forum

Tucson, AZ, April 16 – 18, 2018

HPC Infrastructure for and Simulations of Impact of Drug-Induced Arrhythmias in Living Hearts

Wolfgang Gentzsch

The UberCloud



Big Thanks

To the HPC User Forum Steering Committee



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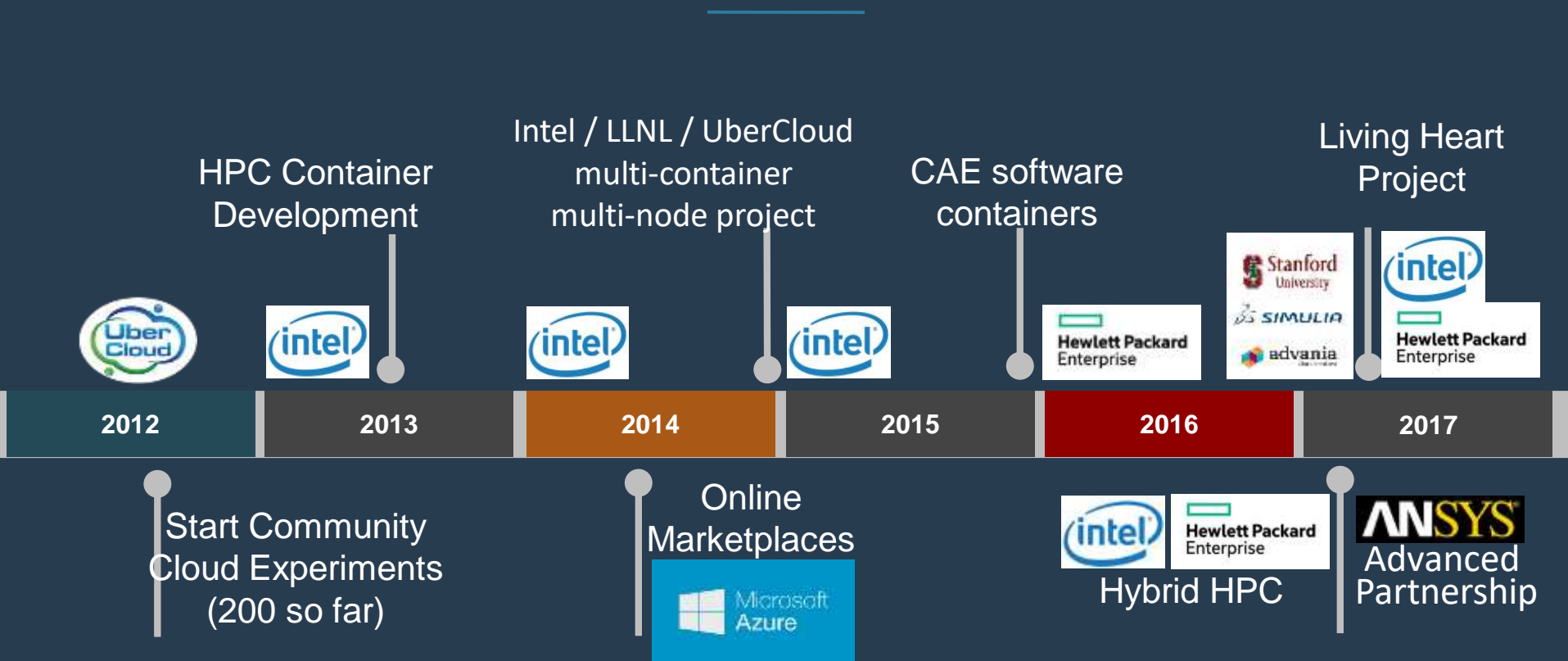


Big Thanks

To the HPC User Forum Steering Committee



Intel - HPE - UberCloud Partnership 2012 - 2017



Lessons Learned

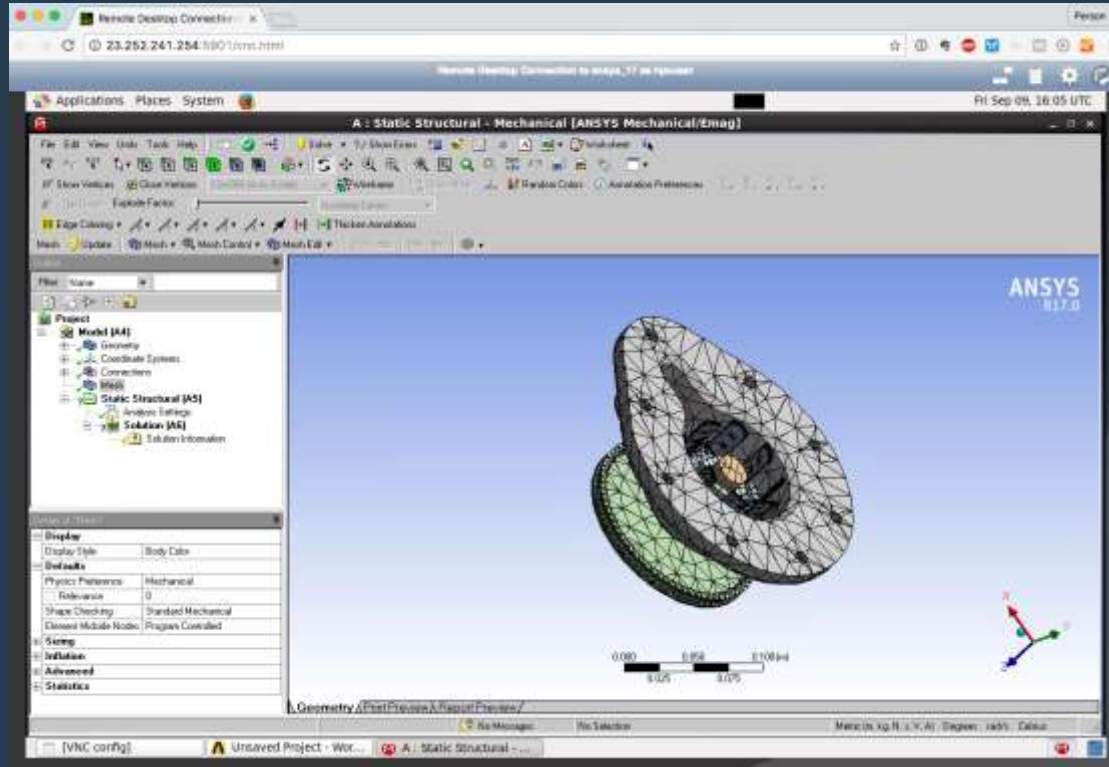
What we learnt from 200 cloud experiments and 80 case studies



Example: ANSYS Container

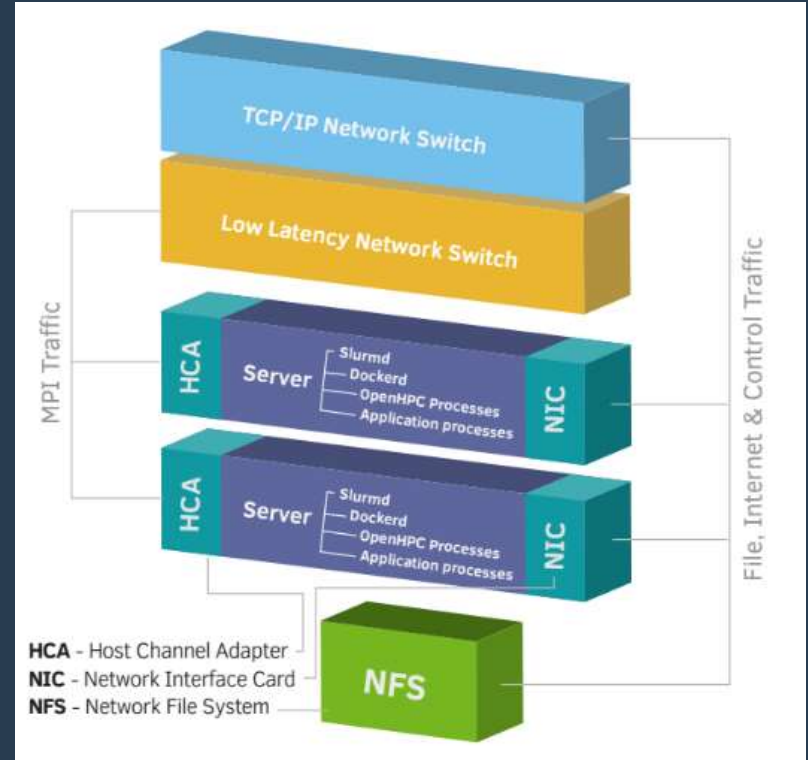
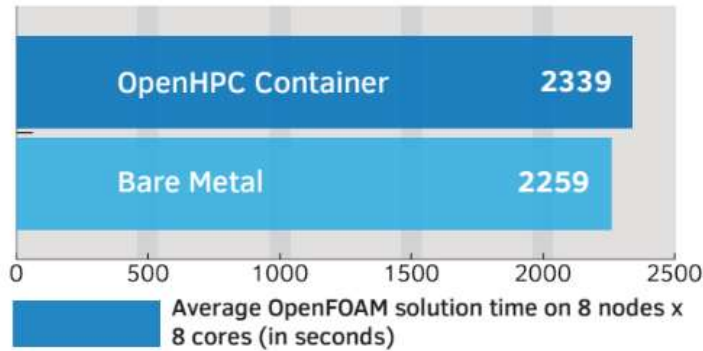


Example: ANSYS Container



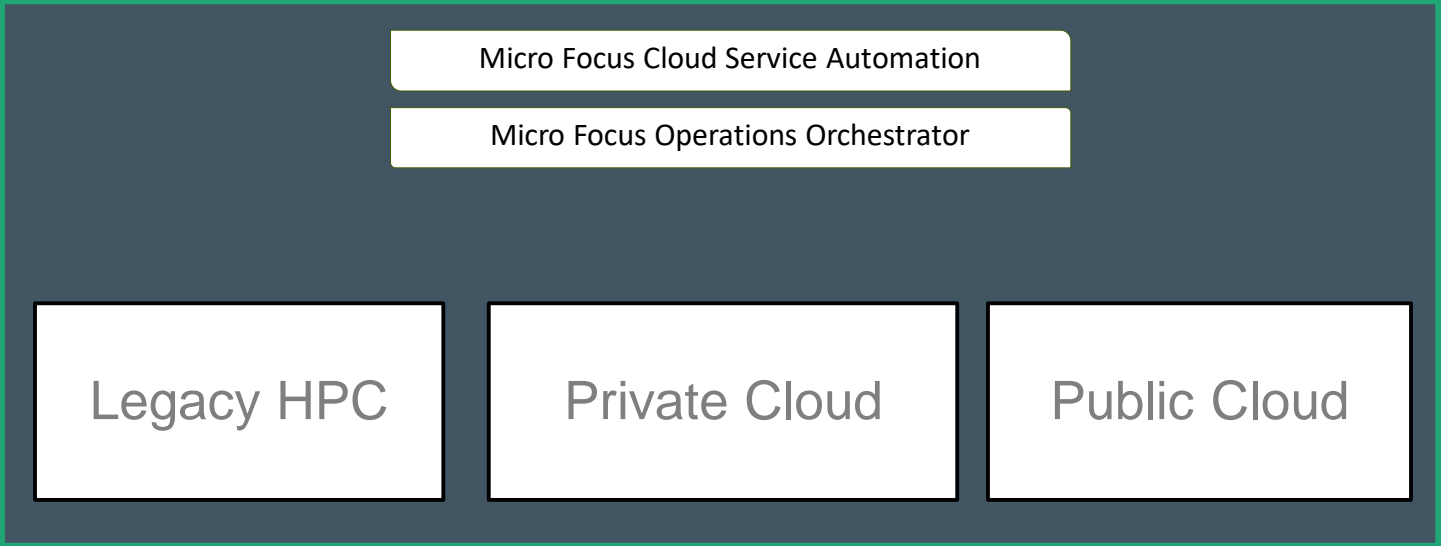
Bare Metal Performance

OpenHPC container has minimal performance impact when compared to bare metal performance



HPE's Cloud HPC Stack v0.0 (presented at SC'17)

ANSYS LINIVA SIMULIA NUMECA
SIEMENS COMSOL MATLAB OpenFOAM TRANSVALOR eDCV
UberCloud Containers



HPE Hybrid HPC Stack

ANSYS

UNIVA

SIMULIA



SIEMENS



MATLAB

COMSOL

OpenFOAM



CCV
desktop cloud visualization

UberCloud
Containers



Micro Focus Cloud Service Automation

Micro Focus Operations Orchestrator

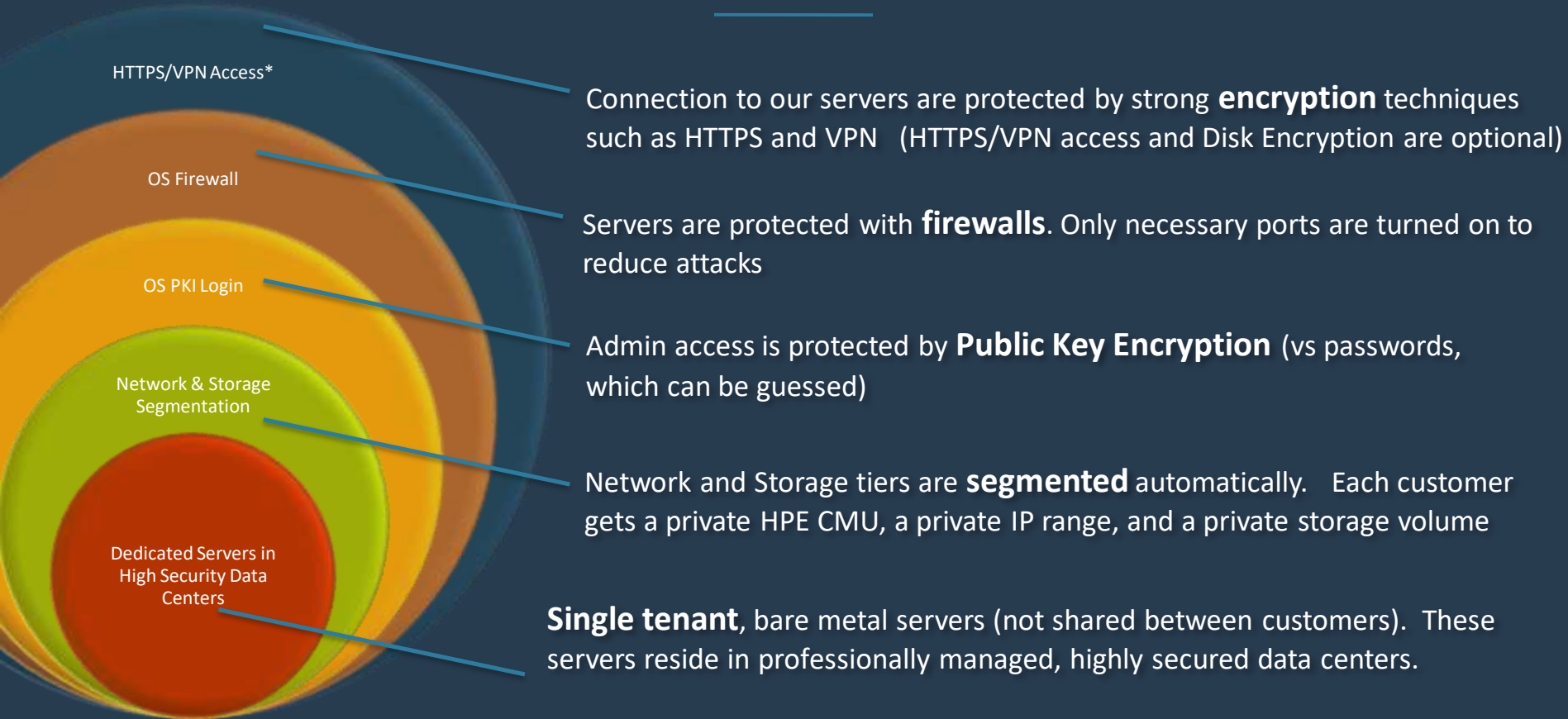
HPC Automated Life Cycle
Management Layer

HPE CMU

Hybrid Cloud

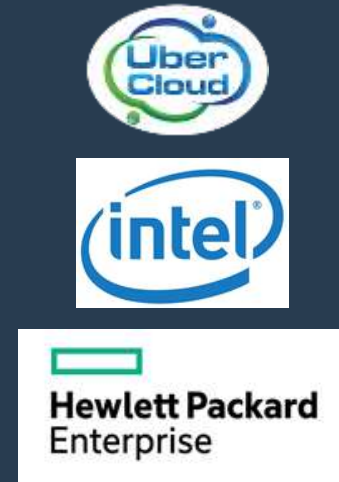


UberCloud Security Layers on Advania, Azure, HPE



Case Study: The Living Heart Project

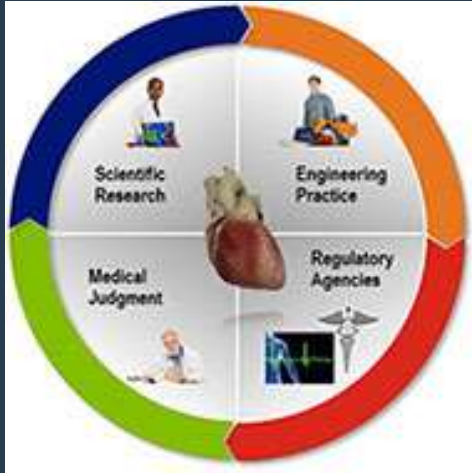
Studying Drug-induced Arrhythmias of a Human Heart with Abaqus 2017 in the Cloud



Arrhythmia affects millions of people

- In Europe and North America, atrial fibrillation affects about 2% to 3% of the population (2014)
- Atrial fibrillation and atrial flutter resulted in 112,000 deaths in 2013, up from 29,000 in 1990
- Sudden cardiac death is the cause of about half of deaths due to cardiovascular disease or about 15% of all deaths globally
- About 80% of sudden cardiac death is the result of ventricular arrhythmias
- Arrhythmias may occur at any age but are more common among older people

The Living Heart Project



- **Members:** Leading cardiovascular researchers, educators, medical device developers, regulatory agencies, and practicing cardiologists
- **Shared mission** to develop and validate highly accurate personalized digital human heart models (DHHM).
- **Living Heart Models** establish a unified foundation for cardiovascular in silico medicine
- Models serve as a **common technology base** for education and training, medical device design, testing, clinical diagnosis and regulatory science
- Rapidly translating current and future cutting-edge innovations directly into **improved patient care**.

HPCaaS Environment and Simulations

Advania / HPE / Intel // Dassault / UberCloud

- **Advania's** HPC as a Service (HPCaaS) hardware configuration
- Built upon 100 **HPE** ProLiant servers XL230 Gen9
- Each with 2 **Intel** Broadwell E5-2683 v4 with Intel OmniPath interconnect
- UberCloud HPC software **containers** hosting Stanford's workflow
- Dassault SIMULIA **Abaqus** for fluid-structure interaction and advanced electro-physiological modelling

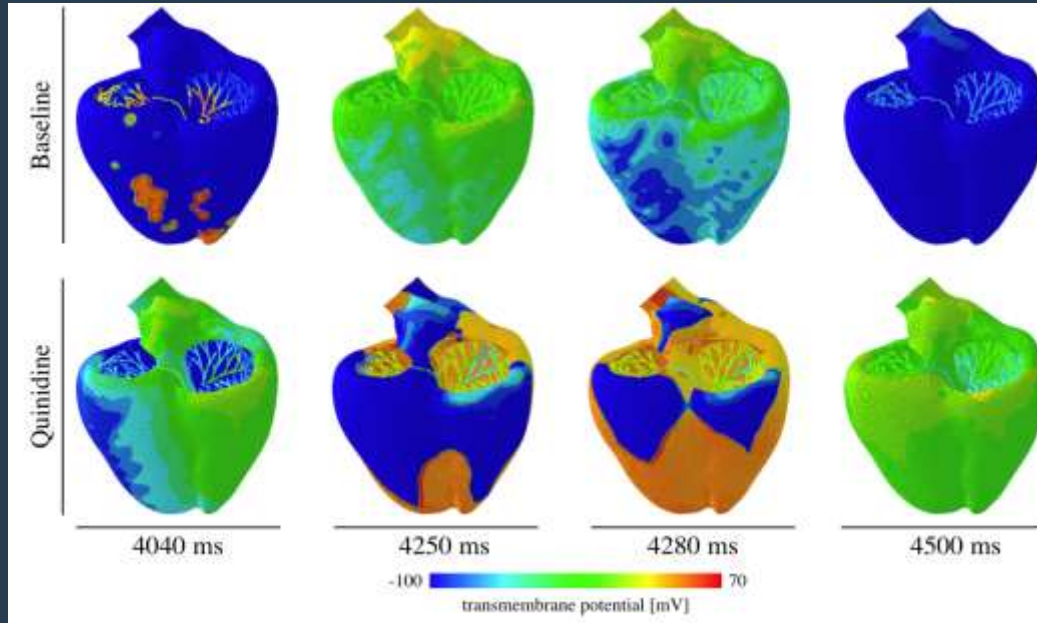
HPCaaS Environment and Simulations

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Goal: create a biventricular finite element model for **Stanford** to study drug-induced arrhythmias of a human heart.

- LHP model scaled well up to 240 compute cores
- 42 simulations each 40 hours on 5-node (160-core) subsystem
- Study: identifying drugs causing arrhythmias
- Applying drugs by blocking different ionic currents in cellular model, replicating what has been observed before in cellular experiments
- For each case, we let the heart beat naturally and see if the arrhythmia is developing

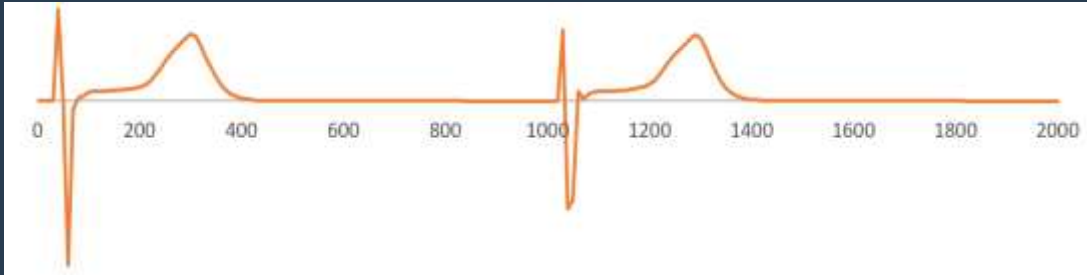
Simulation Results



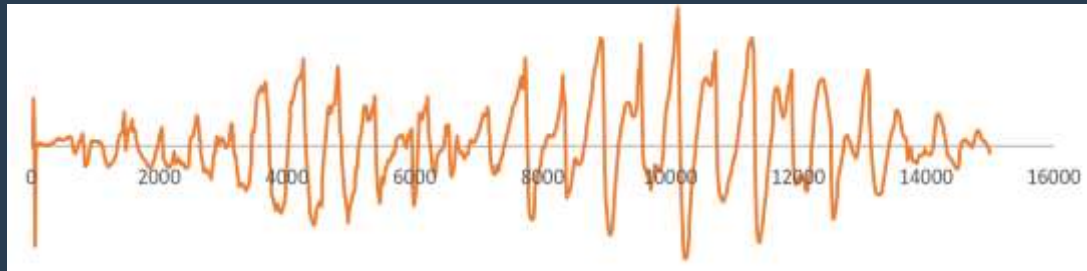
Evolution of electrical activity: After application of Quinidine, the electrical propagation turns chaotic, showing the high risk of Quinidine to produce arrhythmias.

Simulation Results

Electrocardiogram (ECG) without and with the drug Sotalol



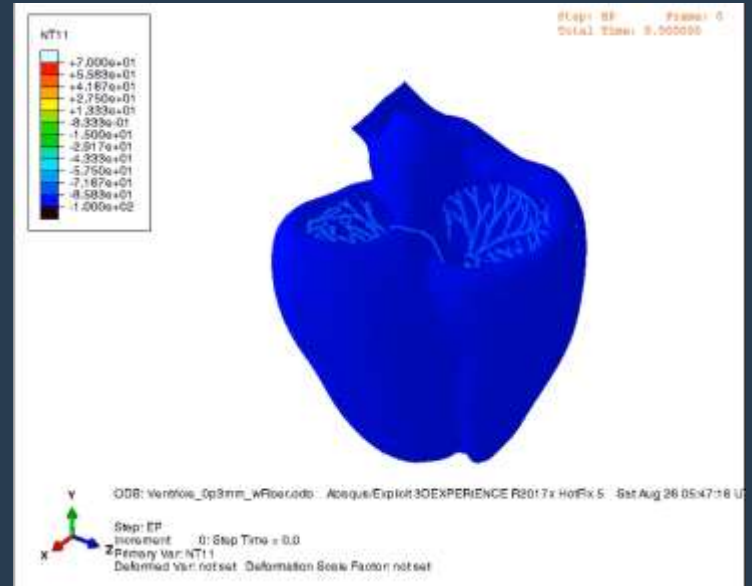
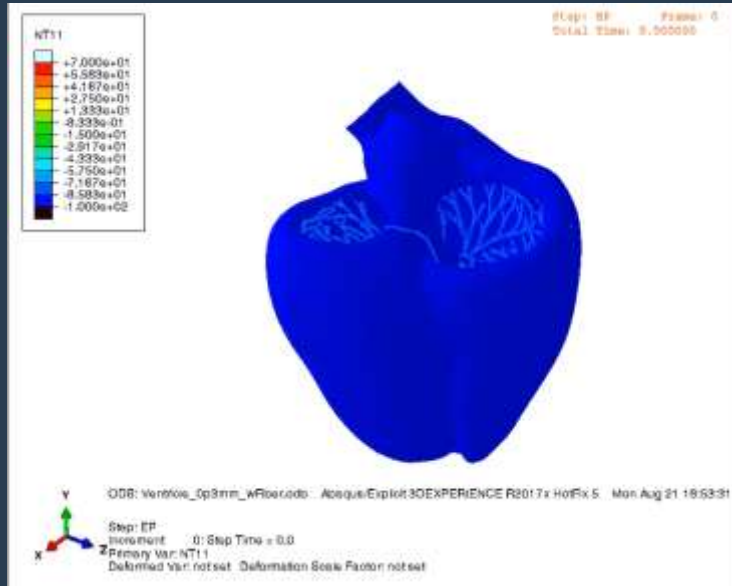
ECG tracing for healthy, baseline case



Arrhythmic development after applying the drug Sotalol. The ECG demonstrates that the arrhythmia is of Torsades de Pointes type.

Note: These are simulation results !

Videos of the healthy case versus the drug-induced case



Application of the drug Quinidine (right) where we observe Torsades de Points arrhythmia

Take Aways



- UberCloud is part of HPE's HPCaaS "Hybrid HPC"
- HPC Containers give us a way to solve software management problems without performance issues
- Able to manage and run the most complex engineering workflows
- Providing SaaS-like user experience and desktop level ease of use



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Thank You

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