High Performance Computing in the AWS Cloud

Jeffrey Layton, PhD
AWS Global Research and
Technical Computing

Who am I?

PhD in Aeronautical & Astronautical Engineering – Purdue

Ex-Army officer

Professor at Clarkson University

Worked for Boeing, Lockheed, NASA, and US Air Force

Worked at Linux Networx, Panasas, Dell, Intel, and AWS

System builder, programmer, admin, author

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At Amazon, we strive to be Earth's most customer-centric company

Retail

Hundreds of millions of active customer accounts

Ten countries:
Austria, Canada, China, France, Germany, Italy, Japan, Spain, United Kingdom, United States

Supporting sellers in over 100 countries

Devices

A growing family of consumer electronic devices

Tablets, mobile phones, television

Media

Services for music, applications, video, gaming, advertising

Original movies and television from Amazon Studios and original games from Amazon Game Studios

Cloud Computing

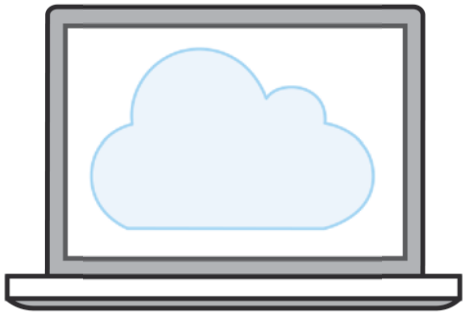
Cloud computing infrastructure that enables organizations to more easily build their technology applications

Over a million active customers in over 190 countries

How did Amazon…
…come to lead
Cloud Computing?

Amazon’s presence in North Dakota

Amazon has several hundred employees with a physical office in Grand Forks



What Is Cloud Computing?

The on-demand delivery of IT resources over public or private networks with zero up-front costs, no long-term contracts, and pay-as-you-go pricing

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Why Are Organizations Adopting Cloud Computing?

Trade capital expense for variable expense

Increase speed and agility

Benefit from massive economies of scale

Stop spending money on running/maintaining data centers

Stop guessing capacity

Go global in minutes

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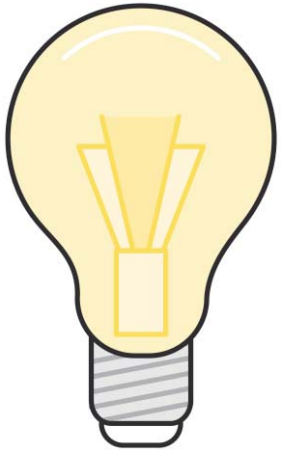
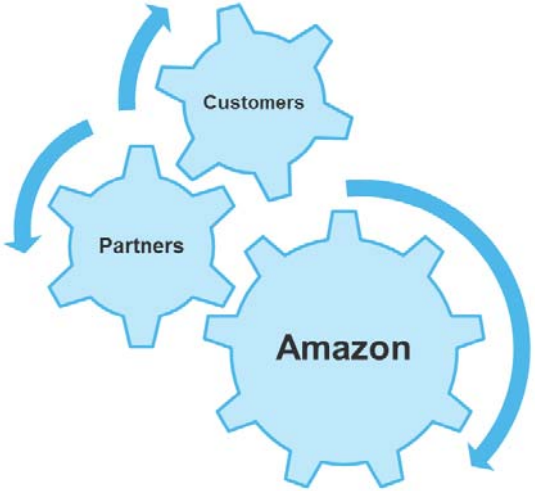
Why Does the Cloud Matter?



Paves the Way for Disruptive Innovation



Drives an Innovative Ecosystem

Makes the World a Better Place

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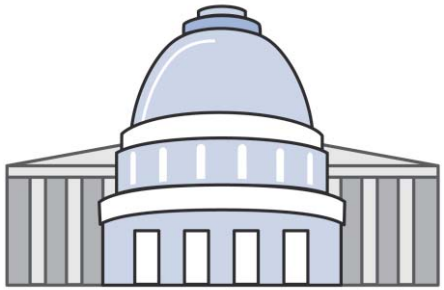
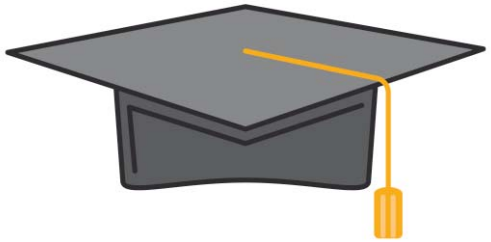
AWS in the Public Sector

2000+ government agencies



5000+ educational institutions



17500+ nonprofit organizations

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Government Agencies and Educational Institutions Use AWS Worldwide

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AWS Partners Focused on Public Sector

amazon web services Partner Network
CONSULTING PARTNER

AQUILENT
Booz | Allen | Hamilton
strategy and technology consultants
Smartronix
ppc
DLT SOLUTIONS
URS
8K Miles
SRA INTERNATIONAL, INC.
SAIC
protera TECHNOLOGIES
cloudnexa
DATAPIPE Managed IT Services
Dewberry
UNISYS
RUNE2E
BlueRiver INFORMATION TECHNOLOGY
info|RELIANCE
HARRIS
I|C|E systems
FOUR POINTS TECHNOLOGY
accenture High performance. Delivered.
A&T Systems Inc.
softwareONE
Infosys
Cognizant
Deloitte.
TVAR SOLUTIONS
Capgemini
CLOUDREACH Make It Happen
CITYTECH
INGRAM MICRO Partner Smart
2ND watch
CACI EVER VIGILANT
Globant we are ready
INFOZEN
FUJISOFT
shi
JHC TECHNOLOGY, INC.

amazon web services Partner Network
TECHNOLOGY PARTNER

Adobe
redhat
esri
Microsoft
Xceedium
ORACLE
ACQUIA
Appian
suse
EQUINIX
SAP
panzura Cloud Storage Made Seamless
ACTUATE The people behind BIRT
ca
Alfresco
CloudCheckr
mongoDB
bmcsoftware FEDERAL
CITRIX
puppet labs
CYCLECOMPUTING
TRADESHIFT
heroku
ALERTLOGIC
Pega
attunix
riverbed
NetApp
LIVING PLANET IMPROVING QUALITY OF LIFE THROUGH TECHNOLOGY
Engine Yard
sumologic
LAYER 7 TECHNOLOGIES
SafeNet
sonian Cloud Powered Archiving and Search
Symantec.
TREND MICRO
RIGHTSCALE

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AWS is Architected for Government Security Requirements

Certifications and accreditations for workloads that matter – Compliant Solutions

AWS CloudTrail and AWS Config – Call logging and configuration management for governance and compliance

- Log, review, alarm on all user actions
- Browse-and-query database of current and previous state of cloud resources

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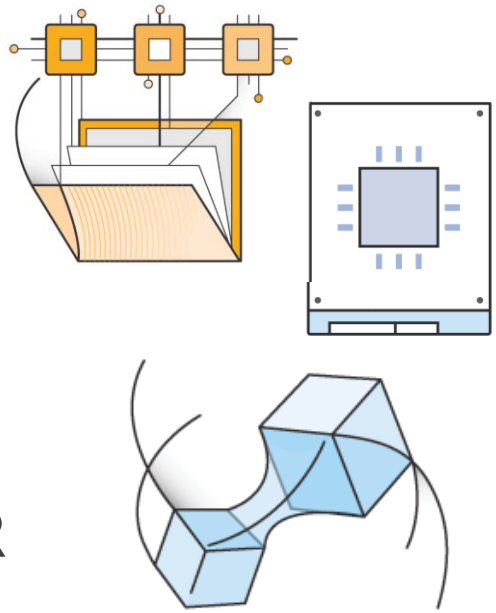
What is High Performance Computing?

HPC is any technically-related computing requiring more than a single server including:

- Potato chip, diaper and lotion design/analysis
- Aircraft and car analysis/design
- Analysis of blood flow in the heart
- Search for future energy resources
- Signal analysis and deep learning



2015: $28.6B industry worldwide, 5% CAGR

2020: $36.9B industry worldwide

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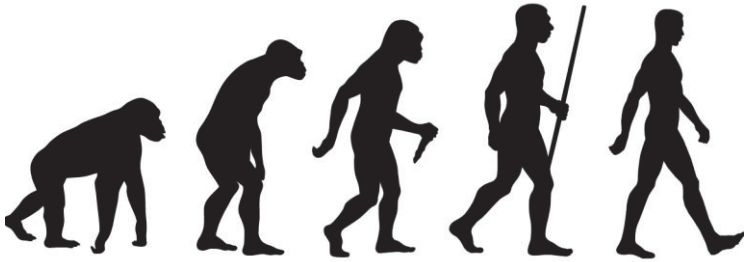
The Evolution of HPC



Traditional HPC

- Aircraft, cars, weather, national defense, oil&gas

Second Wave of HPC

- Chemistry, genomics, biology, social sciences

Third Wave of HPC

- “Big Data”, Deep learning, machine learning

Fourth Wave of HPC

- IoT, real-time processing

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Applications for Energy

> “Solar energy has the potential to replace some of our dependence on fossil fuels, but only if the solar panels can be made very inexpensively and have reasonable to high efficiencies. Organic solar cells have this potential.”
>
> USC Chemistry Professor - Dr. Mark Thompson

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Customer Challenge

Challenge

Examine possible organic compounds for producing solar energy

- Computational testing of 205,000 compounds

Requirements

Requires 2,312,959 core-hours

- 264 compute years

$68M on-premise system

Solution

- Use the world-wide AWS cloud
- Cost only $33,000

Why use the AWS Cloud?

- Finding new energy resources is a “spiky” proposition (sometimes you need all the computers in the company)
- Time to results is key! (time = money)
- Massive amounts of data (Need to store it a long time)

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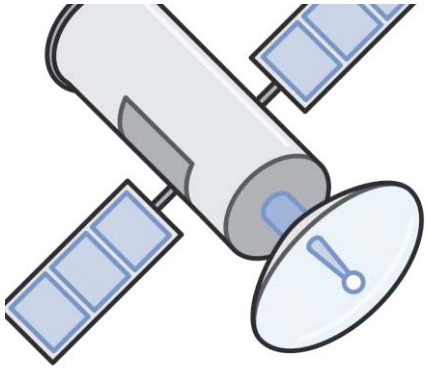

Applications for Cloud & Aerospace

- Aerospace has been a key HPC user for many years and most aircraft are designed using HPC
  - Classic example is 737 (one of the first to use CFD)
- During design and test, workloads can be “spiky”
- HPC now being used for operations
  - 1TB per aircraft per flight (mostly engine information)
  - Starting to mine this information
- UAV’s and sensors leading to Big Data and IoT

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Project:

Head in the Clouds

Goal

Use NGA data to estimate tree and bush biomass over arid and semi-arid zone on the south side of the Sahara

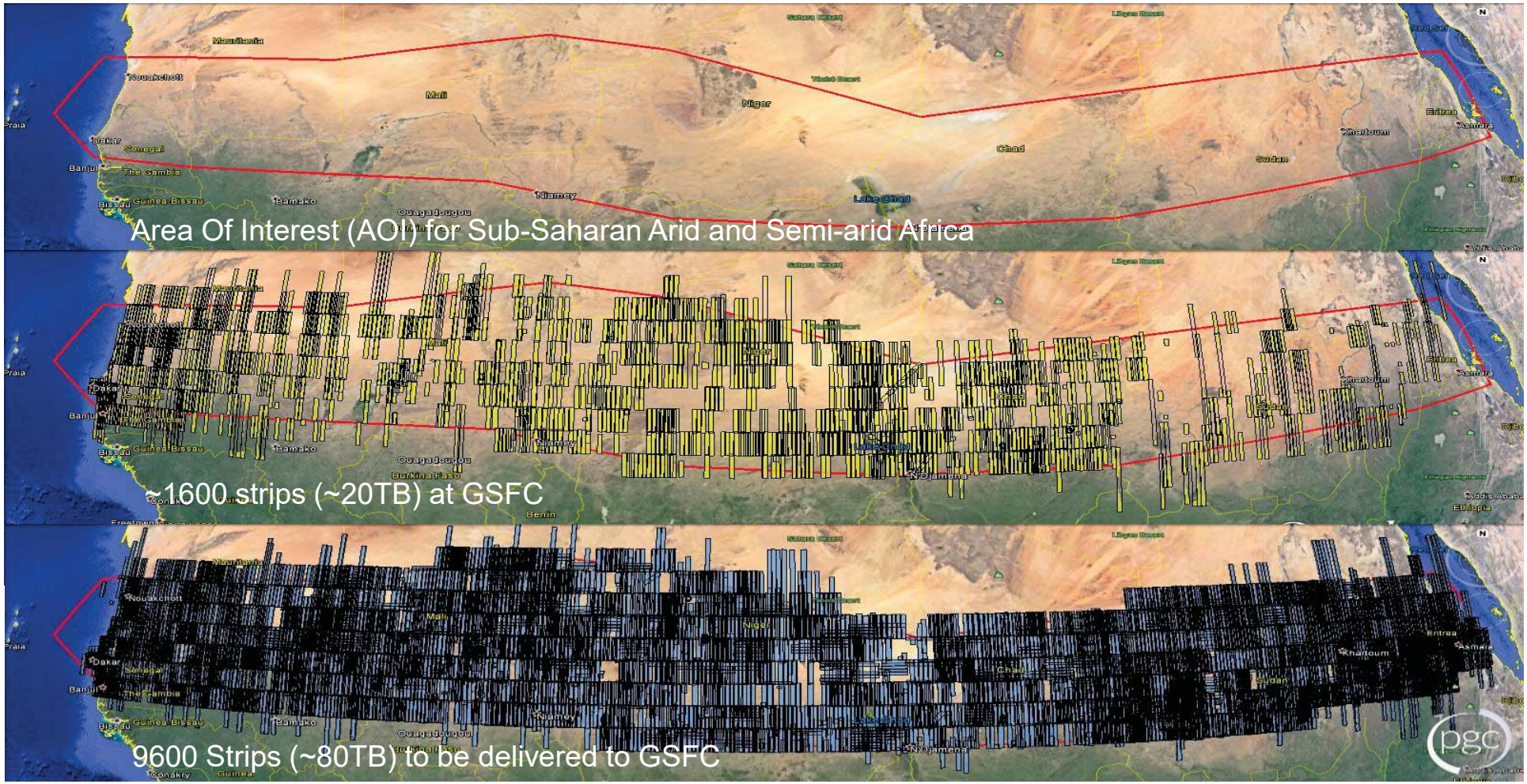
Summary

Estimate carbon stored in trees/bushes in arid and semi-arid south Sahara
Establish carbon baseline for research on CO2 uptake in region

PIs

- Dr. Compton J. Tucker, NASA Goddard Space Flight Center
- Dr. Paul Morin, University of Minnesota

Existing Sub-Saharan Arid and Semi-arid Sub-meter Commercial Imagery



Project:

Head in the Clouds

CYCLECOMPUTING

Test

- Approximately 1/3 of data processed of single UTM
- 200 Spot instances and six hours of processing
- Run in us-west-2 region
- Cost: $80 using SPOT with $390 with on-demand

Production

- Cloud Cost: $2,640
  - On-premise cost: $270,000

Saved over $267,000 using the AWS Cloud

Some costs based on estimates

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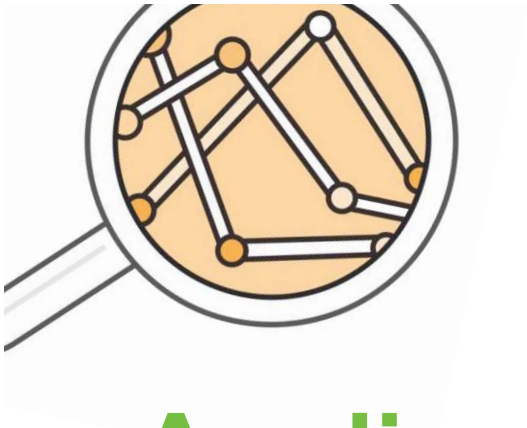

Applications for Research & Education

- Research needs
- Need for people who understand HPC
- Need for people who understand the Cloud
- New ideas and new algorithms
  - “Fail quickly and cheaply”
- World-wide collaboration and education (24/7)

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Accelerating Science

The Problem for Cancer Drug Design:

Cancer researcher needed 50,000 cores,
(not available in-house)

The options they didn't choose:

Buy infrastructure: Spend Millions, wait 6 months

Spend months writing software

"We contacted our friends at Cycle Computing, AWS, … to create a system that was fast, extremely secure, … inexpensive, and easy to use."

Final Solution

3 new compounds found

- 40 years of computing
- 10,466 servers World-Wide

$44M cluster for 8 hours for $4,362

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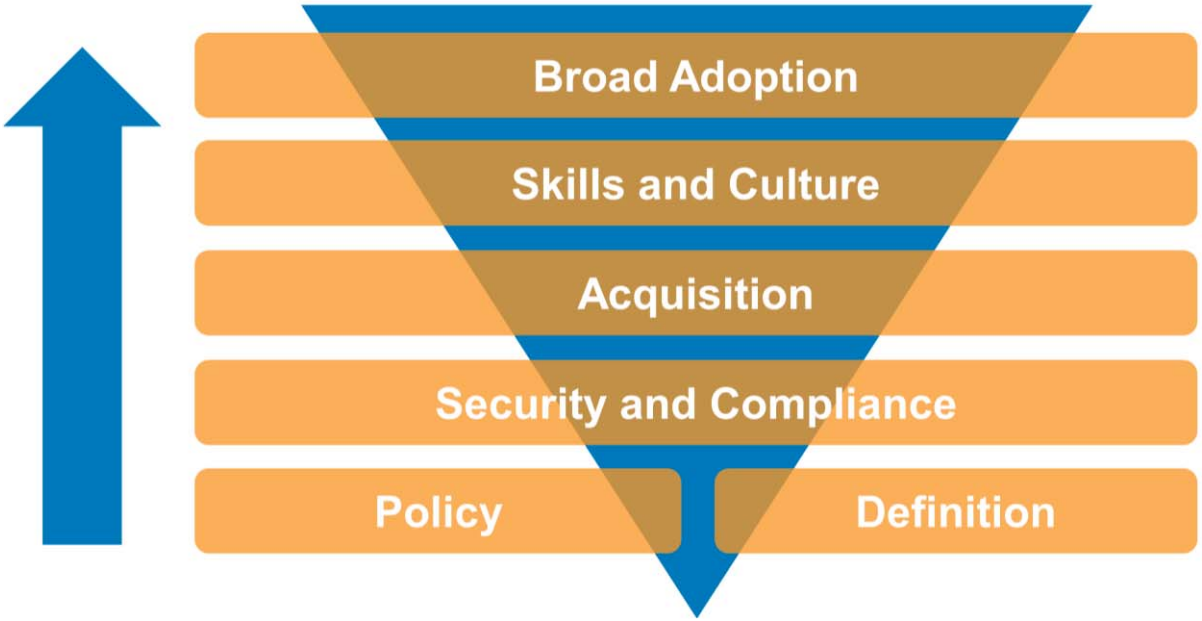
Paving the way for government reinvention



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Thank you!

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