



ORACLE
OPEN
WORLD

Your. Open. World.

Oracle Database in the Cloud

Sushil Kumar
Senior Director of Product Management

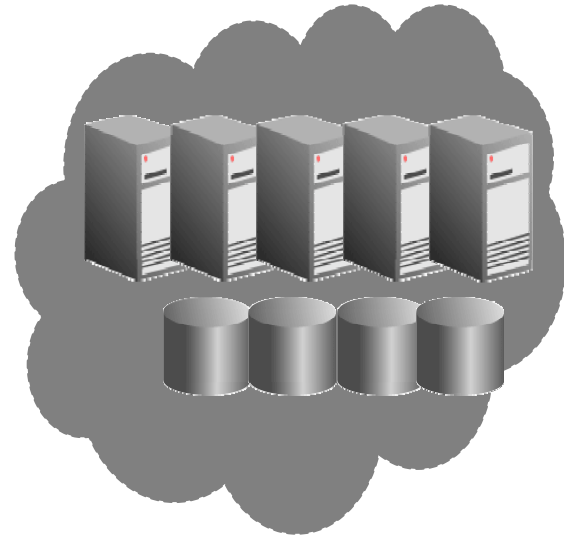
Peter Tonellato
Harvard Medical School



The following is intended to outline our general product direction. It is intended for information purposes only, and may not be incorporated into any contract. It is not a commitment to deliver any material, code, or functionality, and should not be relied upon in making purchasing decisions. The development, release, and timing of any features or functionality described for Oracle's products remains at the sole discretion of Oracle.

What Is Cloud Computing?

- Computing resources residing on Internet ('the cloud')
- Underlying physical resources not exposed
 - Abstracted at various levels (virtual machines, database as a service, etc.)
 - No direct hardware control
- Infinitely scalable
- Billed by consumption
 - Per hour, per GB, etc.
- Typical Interface: Web Services
 - REST, SOAP



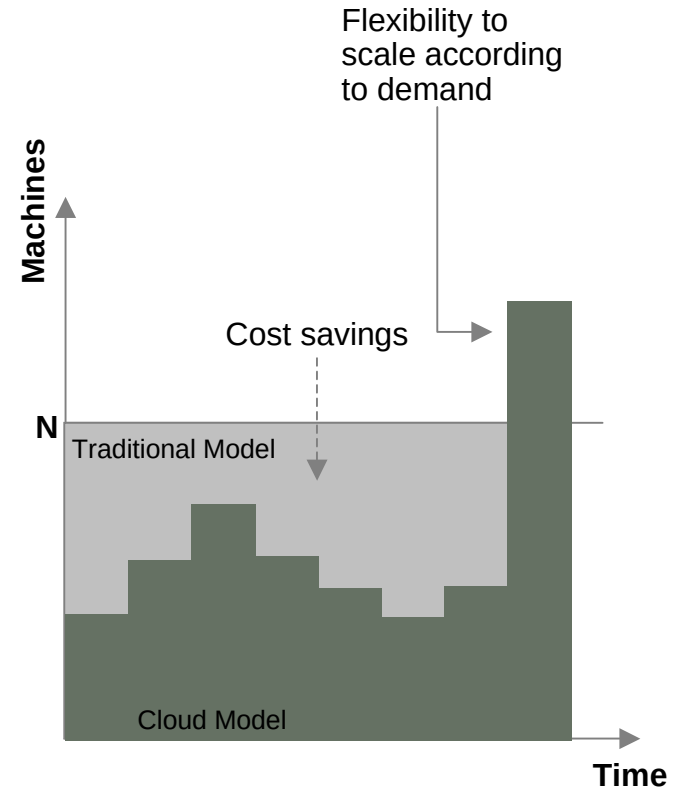
Why Cloud Computing?

Cost

- Cost Savings
 - Pay only for what you use and when you use it (\$0.40/hour Vs. \$700 per month+\$800 set up)
 - Better per unit rates due to economies of scale

Flexibility & Agility

- Quick, Self-Service Provisioning
 - Developers no longer waiting on IT to respond
 - Eases and Speeds Up Application Development
- Elastic
 - Scale up and down rapidly



Cloud Computing and Oracle



Cloud Computing and Oracle

- Cloud Computing today:
 - Developers are the primary users
 - Infrastructure not enterprise ready
 - Non-mission critical systems
- Oracle's goal is to make cloud computing relevant to enterprises by
 - Providing right set of products and services
 - Lead the industry efforts in developing Cloud standards, ensure data security, etc.
- Amazon is #1 Cloud Computing vendor & Oracle's 1st Partner



Amazon Web Services (AWS)

Introduction



- Amazon Data Center in the Cloud
- Fast, easy, inexpensive renting of servers / storage
 - Elastic Compute Cloud (EC2) – Rent Linux virtual machines
 - 10-80 cents/hour
 - Simple Storage Service (S3) – Store files
 - 15 cents/GB/month (US)
 - 18 cents/GB/month (Europe)
 - Bandwidth Costs
 - 10 cents/GB incoming
 - 10 – 17 cents/GB outgoing (based on volume)
- Customers demand for Oracle products to run on AWS

<http://aws.amazon.com>

EC2 Virtual Machine Configurations

	Small Instance	High CPU Medium Instance (~Single Socket DC Server)	Large Instance (~Single Socket DC Server)	Extra Large Instance (~Single Socket QC Or Dual Socket DC Server)	High CPU Extra Large Instance (~Dual Socket QC Server)
Virtual Cores	1 x 1.2 GHz	2 x 2.5 GHz	2 x 2.0 GHz	4 x 2.0 GHz	8 x 2.5 GHz
Memory	1.7 GB	1.7 GB	7.5 GB	15 GB	7 GB
Storage	160 GB	350 GB	850 GB	1.7 TB	1.7 TB
	Additional Shared Storage Available for Extra Cost				
I/O	Moderate	Moderate	Good	Good	Good
Target Application	Web Servers, Developer Sandbox		Databases (and other resource intensive applications)		
Cost	\$0.10 / Hour (\$72/Month)	\$0.20 / Hour (\$144/Month)	\$0.40 / Hour (\$288/Month)	\$0.80 / Hour (\$576/Month)	\$0.80 / Hour (\$576/Month)
	\$0.010 - \$.17/GB/Month network bandwidth (in and out of Amazon Data Center)				

Amazon EC2 Features

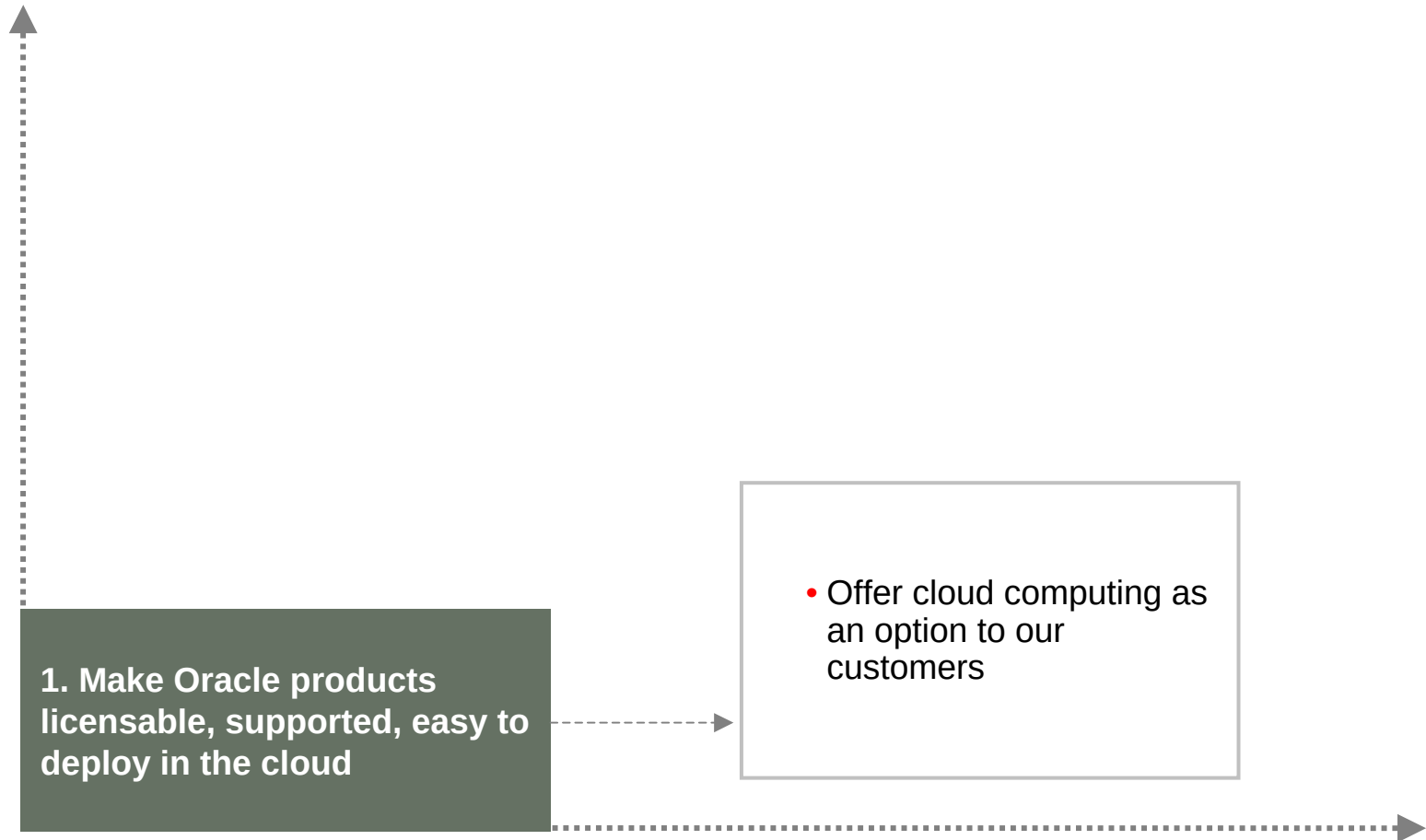
- Elastic (Static) IP Addresses
 - Pre-assigned static IP addresses that can be associated with any EC2 instance
- Elastic Block Storage
 - Persistent “NAS” style storage
 - Allows users to create volumes and snapshots
 - Default EC2 storage is ephemeral – you lose everything the moment you shut down an instance
- Availability Zones
 - Spread your instances across multiple locations for business continuity
- Security
 - Private/Public key pair based, SSH-only administrator access
 - Ability to configure firewall and network port settings

Amazon Simple Storage Service (S3)

- S3 - store files on Amazon storage cloud
 - Primarily used for backups, images, virtual machine snapshots
- Asynchronously replicates data to several data centers for HA and scalability
 - Typically in minutes
 - Claim to never have lost any data, but no guarantees
 - 99.99% uptime SLA
- Pricing
 - Storage
 - \$0.15 to \$.18/GB/Month (Higher price for data stored in Europe)
 - Bandwidth – free if from EC2
 - \$.10 - \$.017/GB Transferred/Month



Oracle's Cloud Strategy – Cloud “enable” Oracle Software



Oracle Software Cloud Licensing

- Oracle software can now be licensed for the Cloud
 - Amazon EC2 supported today
- Database, Middleware, Grid Control
 - EE: Each virtual core counted as a physical x86 core (EE)
 - SE/SE1 license based on the EC2 instance size
 - 0-4 virtual cores = 1 processor (socket)
 - >4 virtual cores = each 4 virtual core counted as a processor (socket)
- Oracle Enterprise Linux
 - Each EC2 instance is counted as a “System”
- Can buy new licenses or use existing ones
- Customers with ULAs can use EC2 without any additional license

Deploying Oracle Software in the Cloud

- Pre-configured virtual machine images (AMIs) available for EC2
- Consists of Oracle Enterprise Linux + Oracle DB + APEX
 - No RAC support currently (EC2 does not support clusters)
- Fully configured hardware and Oracle environment in less than 30 minutes
 - For test, dev, QA, POC, and other short-term projects
 - Such projects otherwise often get bottlenecked by IT
 - Can also be used as “sandbox” to try out new releases/options
- More AMIs to be released in the future

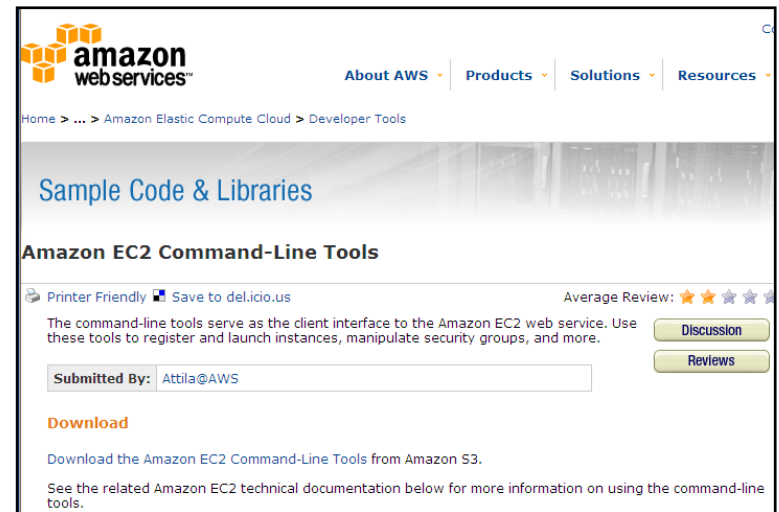


Getting Started with Oracle on Amazon EC2

Set up Amazon EC2 account

- Sign up for Amazon Web Services and EC2
 - Can use your regular Amazon account
 - Create your secure X.509 certificate and create key pair for command line access to EC2
 - Using tools like SSH and PuTTY
- Download and install EC2 command line tools

<http://aws.amazon.com>



Getting Started with Oracle on Amazon EC2

Pick an Oracle AMI

**Oracle Cloud Connect**

Oracle has played a pioneering role in shaping enterprises with ground breaking Automatic Storage Management (ASM), a Computing to middleware with the Application products/technologies make the enterprise without any theoretical upper limit, as well order to meet dynamic business priorities.

Continuing its pioneering role in shaping offerings that allow enterprises to benefit Computing. As a part of our initial offering environment to offer the following product

- ➔ Deploy Oracle Software in the Cloud
- ➔ Backup Oracle Database in the Cloud

These offerings may be extended to other

Amazon Machine Images (AMIs)

Oracle Database 11g Release 1 Enterprise Edition - 32 Bit

Printer Friendly Save to del.icio.us Average Review: ★★★★★

This is an Oracle Corporation supplied and publicly available AMI that includes Oracle Enterprise Linux Release 5 Update 1 and Oracle Database 11g Release 1 Enterprise Edition - 32 Bit.

Submitted By: William Hodak

AMI ID: ami-cecb2fa7

AMI Manifest: oracle-corporation/database-ami/32-bit/oracle_11106_EE_32Bit-image.manifest.xml

License: Public

Discussion

Reviews

This AMI comes with Oracle Enterprise Linux Release 5 Update 1 and Oracle Database 11g Release 1 Enterprise Edition software pre-installed and configured on the 32 Bit platform. In a matter of minutes, you can have a fully configured Oracle Database computing environment running on Amazon EC2 that includes the web based management tool Enterprise Manager Database Control and the web based rapid development tool Applications Express (APEX). For further information about Oracle Database in the Cloud or this Amazon Machine Image, please visit <http://www.oracle.com/technology/tech/cloud/index.html>

<http://www.oracle.com/technology/tech/cloud/index.html>

Getting Started with Oracle on Amazon EC2

Start a New EC2 Instance with Oracle AMI

- Configure EC2 firewall settings to open the required network ports (one time operation)
 - 1521 (listener), 8080 (APEX), 1158 (EM), etc.

```
ec2-authorize default -p 1158
```

- Start up an EC2 Instance with Oracle AMI

```
ec2-run-instances ami-cecb2fa7 -k <keypair>
```



Deploying Oracle on EC2

DEMONSTRATION

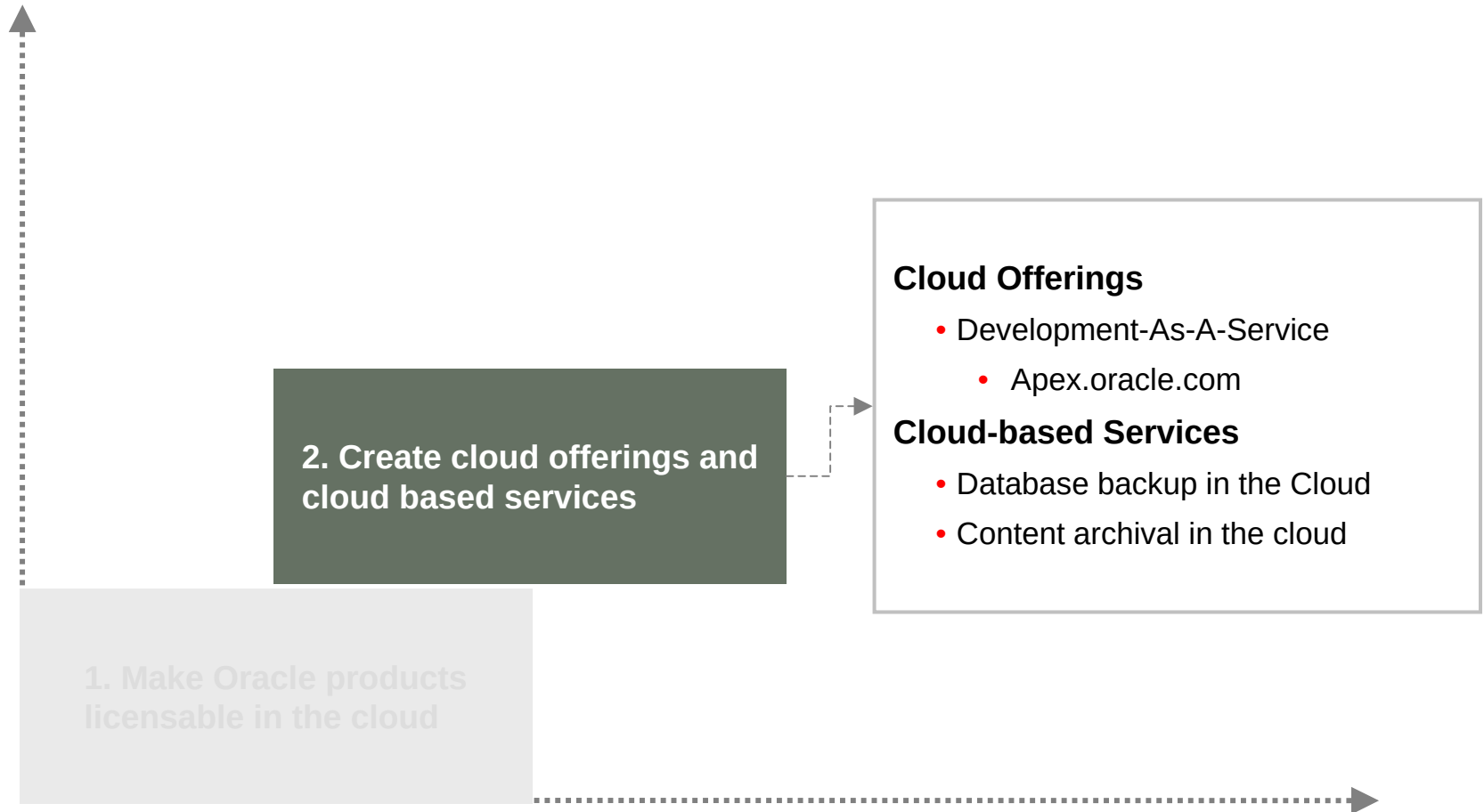
Oracle on Amazon EC2

First Reactions (From AWS website)

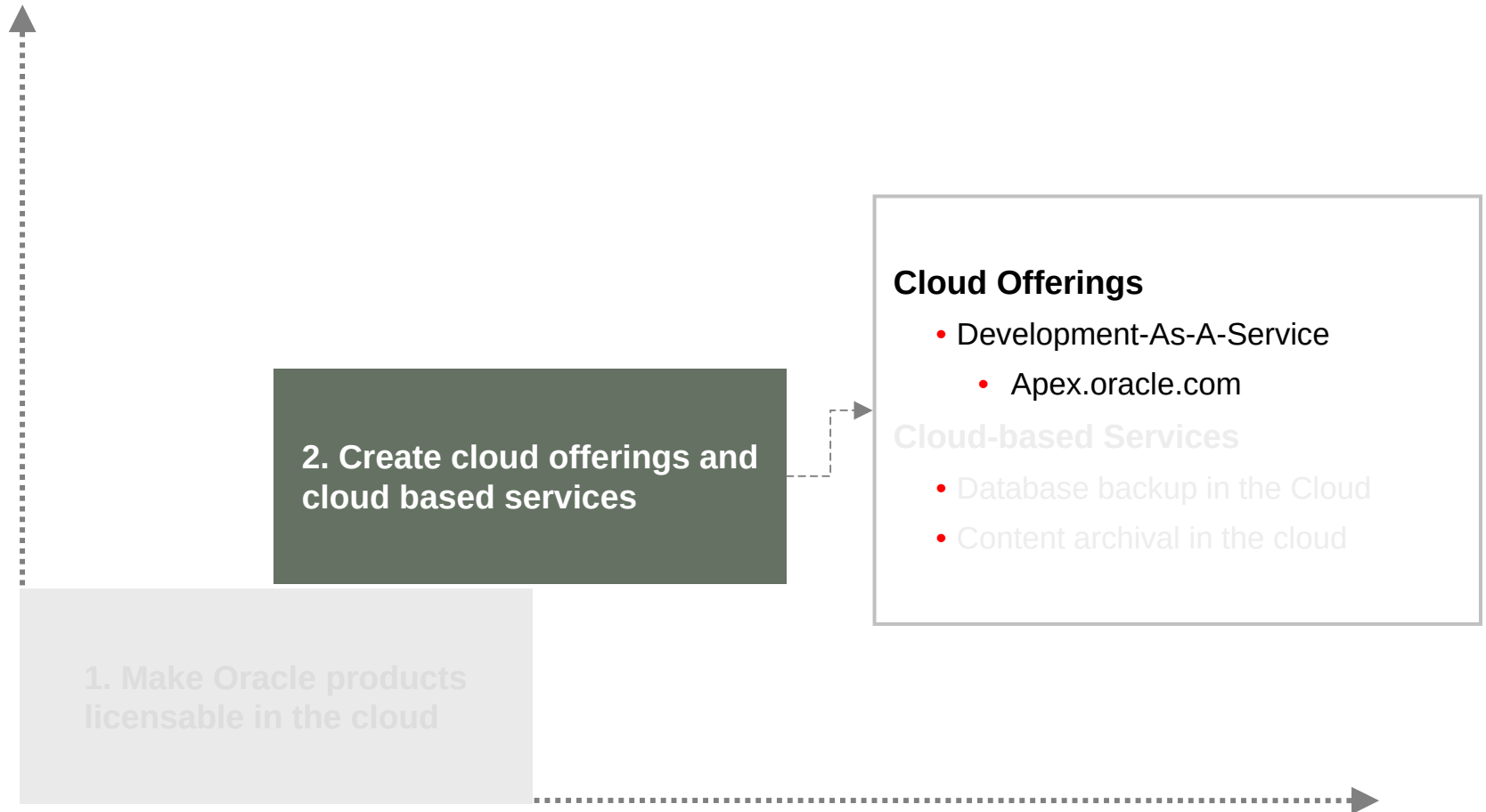
“Normally Oracle is a nightmare to install. However, what’s amazing is how pain-free this was to get going. Oracle really did a good job.”

“First class Database + linux available in 8 minutes!!. Don't you believe? Try this AMI and enjoy with APEX and its GUI for the administration. Specially amazing with EBS.”

Oracle's Cloud Strategy – Cloud-based Services

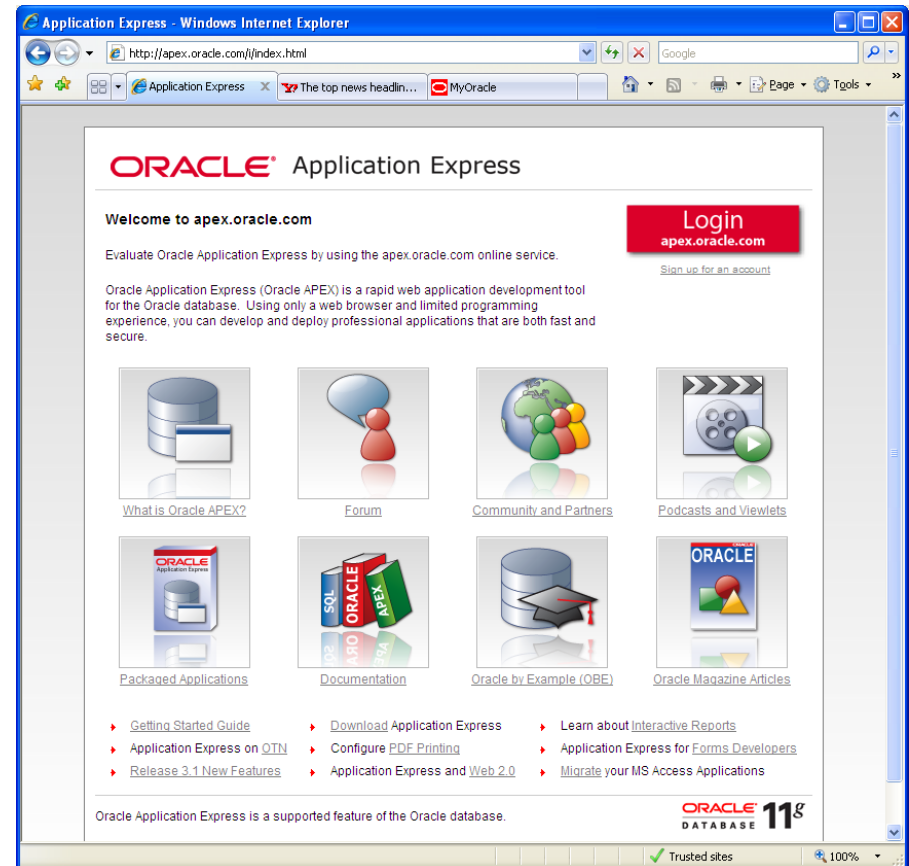


Oracle Cloud Strategic Options – Cloud-based Services

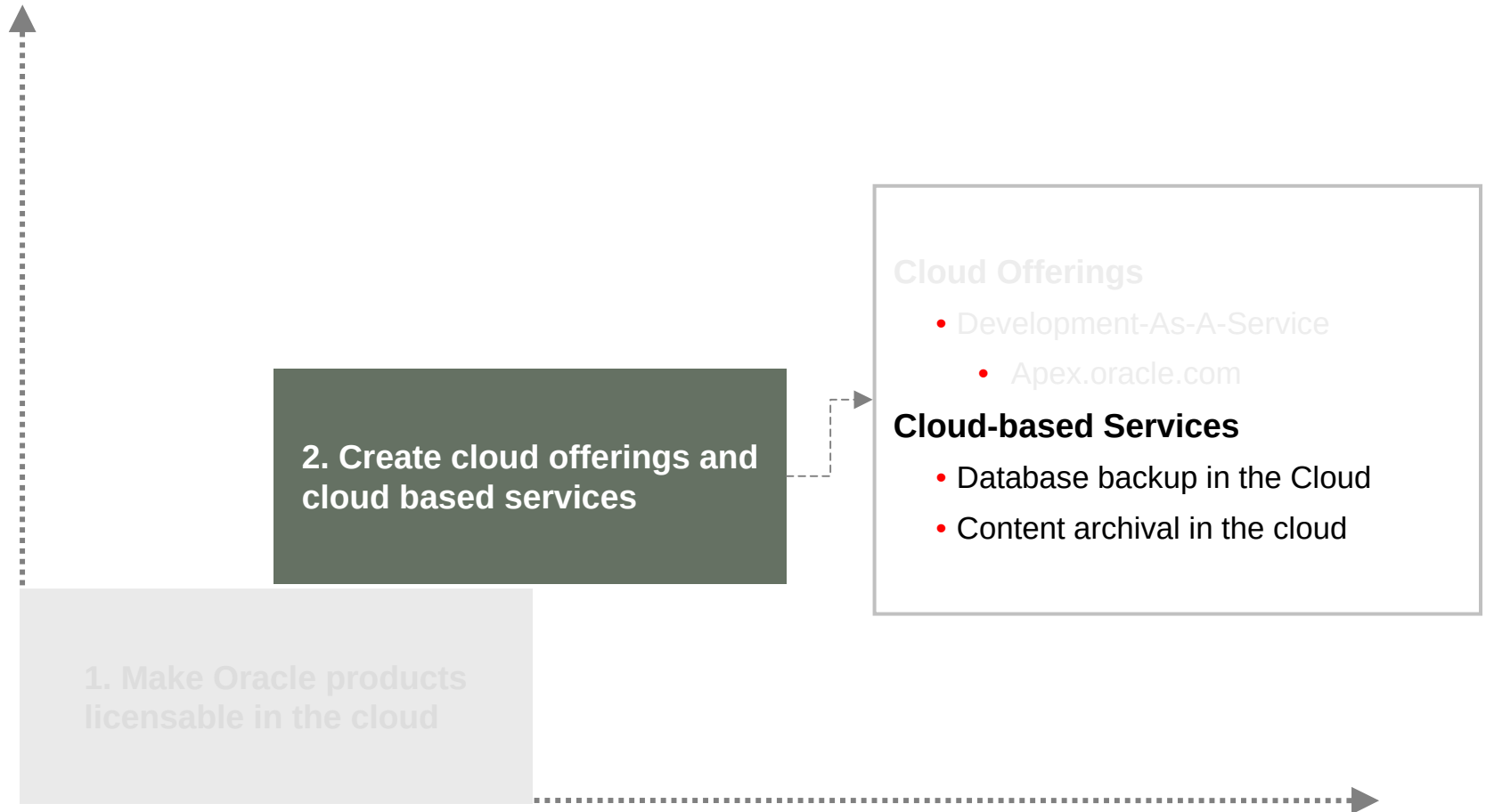


Oracle Database Development-as-a-Service

- Apex.oracle.com – Cloud based Oracle development platform
- 14000 users, 300 new users every week, 10M page views/month
- Free

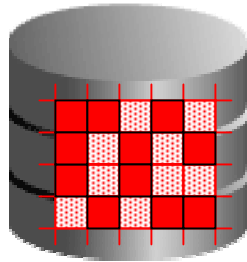


Oracle Cloud Strategic Options – Cloud-based Services

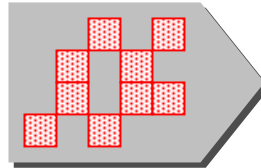


Current Database Backup Best Practice

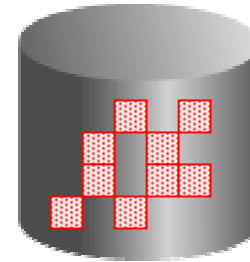
Database Files



RMAN Backup

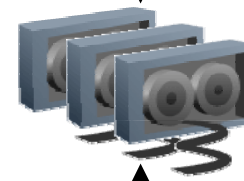


Local Disk Backup



- Backup to Local Disk
- Migrate backups from disk to tape
- Move tapes to off-site location (e.g. Iron Mountain)

RMAN Tape Interface



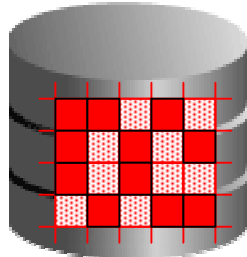
Offsite Tape Storage



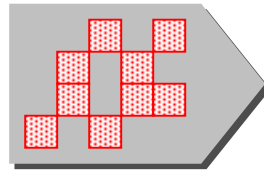
ORACLE®

Offsite Backups in the Cloud

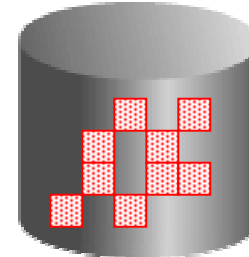
Database Files



RMAN Backup



Local Disk Backup



RMAN Tape Interface

Secure
Backup Cloud
Module

Compression

Encryption



- New Oracle Secure Backup module to move database backups to Cloud
 - Works with 9i and higher DB versions
 - Amazon S3 supported today
- More Reliable than tapes, Faster Restores
- Eliminates tape backup and offsite tape management overhead



ORACLE®

Oracle Secure Backup Cloud Module

- A new library that interfaces with RMAN and Amazon S3
 - Using RMAN's SBT (Tape) Interface
 - Part of Oracle Secure Backup product family
 - Licensed based on number of concurrent parallel streams (RMAN channels)
 - Includes encryption and compression capability
- Currently available on Linux 32, Linux 64, Windows 32
 - Cloud Backup Installer included in Oracle AMIs
 - OTN download coming soon for on-premise databases
- Fully compatible with existing backup scripts and EM

See Cloud Backup TWP on OTN for details

Database Backups to Cloud – Benefits

- Always accessible, Faster restore
 - No need to call any one, ship tapes
 - Cloud backups can be used to quickly create test, dev DBs
- Better reliability
 - Disks are more reliable than tapes
 - S3 makes several redundant copies for data
- Cost effective
 - No capital expense
 - Compelling S3 storage costs (~\$350/Month for a 250 GB database)
 - Can reduce tape backup software licensing and support costs
 - Eliminates need for additional offsite storage

Backup in the Cloud – Performance

Viable Even For Large Databases

DB Size (GB)	Full DB Backup Time	Incremental Backup Time	Monthly Amazon S3 Cost
500	4 Hours	30 Minutes	\$200
300	2 Hours	15 Minutes	\$120
100	40 Minutes	5 Minutes	\$40

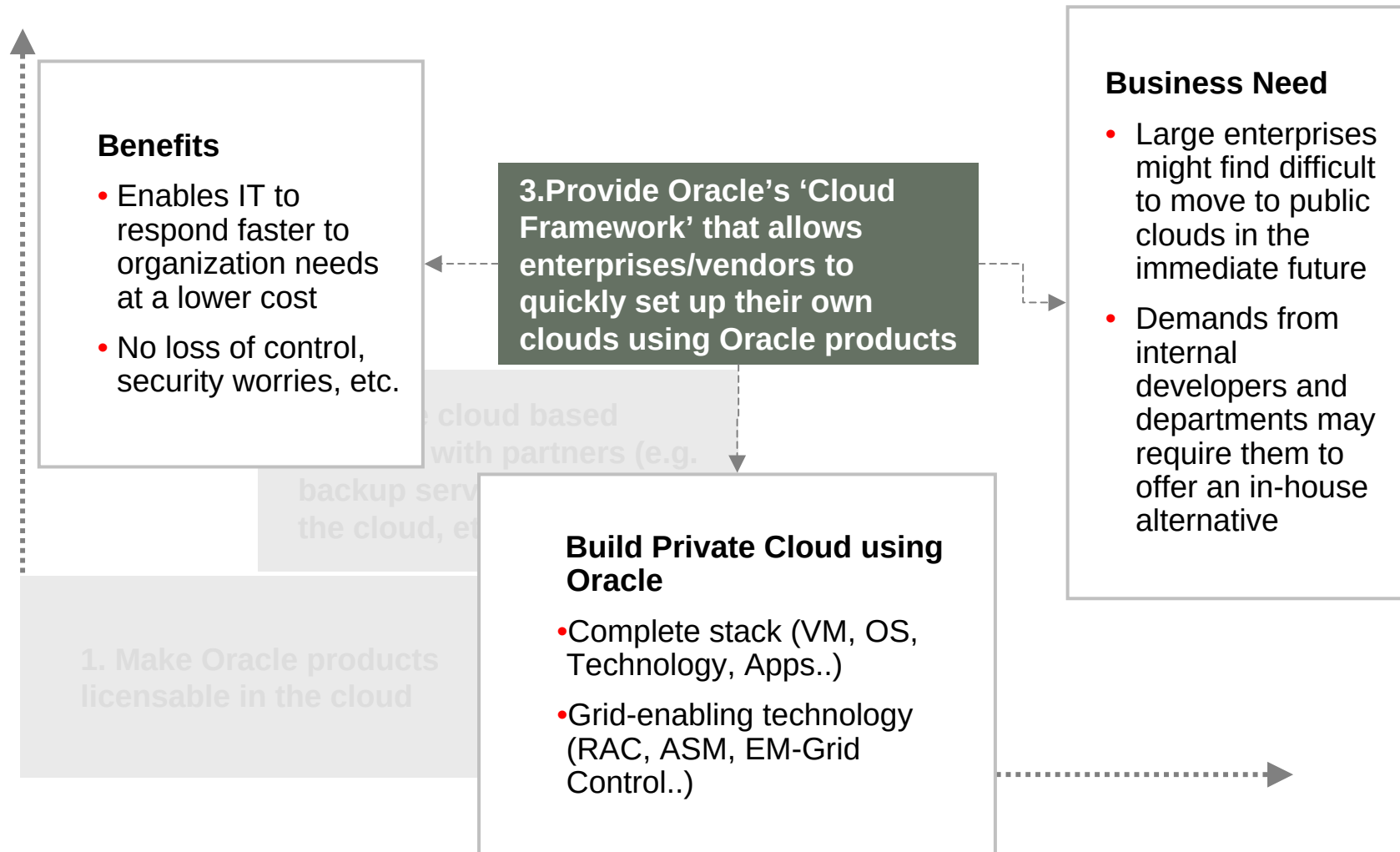
On-premises DB; Compressed Parallel Backups



Oracle Database Backup in the Cloud

DEMONSTRATION

Oracle Cloud Strategy – Enabling (Private, On-Premise) Clouds



Oracle VM

Server Virtualization and Management

- Oracle VM contains...
 - Oracle VM Server
 - Oracle VM Manager
- Oracle VM Server
 - Open source server software tailored by Oracle
 - Installs on “bare-metal” servers from a single CD in about a minute
 - x86 and x86_64 based Intel and AMD Systems
- Oracle VM Manager
 - Web browser-based management console
 - Java-based management server
 - Database repository: XE (incl.), or SE, EE, or RAC



Oracle VM Templates

Rapid Application Deployment

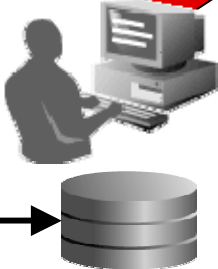
ORACLE E-Delivery

Download from Oracle

- Pre-built, pre-configured VM
- Complete app, middleware, DB installation
- Complete Siebel CRM, Database 11g, Enterprise Manager...

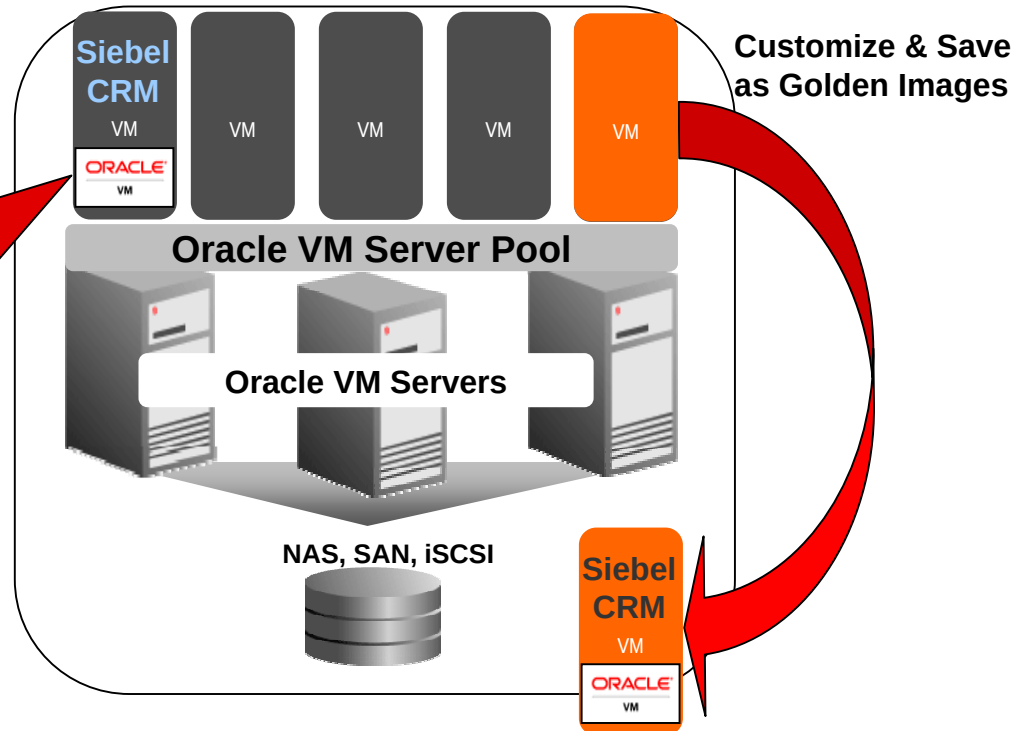


Import to
Oracle VM
Manager



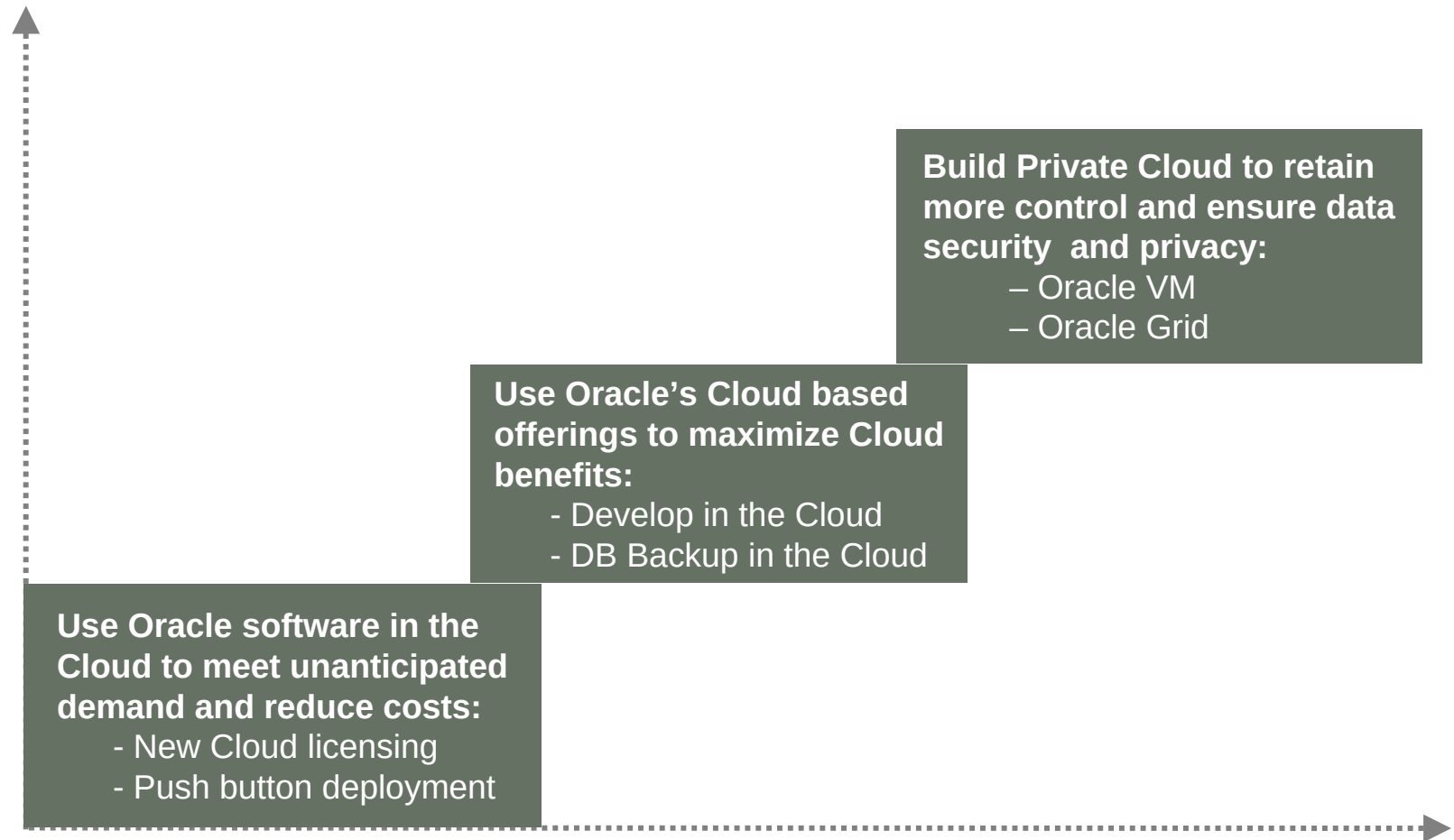
Start-Up in
Oracle VM Pool

Save days or weeks in installation
and configuration time



ORACLE

Enterprise Cloud Computing with Oracle



Additional References

- Oracle Cloud Computing Center (OTN)
 - <http://www.oracle.com/technology/tech/cloud/index.html>
 - Provide feedback and ask questions using the “Cloud Computing Discussion Forum”
- Amazon Web Services Website
 - <http://aws.amazon.com>
- Amazon Web Services Booth in Moscone South DemoGrounds

ORACLE®

Clouded Clinical and Translational Science

Peter J. Tonellato, Ph.D.

Laboratory for Personalized Medicine (LPM)

Center for Biomedical Informatics

Harvard Medical School



Harvard Medical School

Drivers of Personalized Medicine

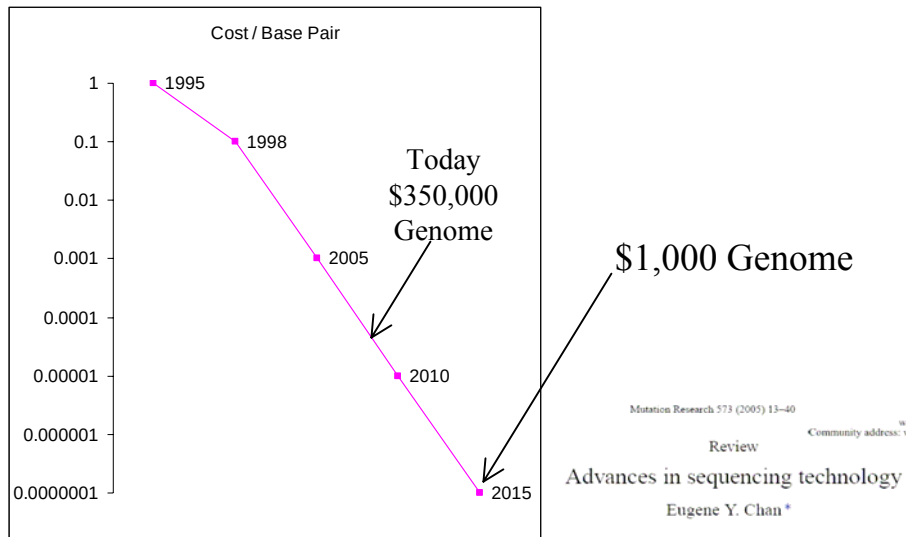
Growth of genomic knowledge

OMIM 2007 Activity

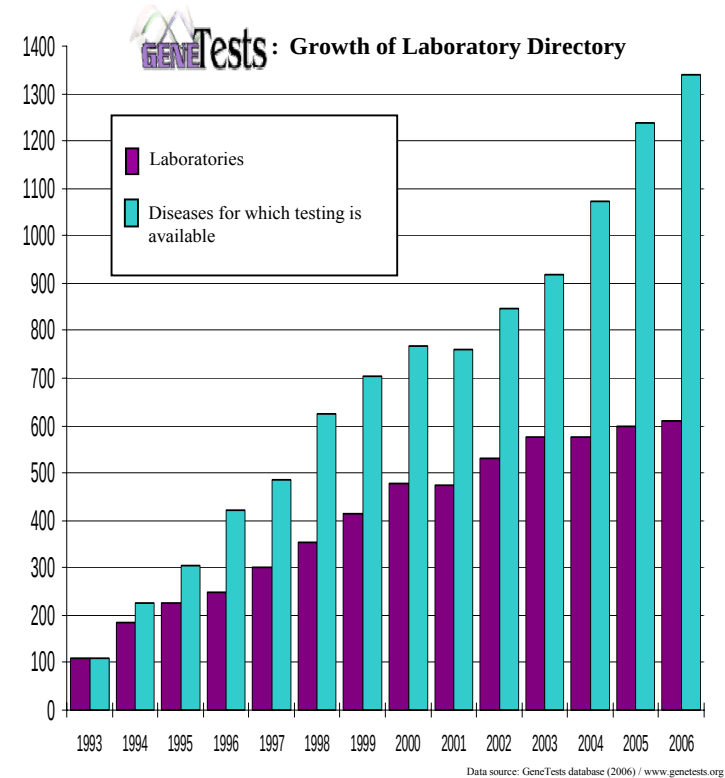
- 1079 New Entries
- 8486 Changed Entries



Decreasing Cost of Sequencing



Development of Tests



Rise of consumer genetic testing

- 23andMe (550K SNPs)
- Navigenics (1.8 MM SNPs)
- decodeMe (~1 MM SNPs)
- Knowme (full 3 billion bp)



Harvard Medical School

Laboratory of Personalized Medicine

CBMI, Harvard Medical School

Established in 2008 to Develop:

- Clinical-genetic mathematical models
- Translational science simulation paradigm and
- Personalized Medicine (PM) Web applications

*and create a facilitated pathway from
genetic discovery to clinical enterprise*



Implementation Platform

Requirements

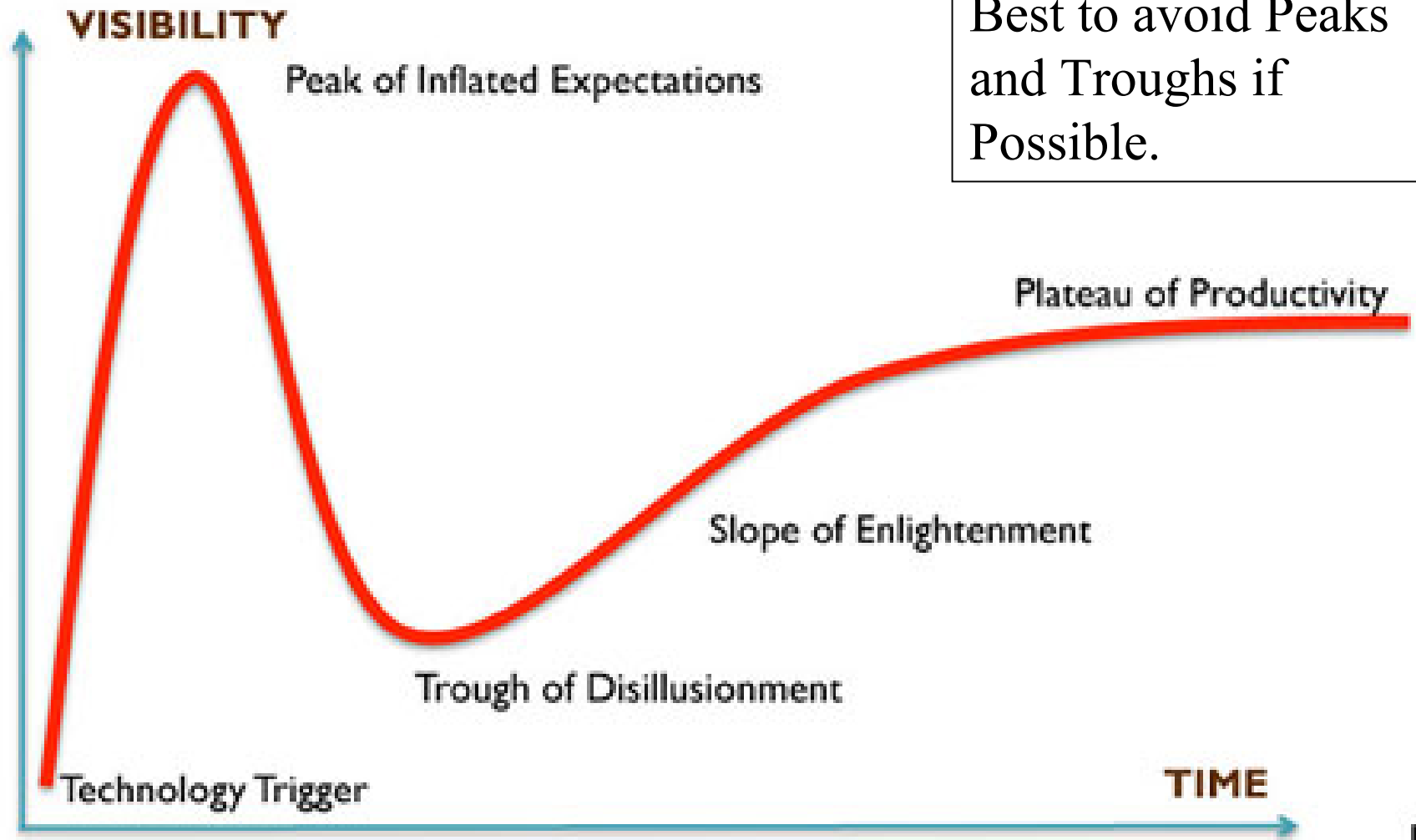
- **Flexible**
- **Extensible**
- **Robust**
- Fast
- Inexpensive

Options

- Dedicated Servers in Lab
- Data Center
- CoLo
- Cloud

Gartner Warnings

Best to avoid Peaks
and Troughs if
Possible.



Oracle in the Cloud

Posted: May 6, 2008 10:43 AM PDT

TimeLine

Here at Oracle, we have been keeping track of the great strides being made by the Amazon Web Services team in enabling a Cloud Computing platform. We are looking to talk with people who are interested in utilizing Oracle technologies within the AWS platform. Please contact me directly at my email address below if you would like to share your thoughts on how Oracle technologies can help your AWS projects or if you are interested in simply sharing your experiences with AWS.

I look forward to hearing from you!

Bill Hodak

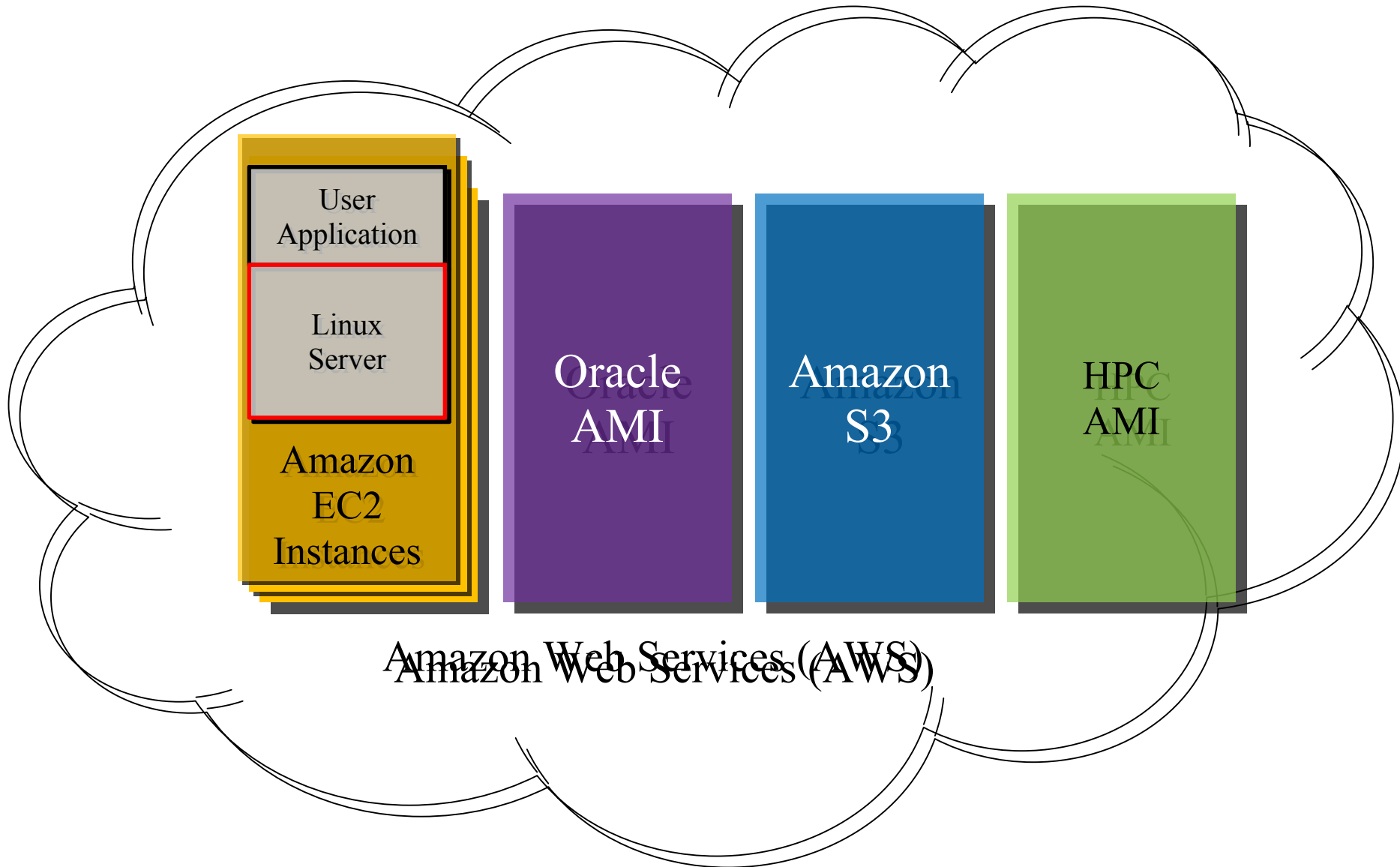
Senior Product Manager - Oracle Corporation

bill.hodak@oracle.com



Harvard Medical School

Fitting the Pieces Together



Amazon Elastic Compute Cloud (Amazon EC2)

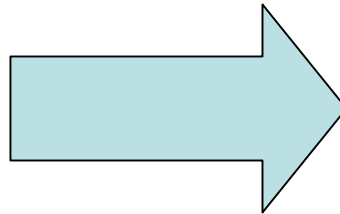
- Resizable compute capacity in the cloud
 - Obtain and boot new server instances in minutes
 - Quickly scale capacity, up or down, as your computing requirements change
- Full root access to a blank Linux machine
- Simple Web service management interface
- Changes the economics of computing

Math Modeling and Simulation

HPC Cloud Service

Simulation as Service Options R Benefits:

- Matlab
- Mathematica
- R
- SAS
- S-PLUS



- Fast computation and statistical analysis
- Large mathematical and statistical library
- Open source
- Highly extensible
- Supportive user community

OpenXava

Business
Components



Controllers



Application Ready for
Production

POJOs + JPA annotations



Warfarin Dosage Simulation - AvatarGroup

Group Id	Group Name	Group Owner	Request Date	Status	# Patients at Risk
21	TestUser	SR	9/16/08	created	1000
22	Test001	PK	9/15/08	done	10
21	Test001	PK	9/15/08	created	1000
15	DenTest00	Den	9/14/08	done	1000
16	DenTest01	Den	9/14/08	done	100
17	DenTest02	Den	9/14/08	done	500
18	DenTest03	Den	9/14/08	done	500
19	DenTest04	Den	9/14/08	done	1000
14	PeterK1000	PK	9/12/08	done	1000
13	DenTest00	Den	9/14/08	done	100

- Deployable on Java Application Server or any Servlet Container, or on a Portal (Liferay, JetSpeed or WebSphere)

“Clouded” Translational Science

- Web application framework is flexible
- Robust technologies
 - Oracle and AWS cloud services in concert with R, OpenXava, Ruby
- Extreme Implementation: LPM team no previous collaboration
- Cloud Service inventory growing rapidly.
 - Subversion - i2b2
 - R/S/Plus
 - Development Platform:
 - OpenXava and dependencies
 - Ruby-on-Rails and dependencies
 - Clinical Trial simulation service,

Posted: May 6, 2008 10:43 AM PDT

TimeLine

From: Tonellato, Peter

Sent: Tuesday, June 24, 2008 12:09 PM

We have successfully launched the personalized medicine translational research platform on AWS. ...

P

Peter J. Tonellato, Ph.D.

Center for Biomedical Informatics

Harvard Medical School

Children's Hospital of Boston

617.432.7185 866.771.2566 (fax)

Footnote:

The team never met together and more than half had never worked together.



Harvard Medical School

Clouded Clinical and Translational Science

Payoff

Warfarin Pharmacogenetic Simulation Service Application

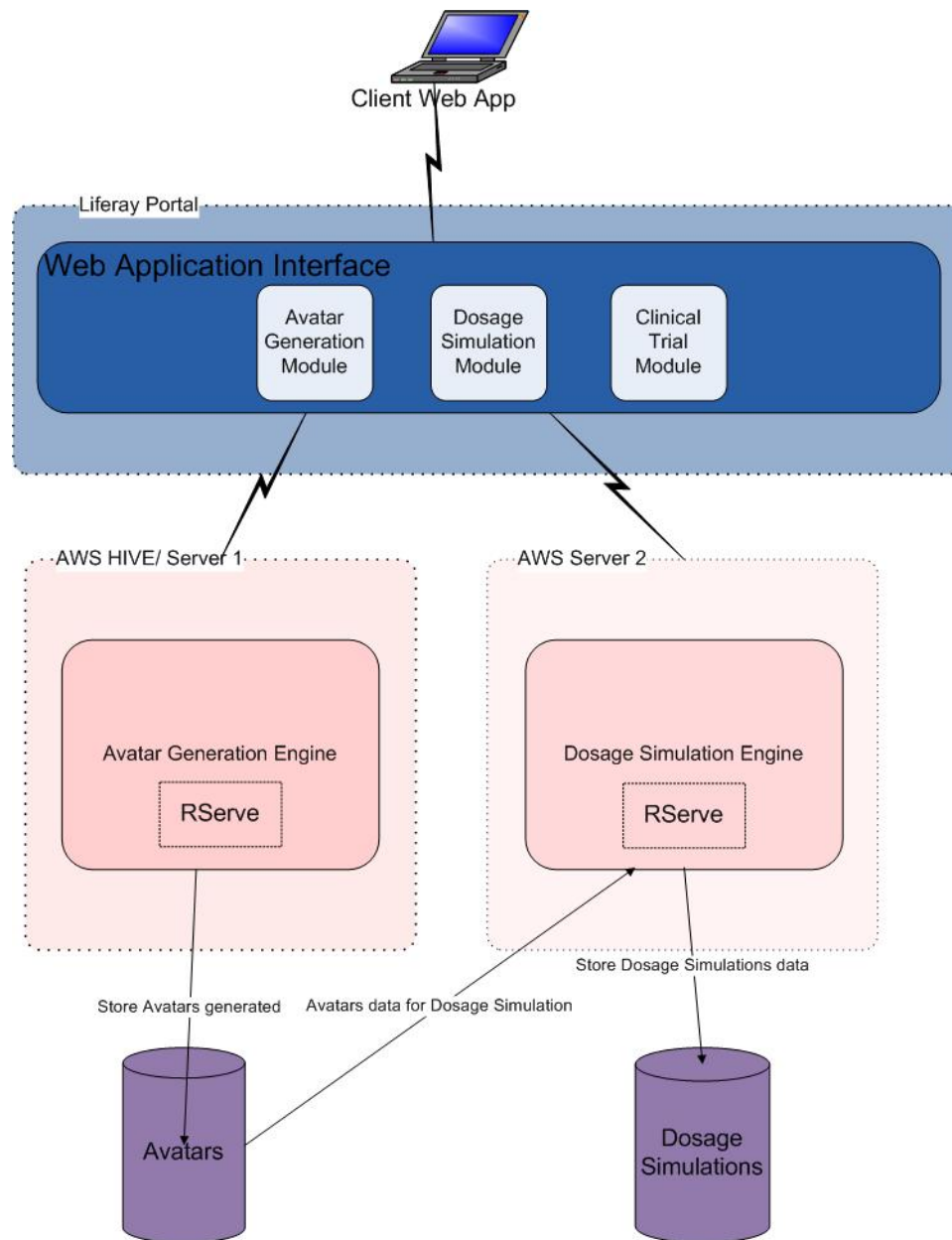
Goals

- Predict dosage to achieve rapid therapeutic dosing
- Create clinical ‘avatar’ patient-base – reflects real data
- Identify patients-types or sub-populations who may experience difficulty achieving therapeutic Warfarin level
- Create flexible and extensible modular framework as the basis for future translational science studies

LPM Warfarin

Web Application

- Use Translational Science Cloud
- Clinical Avatars:
 - Set parameters for avatar generation
 - Execute avatar generation
 - Review Patient-Base
- Warfarin Dosage Predictions
 - Select from Clinical Avatar Patient-Base
 - Execute dosage simulation
 - Analyze results



<http://ec2-75-101-221-79.compute-1.amazonaws.com:8080/web/guest/home>

OpenXava - Laboratory for Personalized Medicine - Mozilla Firefox

File Edit View Go Bookmarks Tools Help

http://ec2-75-101-221-79.compute-1.amazonaws.com:8080/web/guest/home

cbmi
Center for Biomedical Informatics

LPM Warfarin Breast Cancer Forums NextBio Harvard NB

Welcome! ▾

Laboratory for Personalized Medicine

The Laboratory for Personalized Medicine (LPM) is a virtual lab within Harvard Medical School (HMS) currently developing bioinformatics web applications.

Current services include:

- Warfarin drug trial population generation/dosage simulation service
- NextBio interactive life-science search engine
- LPM forum for communication and collaboration

Upcoming additions:

- Breast Cancer prediction/prevention simulation service

Sign In

Login

Password

Remember Me ☐

[Forgot Password?](#)

Warfarin Dosage Simulation - AvatarGroup


[Detail](#) - [List](#)

Group Info

Group Name Group Owner
Request Date Status

[Requirement](#)
[Result](#)
[Avatars](#)

Simulate Dosage

		Age	Gender	Race	CYP2C9 *2	CYP2C9 *3	VKORC1 (-1639)	VKORC1 (1173)	BSA	DVT	Smoker	Target INR	Gage Dose	Anderson Dose
		=	starts	starts	starts	starts	starts	starts	=	starts	starts	=	=	=
☐		25	F	African-American	T/T	A/A	A/A	C/C	1.8	N	Y	2.5	3	6.2
☐		65	M	Native-American	C/T	A/C	G/G	C/T	2.2	N	N	2.5	3.8	2.1
☐		79	F	Asian	T/T	A/A	G/A	C/C	2	N	N	2.5	2.8	4.1
☐		58	M	African-American	C/C	A/A	G/G	C/T	1.8	N	N	2.5	6.2	4.8
☐		52	F	African-American	T/T	A/A	G/G	C/C	1.7	N	N	2.5	4.1	4.7
☐		67	F	African-American	C/T	A/A	G/G	C/C	1.7	N	N	2.5	4.5	4.5
☐		49	F	Asian	C/C	A/C	G/G	T/T	1.8	N	N	2.5	4.5	2.6
☐		41	M	African-American	T/T	A/A	A/A	C/C	1.9	N	N	2.5	2.6	5.8
☐		57	M	Native-American	T/T	A/A	G/G	T/T	2.4	N	N	2.5	5.4	3.3
☐		61	M	Native-American	C/C	C/C	G/G	C/T	1.7	N	N	2.5	2.6	0.9

1 2 3 4 5 6

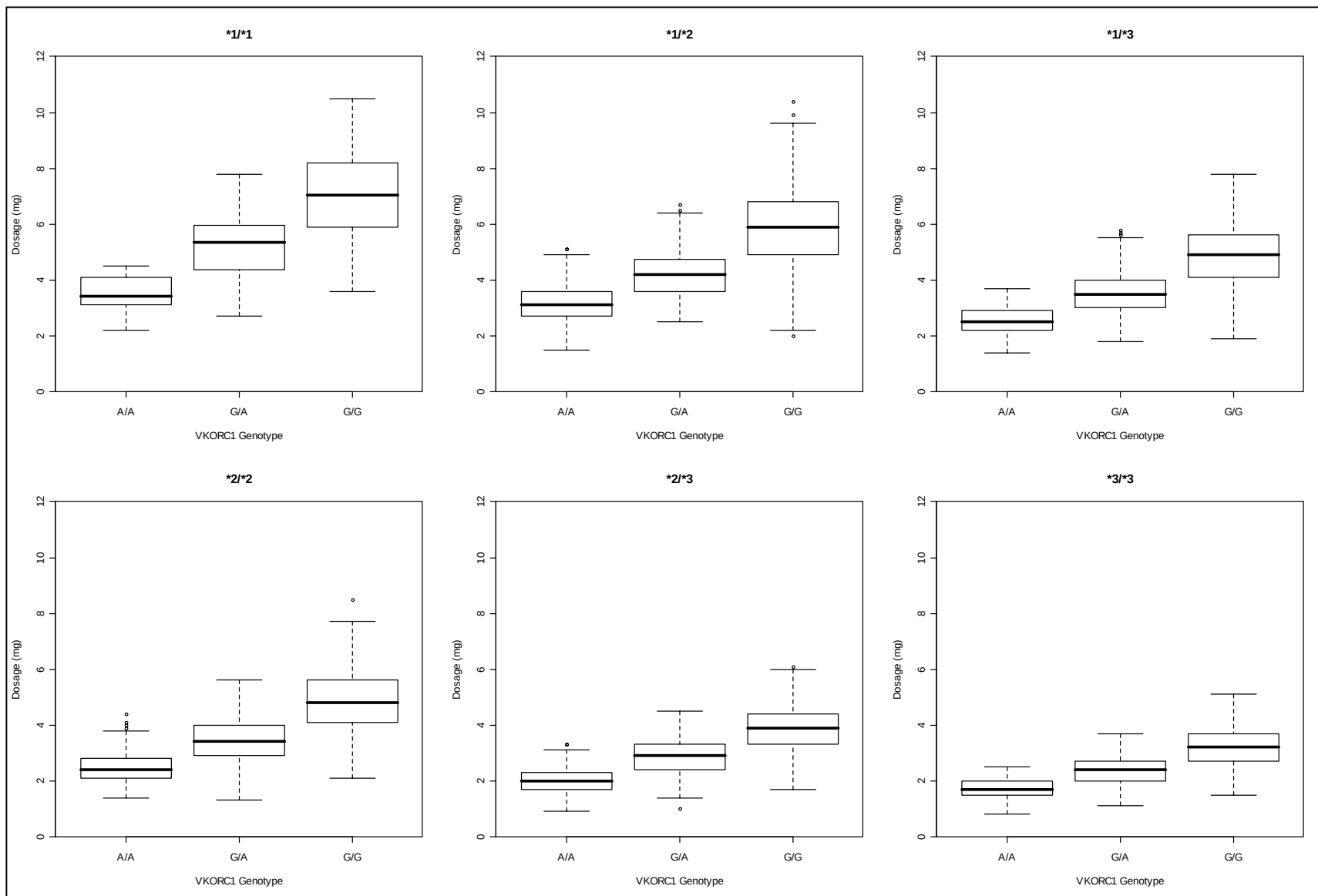
There are 100 objects in list

Gage et. Al ²:

$$\begin{aligned} \text{Dose} = & \exp[0.9751 - 0.3238 \times v(y) + (0.4317 \times \text{BSA}) - 0.4008 \\ & \times c_3(y) - (0.00745 \times \text{age}) - 0.2066 \times c_2(y) + (0.2029 \\ & \times \text{target INR}) - (0.2538 \times \text{amiodarone}) + (0.0922 \times \text{smokes}) \\ & - (0.0901 \times \text{African-American race}) + (0.0664 \times \text{DVT/PE})] \\ & \{ 0 \text{ if VKORC1 -1639 genotype} = \text{G/G} \\ v(y) = & \{ 1 \text{ if VKORC1 -1639 genotype} = \text{G/A} \\ & \{ 2 \text{ if VKORC1 -1639 genotype} = \text{A/A} \\ & \{ 0 \text{ if CYP2C9*2 genotype} = \text{C/C} \\ c_2(y) = & \{ 1 \text{ if CYP2C9*2 genotype} = \text{C/T} \\ & \{ 2 \text{ if CYP2C9*2 genotype} = \text{T/T} \\ & \{ 0 \text{ if CYP2C9*3 genotype} = \text{A/A} \\ c_3(y) = & \{ 1 \text{ if CYP2C9*3 genotype} = \text{A/C} \\ & \{ 2 \text{ if CYP2C9*3 genotype} = \text{C/C} \end{aligned}$$

2. Gage B, Eby C, Johnson J, Deych E, Rieder M, Ridker P, et al. Use of Pharmacogenetic and Clinical Factors to Predict the Therapeutic Dose of Warfarin. Clin.Pharmacol.Ther. 2008 Feb 27.

Variation of CYP2C9 Genotype (Gage Model)



Warfarin Sensitivity Index

Dosage (Gage) vs. Warfarin Sensitivity Index



Current Results

- LPM Warfarin Web App Completed in two months
- 100 Million clinical avatar and dosing simulations
- Translational Science paradigm supports clinical trial simulation, incidentalome testing, and leads to new metrics for clinical efficacy
- New Metrics for Clinical Efficacy e.g. Warfarin ‘Sensitive’ Participants

We have demonstrated the value and flexibility of Cloud Services and Framework for future projects.

Next Steps

- More Personalized Medicine Applications:
 - Risk to Cancer
 - Tumor Typing
 - Pharmacogenetics
- Work with Oracle and Amazon to create/test robust HPC services
- Create “best practice” Biomedical Science Cloud Service
- Identify additional collaborators and applications

Collaborators

- Sushil Kuman, William Hodak and team
- Terry Wise and AWS group
- Harvard Medical School
 - I2b2 - NIH Center for biomedical informatics
 - CTSC – NIH Clinical and Translational Research Center
- Partners HealthCare
- Harvard-Partners Center for Genomics and Genetics



Acknowledgements

Laboratory for Personalized Medicine

Peter J. Tonellato, Ph.D.

- Prasad Patil
- Peter Kos
- Zhitao Wang
- Dan Chen
- Haiping Xia
- Stephanie Tauber
- Sumana Ramayanam

Partners HealthCare

- Mollie Ullman-Cullere