Software defined infrastructure for hyperscale Data processing and HPC

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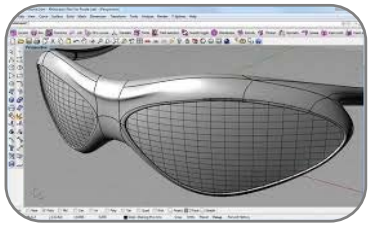
Cloud Infrastructure Enables New Usages

Cloud 2015
Digital Services Economy

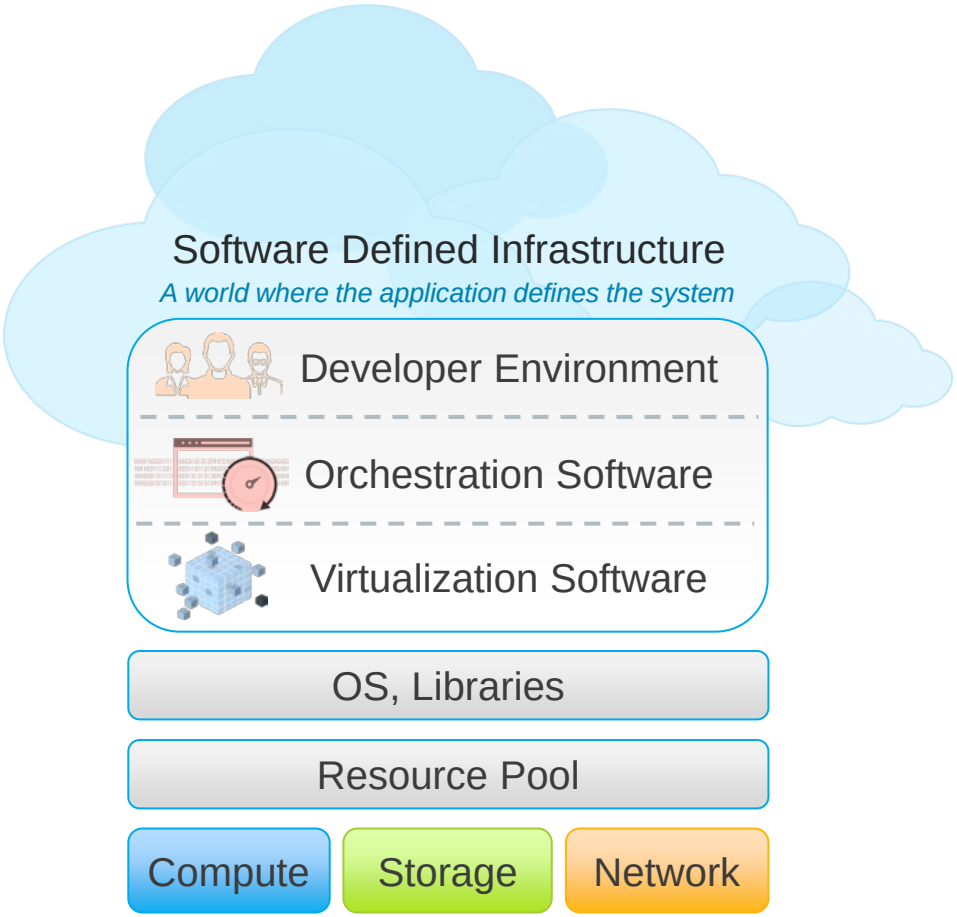
75% of[1] current cloud demand comes from consumer services

Cloud 2020
IoT, Big Data, and Enterprise



By 2020, 65-85%[2] of apps will be delivered via cloud infrastructure

But… Cloud Technology is Too Complex



Merging Technology Paths

- Enterprises seeking Cloud Native Apps
- Hyperscale Providers expanding into traditional workloads

Fragmented Cloud Ecosystem

- Growing Cloud ecosystem
- Limited out of the box solutions

Industry Is Not Moving Fast Enough

	Hyperscale	Fast Followers	Broad Enterprise
			
GOAL	Deliver the best performance / TCO	Deliver differentiated services at hyperscale economics	Enable business innovation through the cloud
CHALLENGE	Continuous workload optimization Volatility of demand	Difficult to achieve high efficiency and scale Fragmented cloud stacks with significant feature gaps	Proprietary solutions can be costly to deploy Open source stacks are complex and lack enterprise features

Ultimate Need for Simple and Effective Cloud Infrastructure

Hyperscale

Deliver the best performance / TCO

Fast Followers

Deliver differentiated services at hyperscale economics

Broad Enterprise

Enable business innovation through the cloud

INTEL STRATEGY:

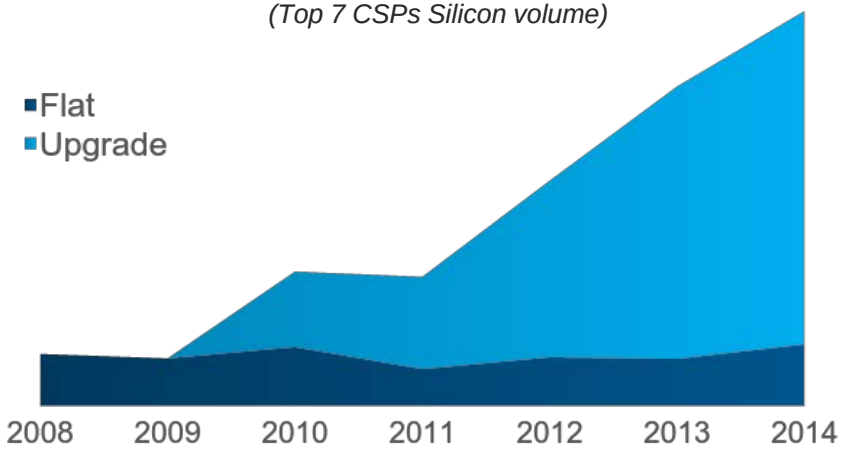
1. **Optimize cloud infrastructure across a full range of workloads**
2. **Improve Software Defined Infrastructure efficiency and ease deployment**
3. **Collaborate with industry leaders**

1 Optimize Cloud Infrastructure across a range of workloads

Optimizing to take full advantage of hardware capabilities

Intel Xeon processor trends

(Top 7 CSPs Silicon volume)



Microsoft Azure-G

amazon web services C4, M4

Shipping custom Si to all hyperscale CSPs

intel inside XEON ALTERA

2x+ performance on programmable algorithms

Early adoption of high performance components

Up to 50% cost reduction in service delivery

Make SDI efficient and easier to deploy

2

What's next

Accelerating technology maturity

- Enterprise ready: reliability features, installation, and operations
- Scale to thousands of nodes
- Intelligent automation and orchestration

Exposing underlying hardware technology

- Support for Xeon, Xeon Phi, SoCs, …
- Workload specific accelerators (eg: FPGA)
- Expose platform telemetry
- Hardware-enabled security

Reduce infrastructure deployment time from weeks to hours

Align the industry

3

Reference Architectures

vmware® REDAPT

redhat TECTONIC by CoreOS

Open Solutions and Industry Standards

openstack CLOUD SOFTWARE

Open Container Project

CLOUD FOUNDRY™

Clear Linux Project

Rackscale Architecture

Routes to market

Cloud SW → OEMs → VARs

Enable thousands of new cloud deployments

Making Cloud Simple & Efficient WILL Accelerate USE

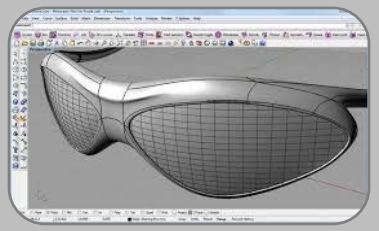
Intel Strategy

1. **Optimize cloud infrastructure across a full range of workloads**
2. **Make SDI efficient and easier to deploy**
3. **Align the industry**

- Up to 50%[1] savings in relative cost per VM instance
- Reduce infrastructure setup time from weeks to hours[2]
- Enable thousands of new cloud deployments

Emerging Cloud Usages 4






Different Workloads - Two Large-Scale Systems

Modern supercomputer

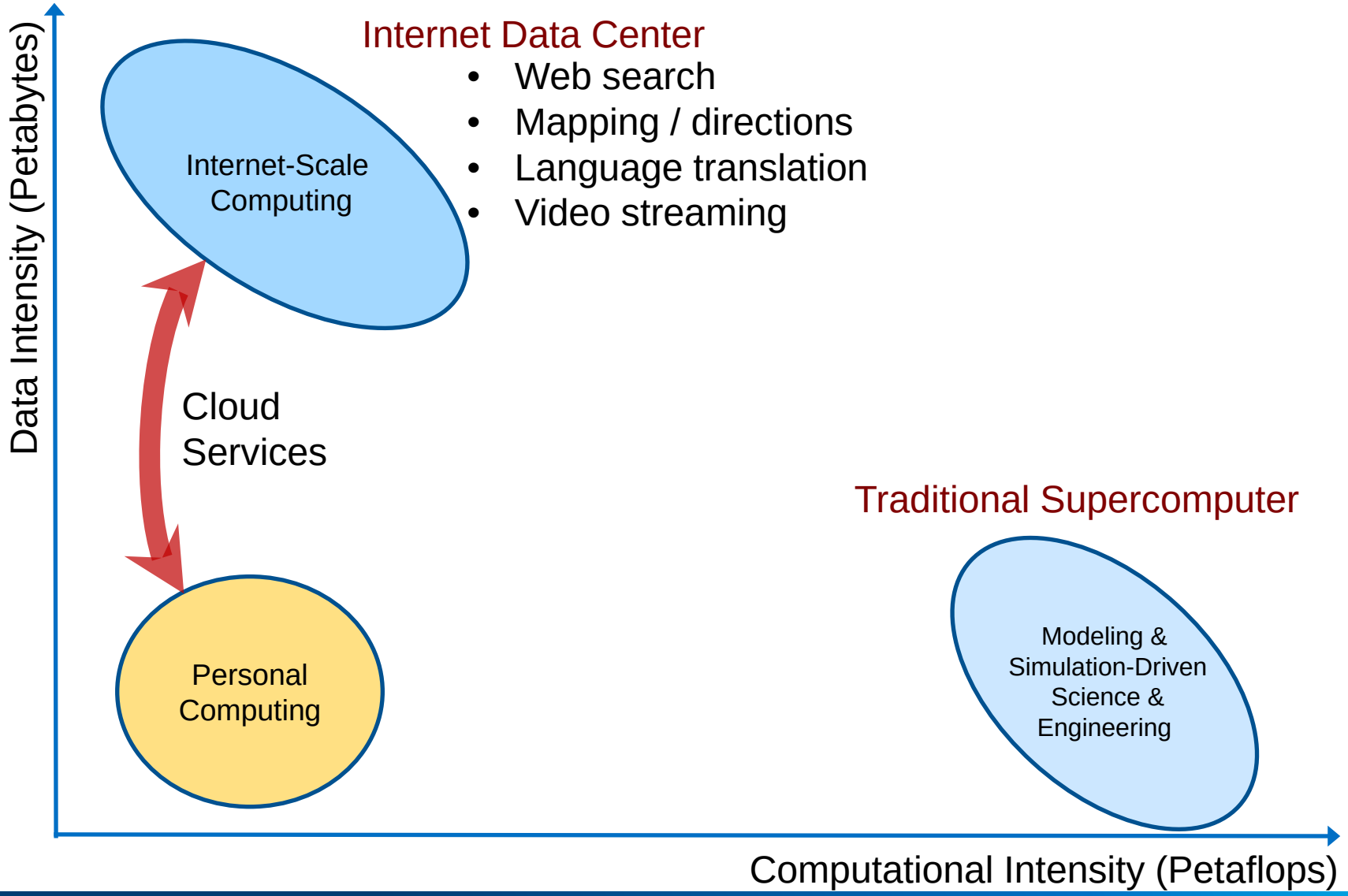
- Run programs in hours or days that would require decades or centuries on normal machine
- Designed for numerically-intensive applications

Internet Data Center

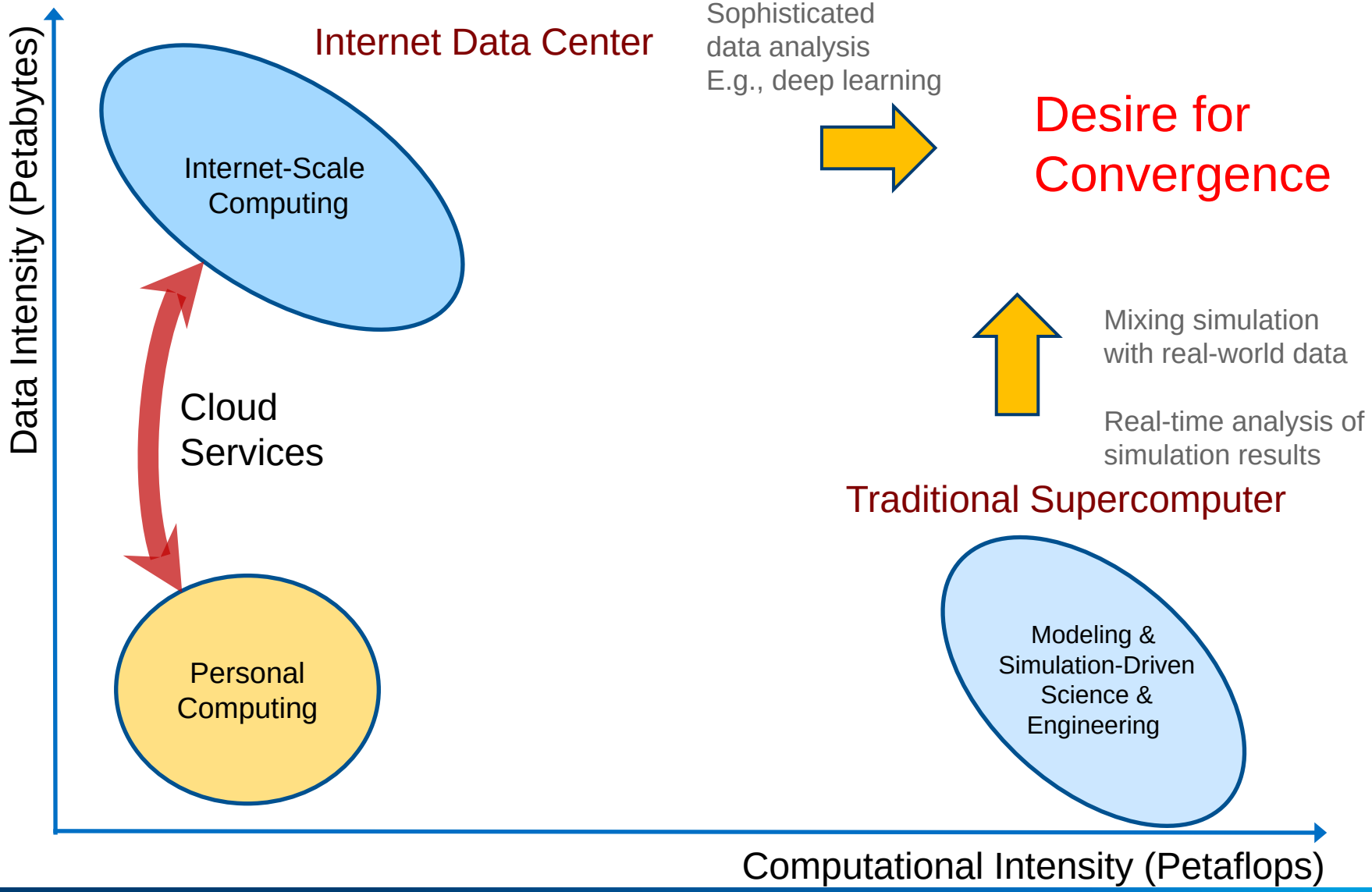
- Support millions of customers
  - Mostly small transactions
  - …and large-scale analytics
- Designed for data collection, storage, and analysis

NCSI August, 2015

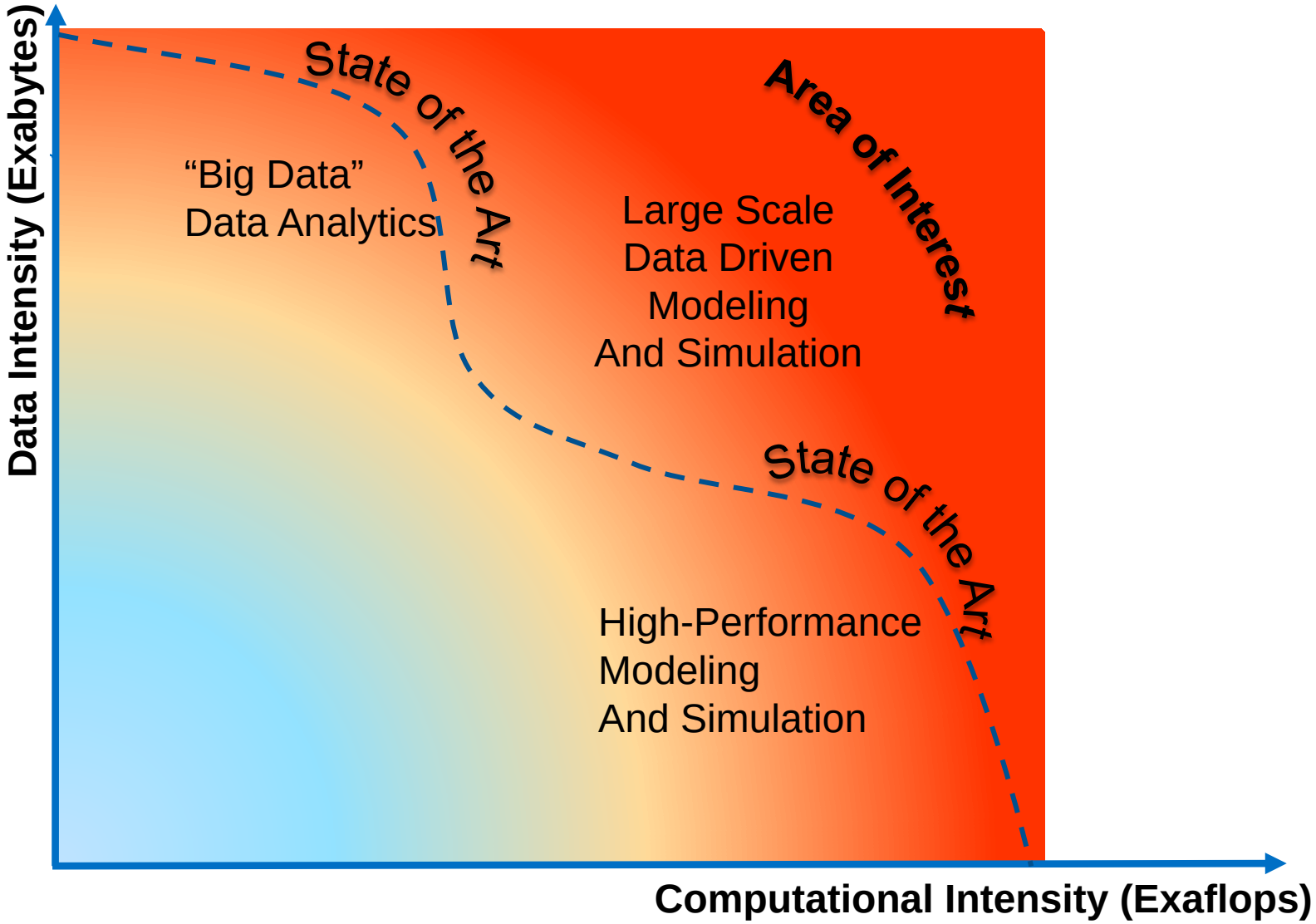
Computing Landscape



Computing Landscape



Aspirations for Convergence



NCSI, 2015

Observations

Cannot Measure a Machine by Single Benchmark

- Top500 benchmark: Perform Gaussian elimination of dense matrix
- Not representative of real-world applications

Cannot Measure a Country's HPC Capabilities by Its Biggest Machine

- Want diversity (size and design) of machines
  - Encourages use and innovation
- Want them widely deployed
- Want well-developed software infrastructure
- Want machines to be running useful applications across many disciplines
- Want research program to ensure continued progress

NCSI, 2015

Modern Supercomputer Programming

System Level

- Message-Passing Interface (MPI) supports node computation, synchronization and communication

Node Level

- OpenMP supports thread-level operation of node CPU
- Exploiting large vectors (SIMD) Xeon Phi and CUDA programming environment for GPUs
  - Performance degrades quickly if don't have perfect balance among memories and processors

Result

- Single program is complex combination of multiple programming paradigms
- Tend to optimize for specific hardware configuration

"As the performance of HPC machines approaches infinity, the number of people who program them is a approaching zero."

— Dan Reed

NCSI, 2015

Supercomputer Programming Model

- Program on top of bare hardware

Performance

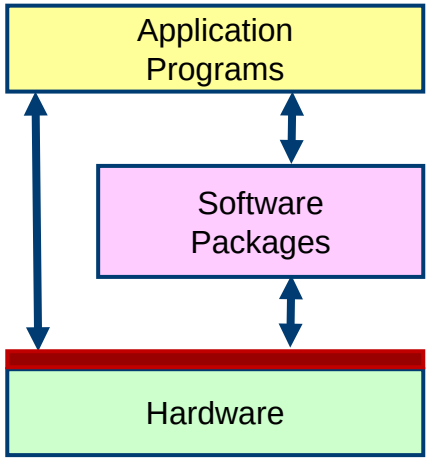
- Low-level programming to maximize node performance
- Keep everything globally synchronized and balanced

Reliability

- Single failure causes major delay
- Engineer hardware to minimize failures

Drawbacks

- Application development requires resources and expertise
- Hard to port applications between systems
- Low degree of software reuse



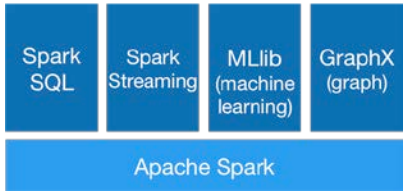
NCSI, 2015

Example Cluster Programming Systems

Hadoop

- Parallel file system aggregating disk drives across cluster
- Map/Reduce programming model providing data parallel programming abstraction

Spark Project



- at U.C., Berkeley
- Grown to have large open source community

GraphLab

- Environment for describing machine-learning algorithms
  - Sparse matrix structure described by graph
  - Computation proceeds by updating node values asynchronously

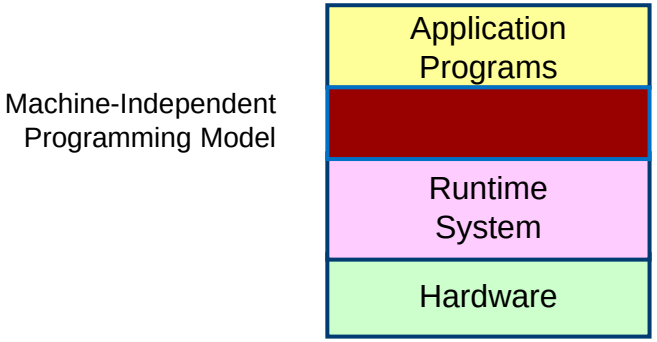
NCSI, 2015

Cluster Programming Model

- Application programs written in terms of high-level operations on data
- Runtime system controls scheduling, load balancing, fault tolerance

Performance Challenges

- Centralized scheduler forms bottleneck
- Copying to/from disk very costly
  - vs. memory-resident computation
- Hard to limit data movement
  - Significant performance factor



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Application Developer's Dream

Develop application based on well-defined abstractions

- Computation
- Data organization
- Resource allocation
- Fault tolerance

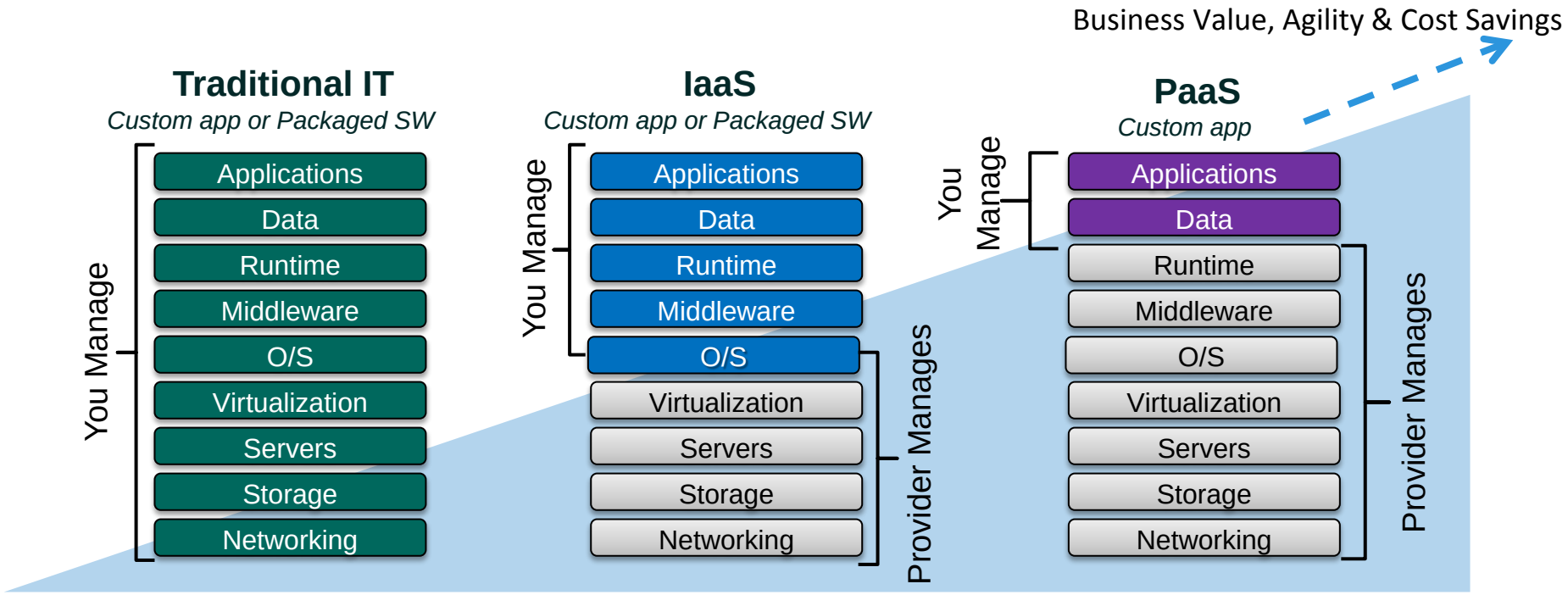
Libraries, compilers, autotuners take care of machine-specific mappings

- Performance comparable to what can be obtained by hand tuning

Rich collection of domain-independent and domain-specific software modules

- Enable sharing and reuse of software

Let Some Dreams Come True - PaaS

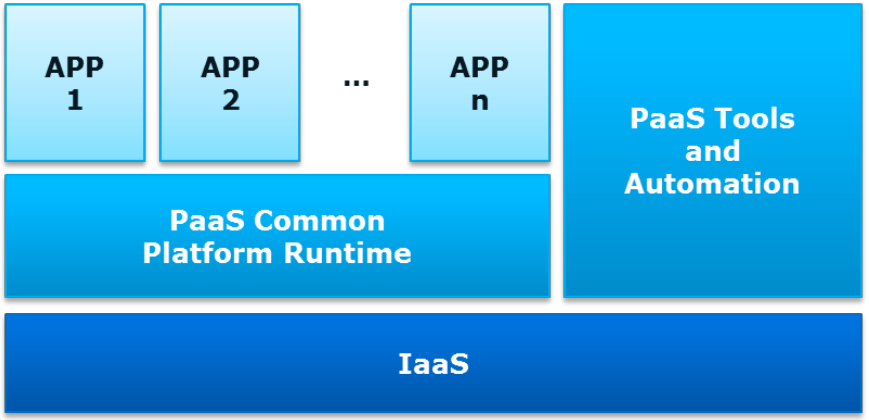


PaaS enables developers to use self-service to build, deploy and manage their custom apps

Why PaaS?

Developers code their app & deploy into production without IT assistance

- Cloud tooling: self-service, on-demand, multi-tenant, metered
- Pre-provisioned common platform of abstracted middleware & infrastructure



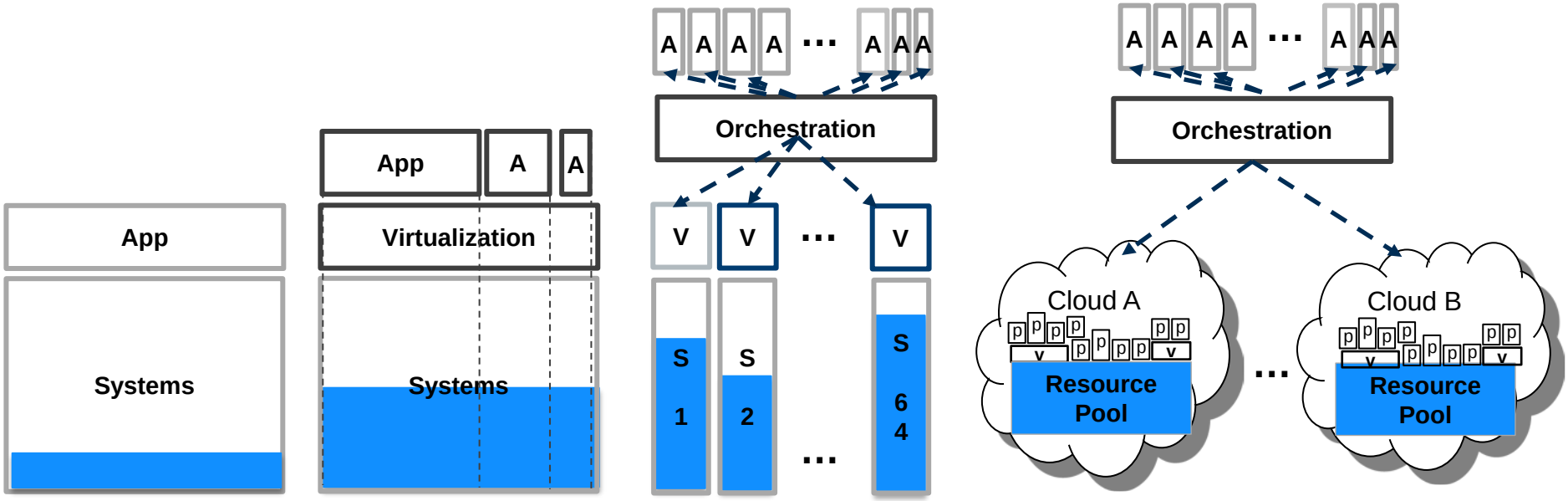
Facilitates creation of cloud-ready applications

- Platform provides runtime container, elastic scaling and high availability
- Maximize resource sharing via multi-tenancy and reusable web services

Speed to market and reduced SW delivery risk

- Reduced time to deploy a new app from 6 months to minutes
- PaaS helps accelerate innovation improving margin vs. reducing cost (IaaS)

Computing Progression for SDI



1. Multi-tenant
2. Rapid elasticity
3. Self-service
4. Measured services
5. Resource pooling

1. Highly optimized
2. Highly efficient
3. Managed cross-cloud
4. Heterogeneous

*Note: not all clouds require virtualization

Multiple computing models will persist for foreseeable future

Go Application Development Platform

Build applications for Distributed, Concurrent & Cloud Computing Applications

Key features

- Statically typed, g
  support at langua
- Support for concu
  and faster compila
- Productivity of a d
- Multiplatform, Por

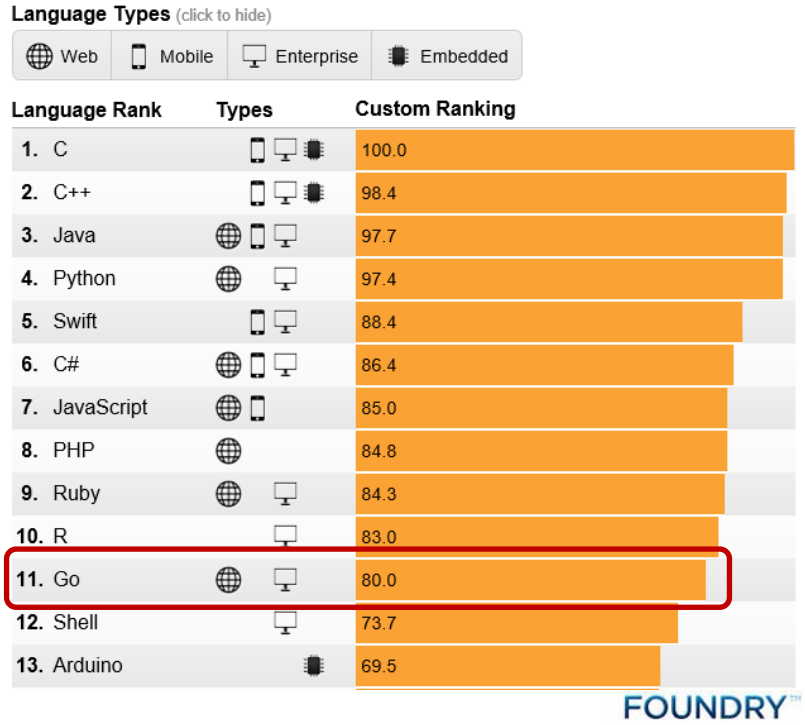
Appeals to..

- SDI domain
- Python & Ruby de
  performance
- C programmers th
  productivity

Challenges

community

upport



kubernetes

CoreOS

SOUNDCLOUD

Call to action!

- Enhance local contribution to Go and PaaS (e.g. CloudFoundry)
- Research the different cloud models – fun and profitable (maybe)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