John Roese

Decade of Change

D✕LLEMC

Change: S&P 500 change

Since 2000, 52 percent of the names on the Fortune 500 list are gone

S&P 500 (2002-2012)

S&P 500 (2012 – PRESENT)

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Change: new IT imperatives

PREDICTIVELY
SPOT NEW
OPPORTUNITIES

DELIVER
PERSONAL
EXPERIENCES

INNOVATE
IN AN
AGILE WAY

OPERATE IN
REAL-TIME
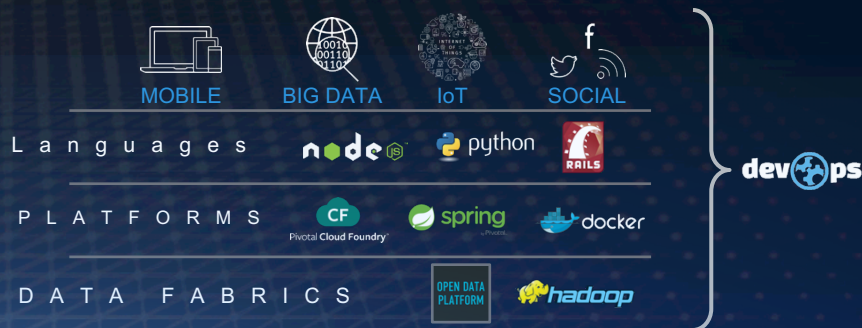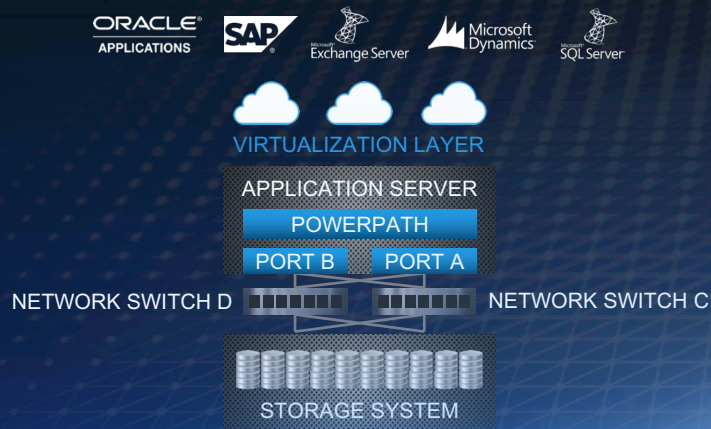
DEMONSTRATE
TRANSPARENCY
AND TRUST

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Change: IT technology

ORACLE APPLICATIONS • SAP • Microsoft Exchange Server • Microsoft Dynamics • Microsoft SQL Server

VIRTUALIZATION LAYER

APPLICATION SERVER

POWERPATH

PORT B • PORT A

NETWORK SWITCH D • NETWORK SWITCH C

STORAGE SYSTEM

MOBILE • BIG DATA • IoT • SOCIAL

Languages — node js • python • RAILS

PLATFORMS — CF Pivotal Cloud Foundry • spring • docker

DATA FABRICS — OPEN DATA PLATFORM • hadoop

dev ps

PRIVATE CLOUD

HYBRID CLOUD

AGILE
SECURE
SIMPLE

PUBLIC CLOUD

virtustream

DATA PROTECTION • PROTECTPOINT • CONTROLLER SOFTWARE • ViPR SRM

EMC² + vmware

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Change or else

UBER 'ed

TESLA 'ed

amazon 'ed

NETFLIX 'ed

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Full Stack
Recommendations

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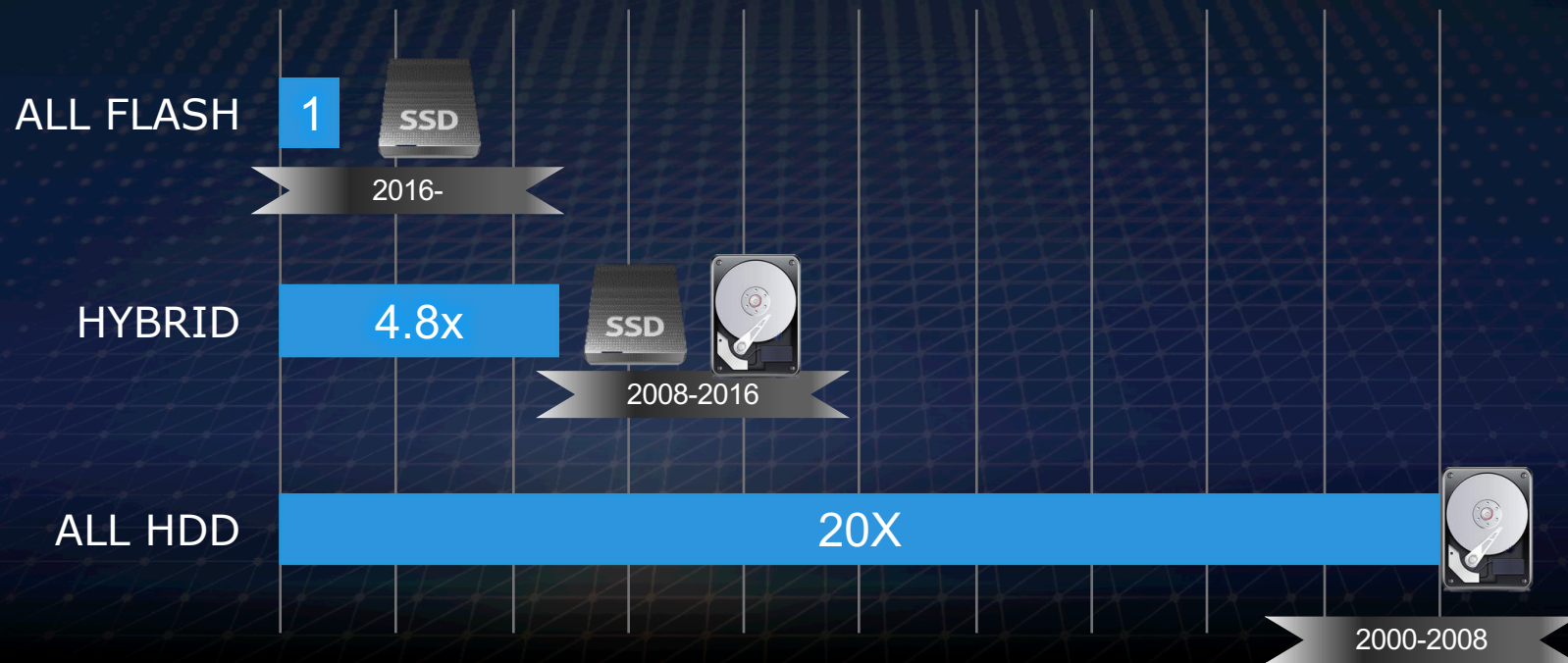
Fundamental economics shift to flash
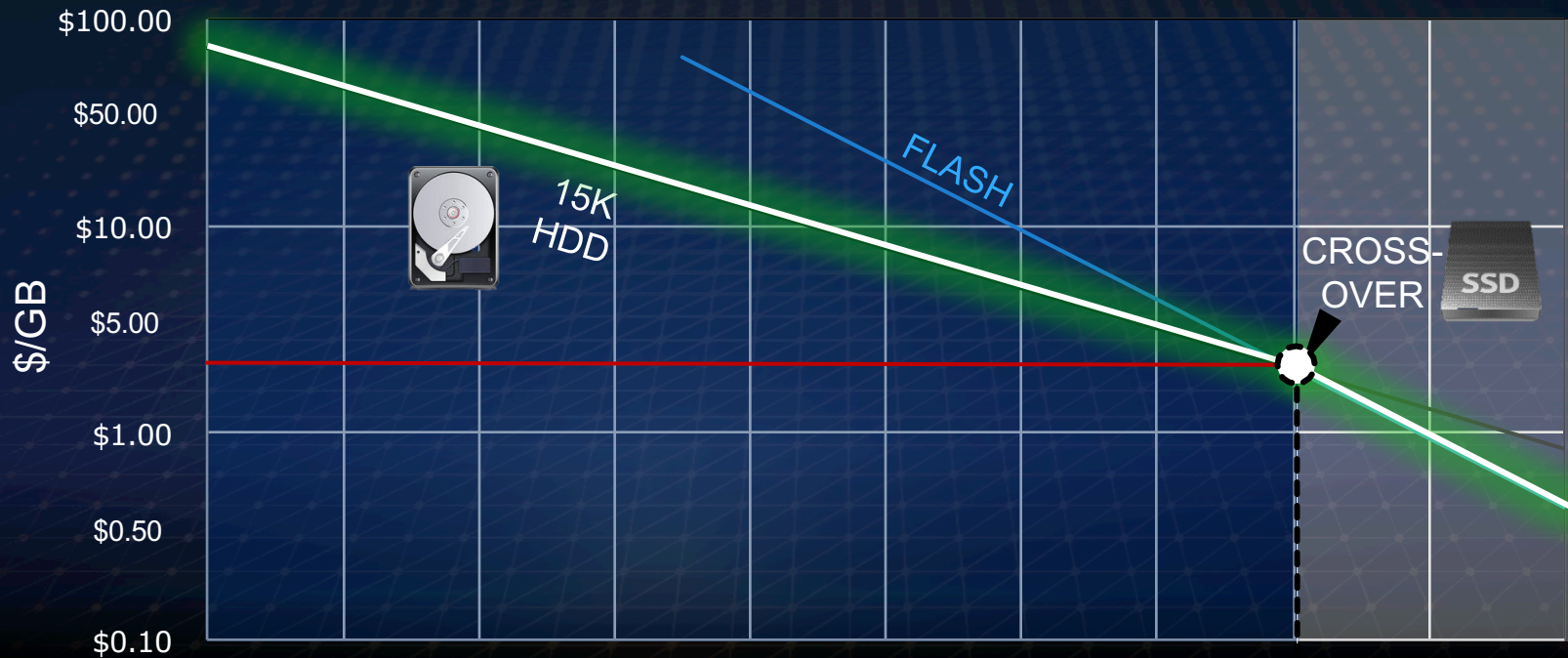
Source: EMC Market Research 2016

Organization
Applications
Processing - Cloud
Data

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2016

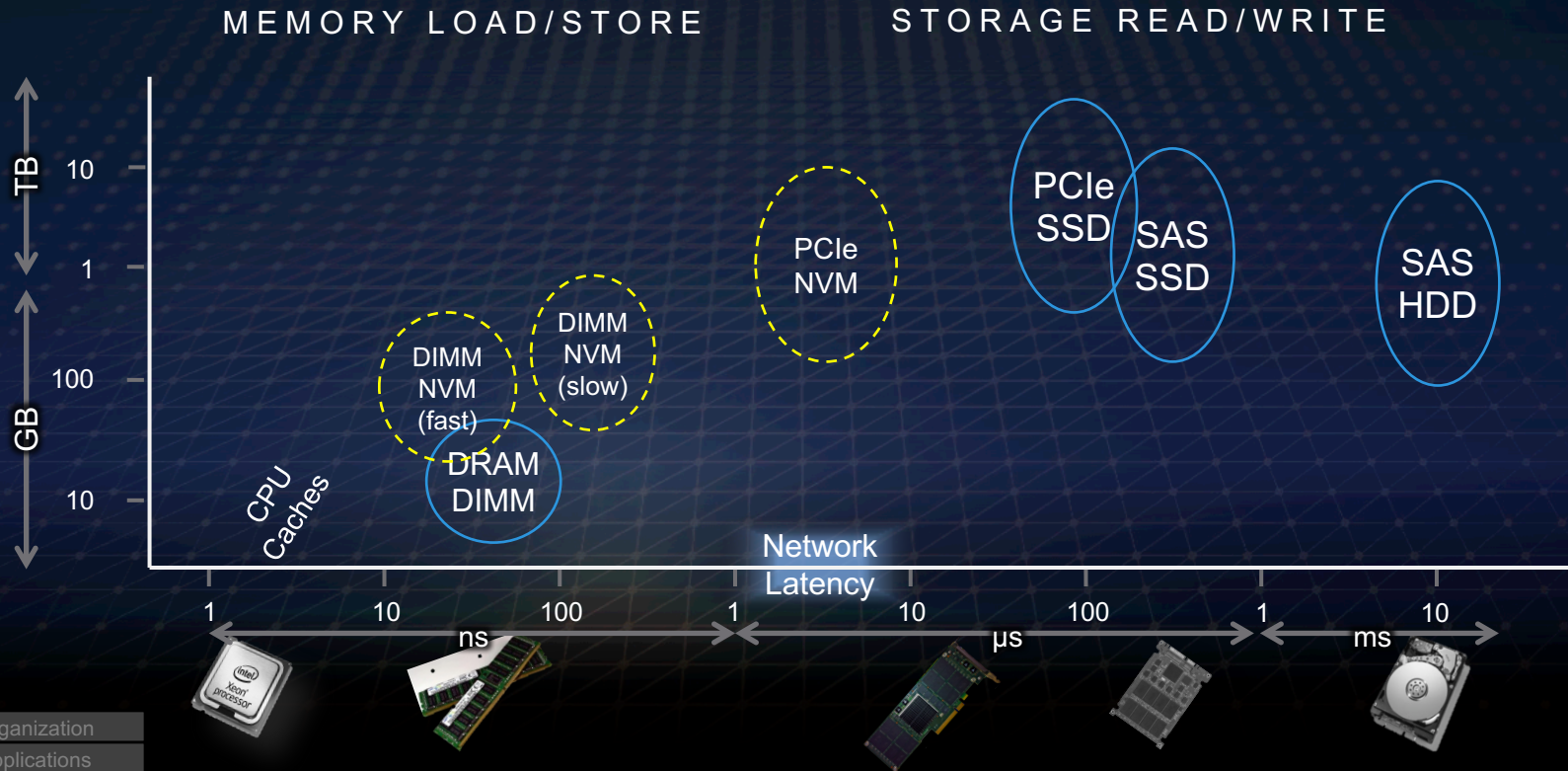# THE YEAR OF
ALL FLASH

FOR PRIMARY STORAGE

Organization
Applications
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Data

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Memory/storage hierarchy convergence

Persistent data media technologies

NAND
- Samsung, Toshiba/SanDisk, Intel/Micron, SK Hynix
- Transitioning from 2D to 3D, enables 5+ years of capacity & $/GB scaling

MRAM
- Magnetic field based: Spin Transfer Torque (STT)
- Avalanche, Toshiba/SK Hynix, Everspin, Crocus, IBM, Samsung

3DXP
- Resistance based phase change (PCM-like)
- Intel/Micron - the basis of "3D CrossPoint", SK Hynix

RRAM
- Resistance based metal ion bridging: Memristor, CB-RAM
- HP, Crossbar, Micron, Adesto, SK Hynix

NRAM
- Carbon nanotube mesh based
- Nantero, IBM

DRAM
- Samsung, Micron, SK Hynix
- Density NOT keeping up with Moore's Law

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Storage media industry roadmap

MEDIA		NAND	RRAM	3DXP*	STT-MRAM	NRAM	DRAM
read latency		10,000s ns	100s ns	100s ns	10s ns	10s ns	10s ns
R:W perf		20:1	1:1	2:1	1:1	1:1	1:1
write bandwidth		~10s MB/s	~100s MB/s	~100s MB/s	~1000s MB/s	~1000s MB/s	~1000s MB/s
retention		weeks	years	months	weeks	years	none
access granularity		block	byte	byte	byte	byte	byte
endurance		10^{4-5}	10^5	10^{6+}	unlimited	unlimited	unlimited
MLC capable?		✔	yes	Yes	yes	✔^{n}	✘
3D capable?		✔	yes	yes	no	yes	no
2017 (raw est)	density	512Gb^m @50^3					16Gb @16
	cost	<$0.25/GB					$3.00/GB

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Near term storage media roadmap

MEDIA	NAND	RRAM	3DXP*	STT-MRAM	NRAM	DRAM
read latency	10,000s ns	100s ns	100s ns	10s ns	10s ns	10s ns
R:W perf	20:1	1:1	2:1	1:1	1:1	1:1
write bandwidth	~10s MB/s	~100s MB/s	~100s MB/s	~1000s MB/s	~1000s MB/s	~1000s MB/s
retention	weeks	years	months	weeks	years	none
access granularity	block	byte	byte	byte	byte	byte
endurance	$10^{4\text{-}5}$	10^5	10^{6+}	unlimited	unlimited	unlimited
MLC capable?	✔	yes	Yes	yes	✔^{n}	✘
3D capable?	✔	yes	yes	no	yes	no
2017 (raw est) — density	$512Gb^m$ @50^3					16Gb @16
2017 (raw est) — cost	<$0.25/GB					$3.00/GB

vs NAND:
- Faster performance
- Better endurance

vs DRAM:
- Bigger, cheaper
- Persistent
- Slower

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Medium term storage media roadmap

MEDIA	NAND	RRAM	3DXP*	STT-MRAM	NRAM	DRAM
read latency	10,000s ns	100s ns	100s ns	10s ns	10s ns	10s ns
R:W perf	20:1	1:1	2:1	1:1	1:1	1:1
write bandwidth	~10s MB/s	~100s MB/s	~100s MB/s	~1000s MB/s	~1000s MB/s	~1000s MB/s
retention	weeks	years	months	weeks	years	none
access granularity	block	byte	byte	byte	byte	byte
endurance	10^{4-5}	10^5	10^{6+}	unlimited	unlimited	unlimited
MLC capable?	✔	yes	Yes	yes	✔^{n}	✘
3D capable?	✔	yes	yes	no	yes	no
2017 (raw est) — density	$512Gb^m$ @50^3					16Gb @16
2017 (raw est) — cost	<$0.25/GB					$3.00/GB

vs NAND:
- Best performance
- Best endurance
- Best retention

vs DRAM:
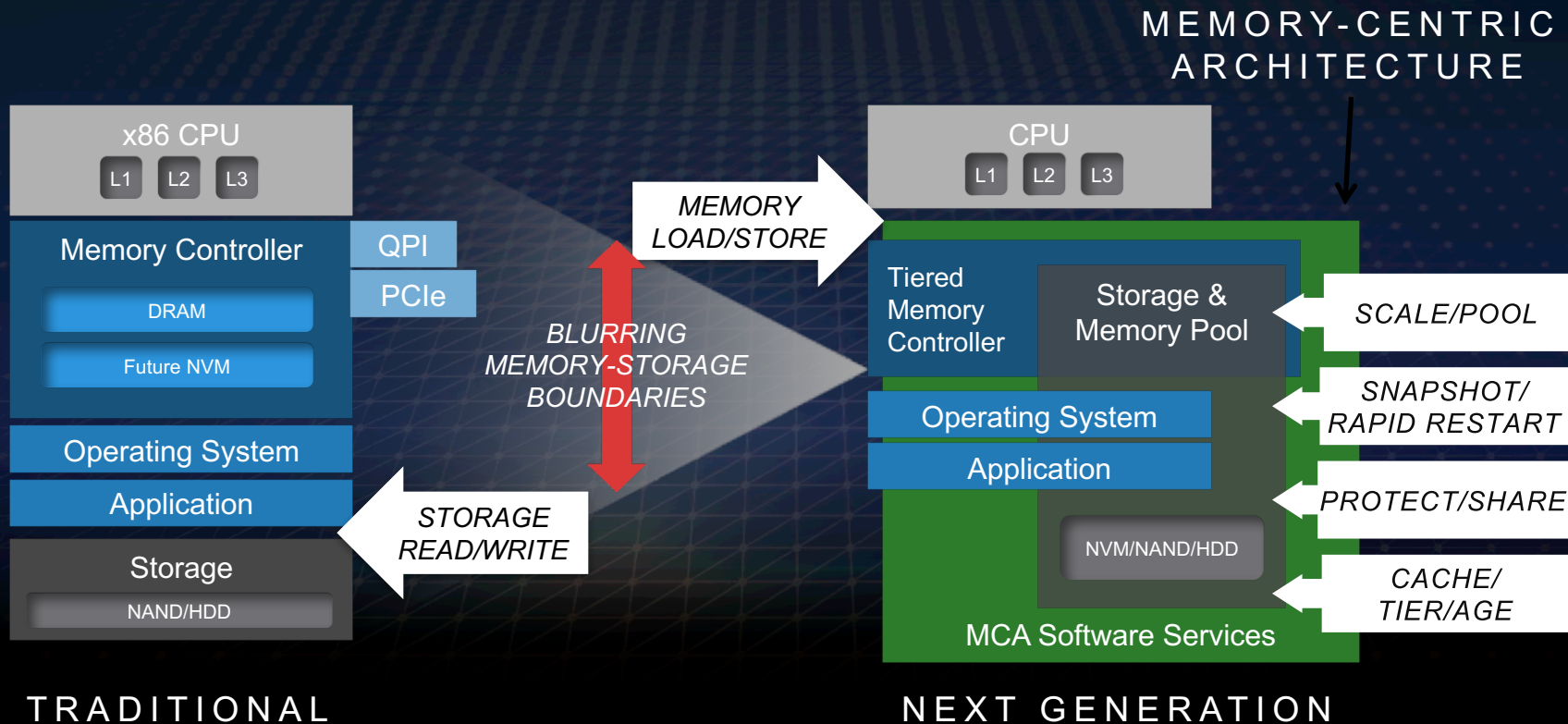- Bigger, faster
- Persistent
- Similar cost

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Blurring the memory/storage boundary
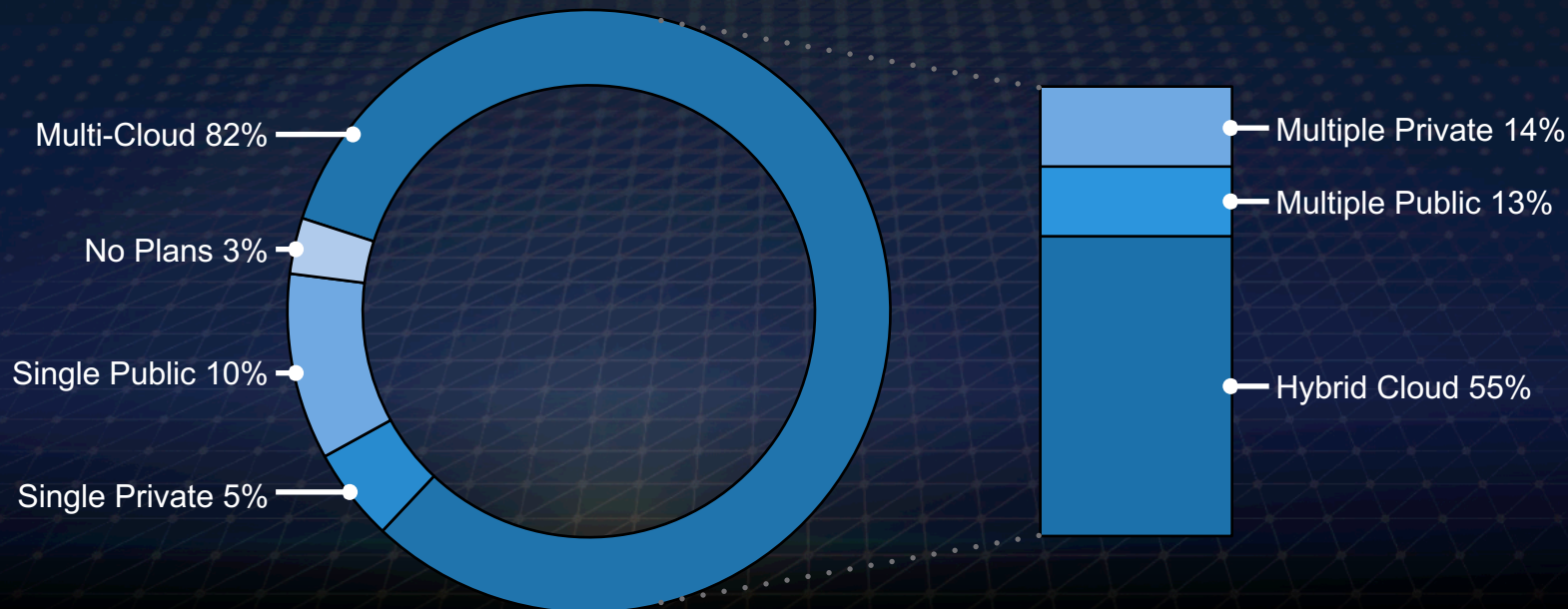
For "born in the memory era" applications

MEMORY-CENTRIC
ARCHITECTURE

TRADITIONAL

x86 CPU

L1 L2 L3

Memory Controller

QPI

PCIe

DRAM

Future NVM

Operating System

Application

Storage

NAND/HDD

MEMORY LOAD/STORE

BLURRING MEMORY-STORAGE BOUNDARIES

STORAGE READ/WRITE

NEXT GENERATION

CPU

L1 L2 L3

Tiered Memory Controller

Storage & Memory Pool

Operating System

Application

NVM/NAND/HDD

MCA Software Services

SCALE/POOL

SNAPSHOT/ RAPID RESTART

PROTECT/SHARE

CACHE/ TIER/AGE

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Multi-cloud – IT infrastructure changes

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Multi-cloud strategy

It needs multiple cloud services

Multi-Cloud 82%

No Plans 3%

Single Public 10%

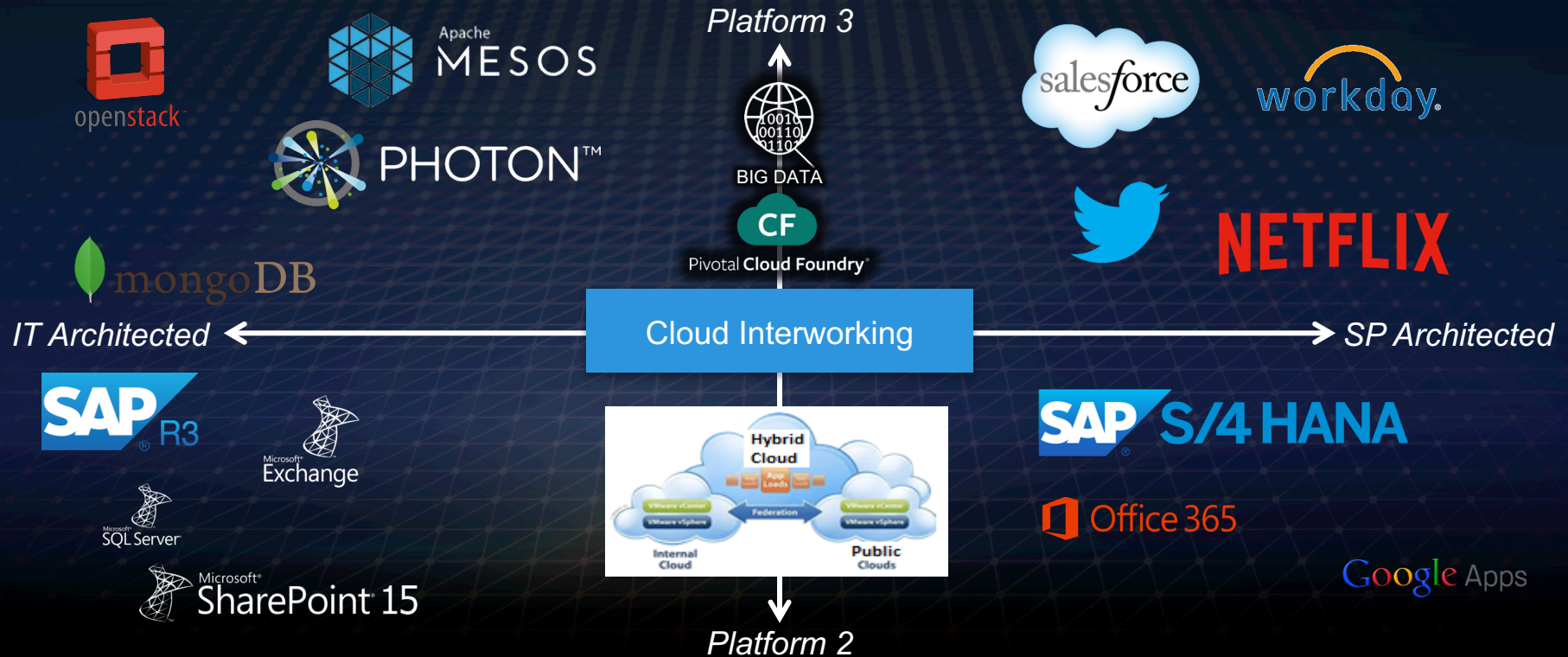Single Private 5%

Multiple Private 14%
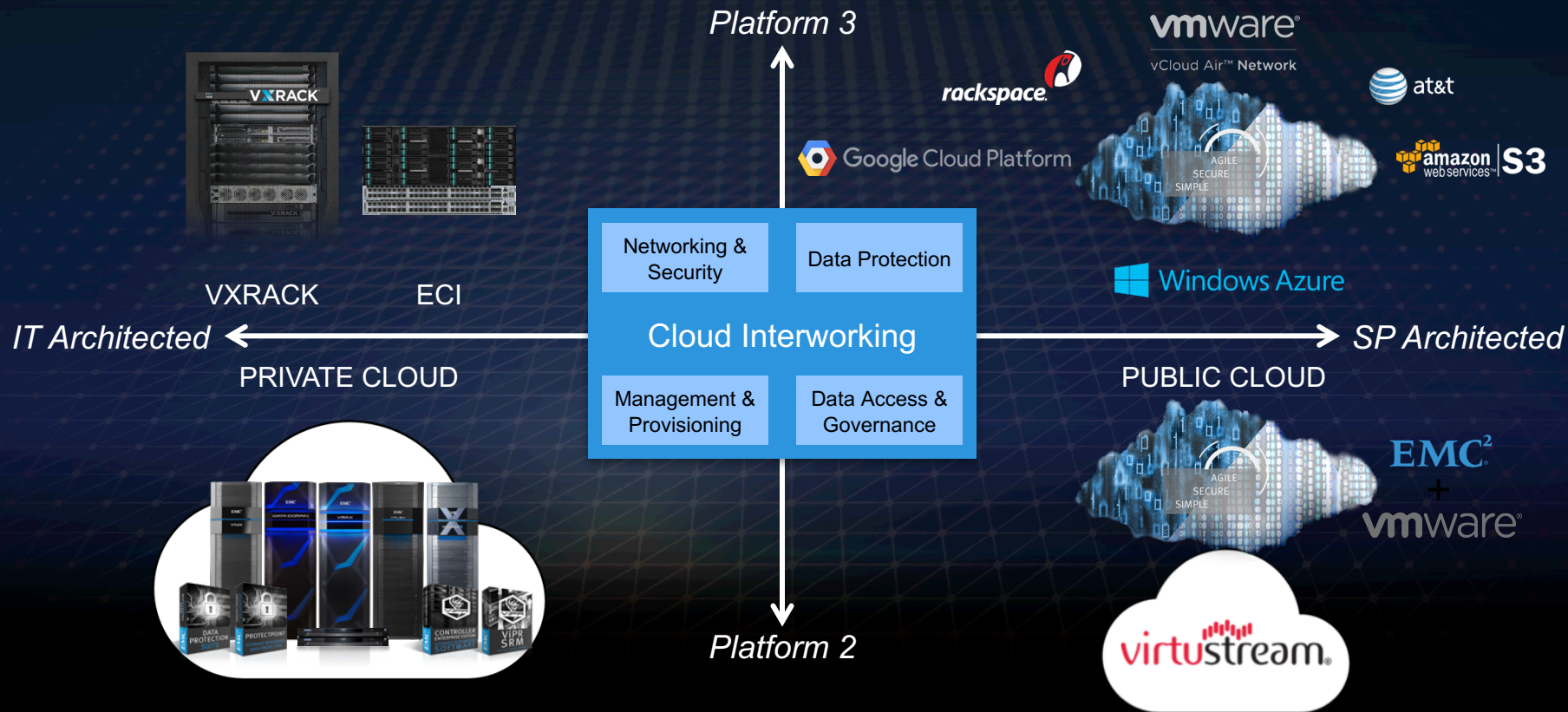
Multiple Public 13%

Hybrid Cloud 55%

Source: RightScale 2015 State of the Cloud report

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Application workloads

Cloud services

Platform 3

VXRACK   ECI

IT Architected ←——————————————

PRIVATE CLOUD

Networking & Security   **Data Protection**

Cloud Interworking

Management & Provisioning   **Data Access & Governance**

——————————————→ *SP Architected*

PUBLIC CLOUD

Platform 2

rackspace

Google Cloud Platform

vmware®
vCloud Air™ Network

at&t

amazon web services™ | S3

Windows Azure

EMC²
+
vmware®

virtustream®

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Application hybridization

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Data

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Faster application development

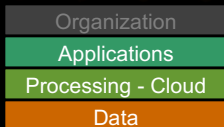Rise to a new iterative agile development models

Applications
Transform
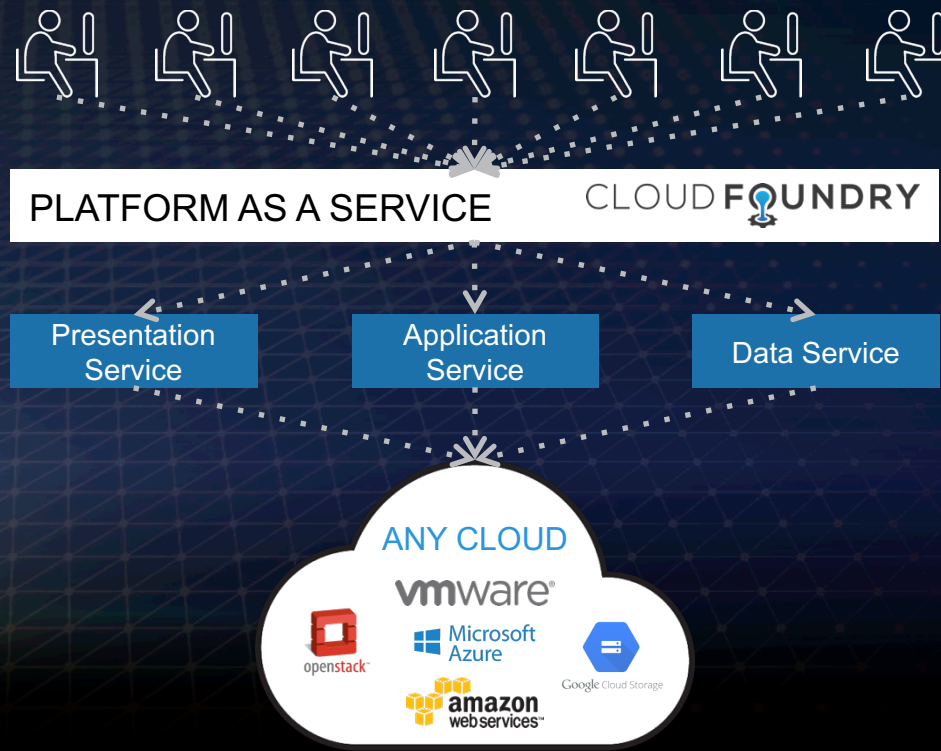Business

Data Generated By
New Applications

SPEED

Analytic Insights Drive
New Functionality,
Which Drives New Data

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Application hybridization

- New platforms
  - Enables Dev/OPS

- Consistent experience for the developer and operator

- Cloud choice
  - Lower cost
  - Greater resiliency
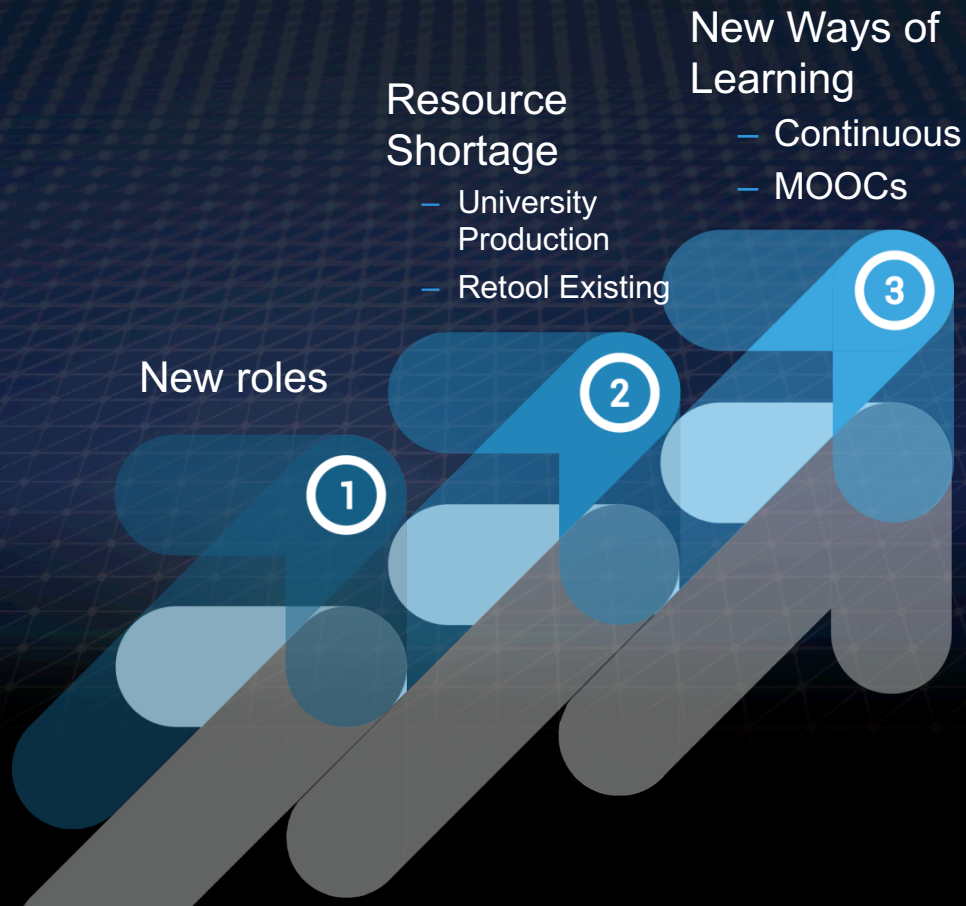 - Great elasticity
  - Prevents cloud lock in

PLATFORM AS A SERVICE   CLOUD FOUNDRY

| Presentation Service | Application Service | Data Service |

ANY CLOUD

vmware

openstack

Microsoft Azure

amazon web services

Google Cloud Storage

| Organization |
| Applications |
| Processing - Cloud |
| Data |

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Organization changes

New Ways of Learning
- Continuous
- MOOCs

Resource Shortage
- University Production
- Retool Existing

New roles

(1)
(2)
(3)

| Organization |
| Applications |
| Processing - Cloud |
| Data |

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IT organization changes

ORGANIZATION TRANSFORMATION

Dev/Ops

Technology Advisor

Service Evaluator

NEW SKILL SETS

FUTURE ROLE CIO

Chief Data Officer

Chief Auditor

Service Broker

Organization
Applications
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Data

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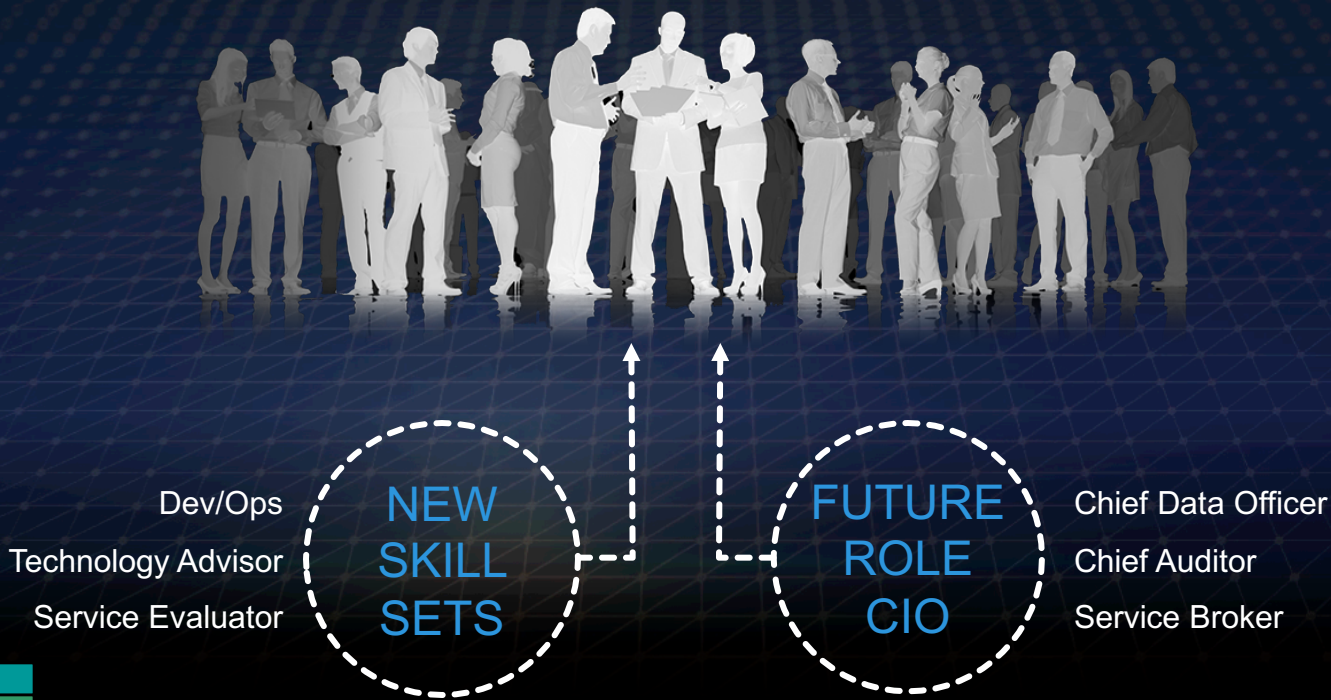
Application developer growth
Supply growing much slower than demand
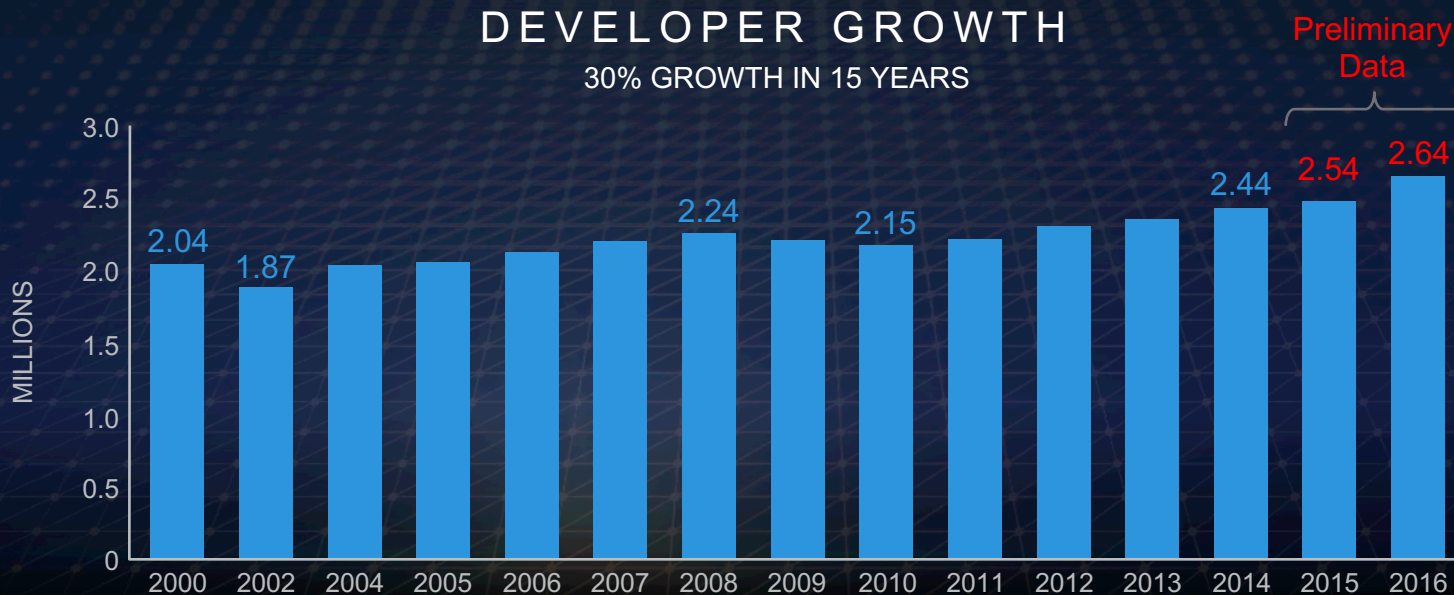
DEVELOPER GROWTH

30% GROWTH IN 15 YEARS

Preliminary Data

MILLIONS

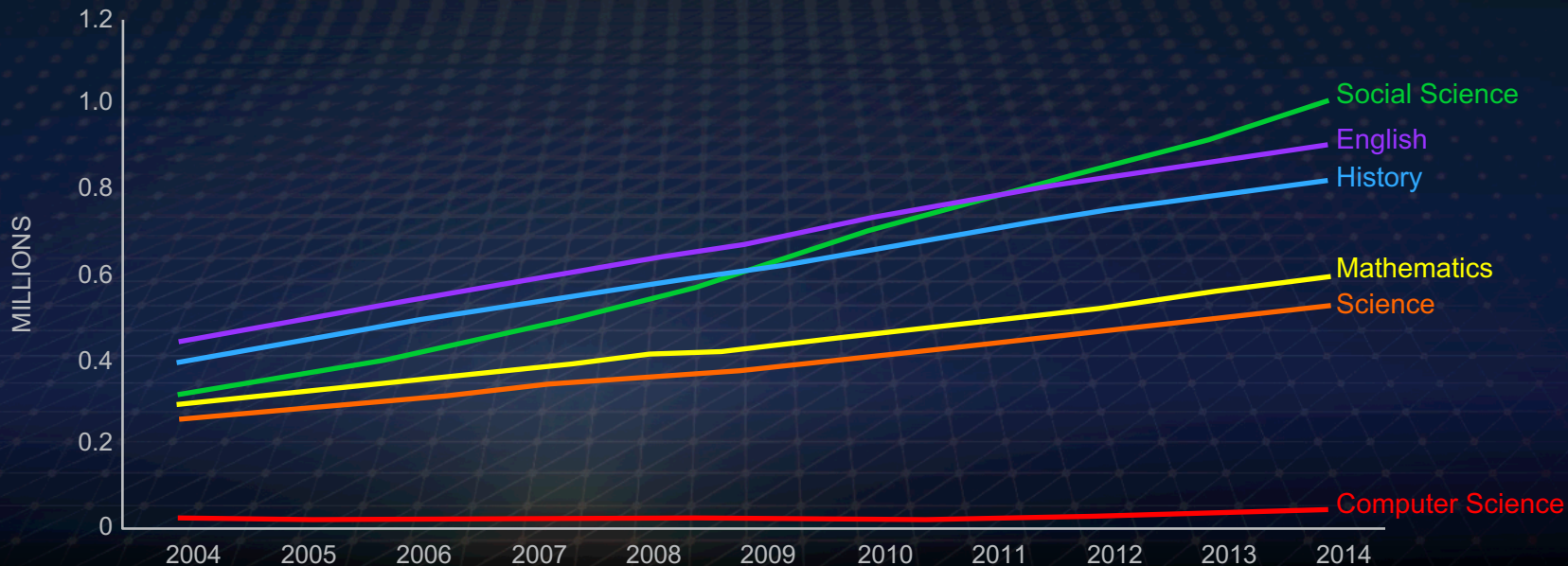| Year	Value
2000	2.04
2002	1.87
2004	
2005	
2006	
2007	
2008	2.24
2009	
2010	2.15
2011	
2012	
2013	
2014	2.44
2015	2.54
2016	2.64

Source: IDC Model based on US BLS Data

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New developers - high school output

Advanced placement exam subjects

MILLIONS

1.2
1.0
0.8
0.6
0.4
0.2
0

Social Science
English
History
Mathematics
Science
Computer Science

2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014

Source: IDC Aggregation of College Board Data

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Grow application developer resources

- Application developer participation growing slower than demand

- Significant decline in % of women developers: from 27% to 22% over 12 years

- Flat to declining trend for African American developers
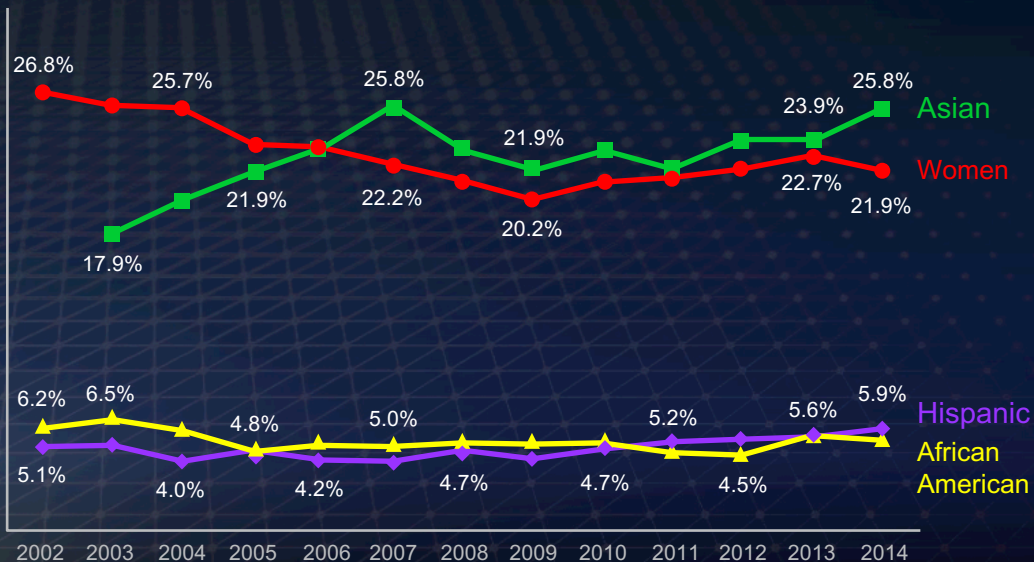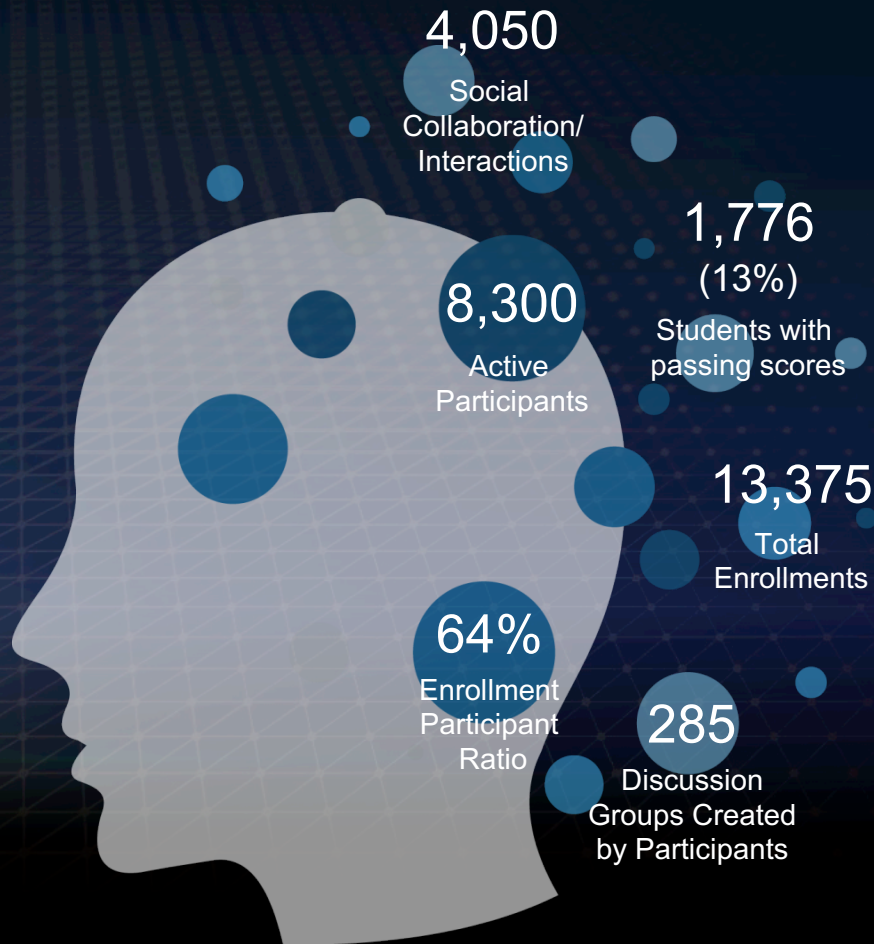

Source: IDC Model based on US BLS Data

| Organization |
| Applications |
| Processing - Cloud |
| Data |

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New continuous learning

Dell EMC big data analytics MOOC results

"Dell EMC has set a new bar with online learning, user engagement/peer learning, and using technology to drive very cost effective learning and educational efficiencies."

— EdCast

4,050
Social Collaboration/ Interactions

1,776 (13%)
Students with passing scores

8,300
Active Participants

13,375
Total Enrollments

64%
Enrollment Participant Ratio

285
Discussion Groups Created by Participants

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New development models

- Accelerated committer status
  - RPI, PAIR Day
  - 6-week mentoring program

- Pivotal Labs methodology

- Bring your-own-project

- Developer and DevOps meetup

- Cloud Foundry contributions
  - New features
  - Technical debt retirement

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- Success of business dependent on IT

- New technologies enables new applications
  - Storage media
  - Automated IT – "clouds"
  - Application development platforms

- New IT skills and roles

- Retooling IT
  - Continuous learning
  - Mentoring

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