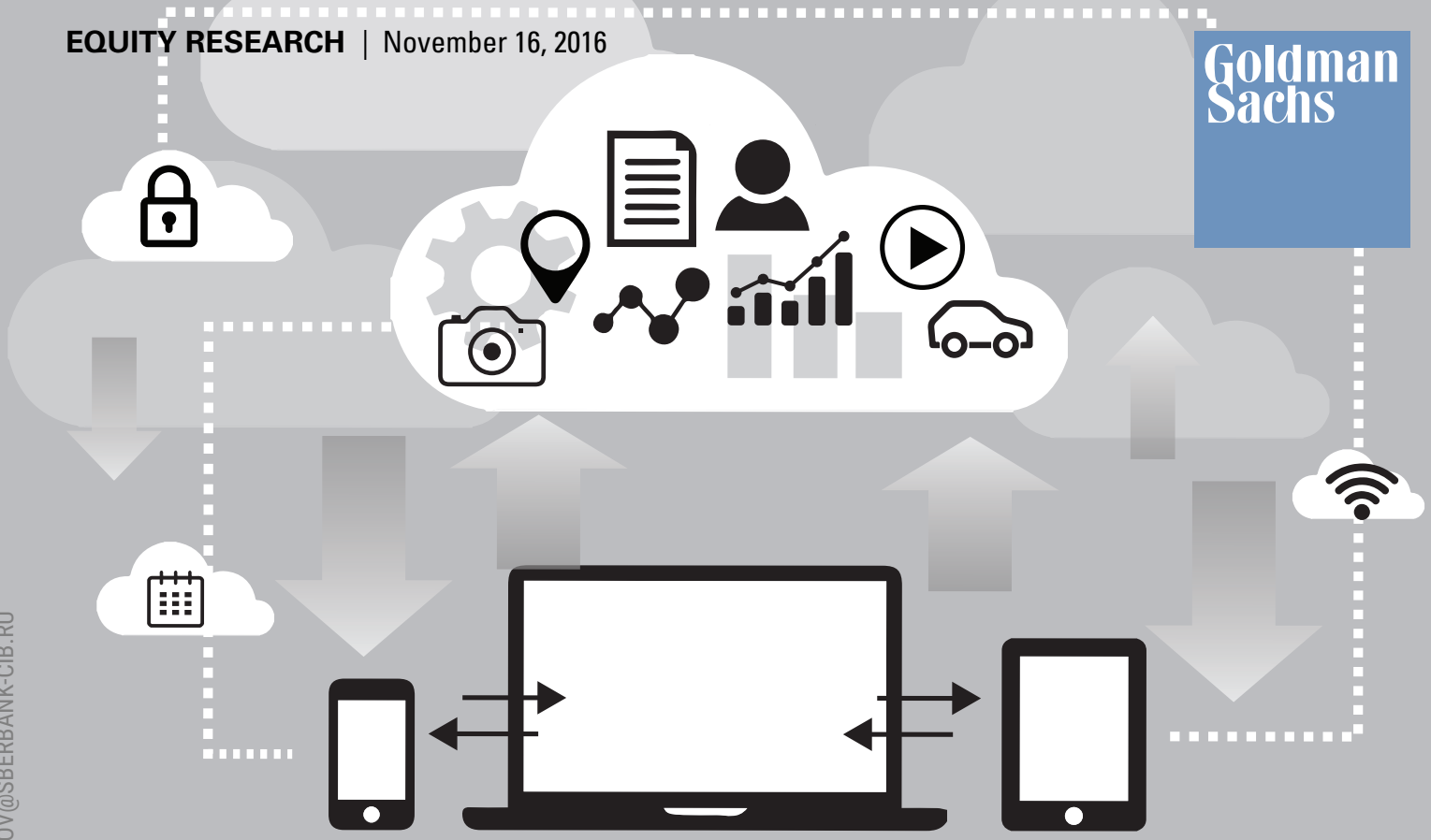
Goldman Sachs





## CLOUD PLATFORMS - VOLUME 4

# THE FUTURE OF PUBLIC CLOUD

Public cloud is set to transform how organizations host and manage their IT infrastructure. While just 6% of workloads were in the public cloud at the end of 2015, we expect this to grow to 19% by the end of 2019 and 50% over the next decade, as we move past the early adopter phase and enterprises migrate critical applications to the cloud. In the fourth volume of our Cloud Platforms series, we estimate public cloud revenue will more than quadruple from ~$30bn in 2016 to ~$140bn in 2020, with the opportunity to disrupt over half a trillion dollars in IT spend. We summarize our findings from conversations with more than a dozen CTOs and show how the market is likely to become more concentrated among four players – Amazon, Microsoft, Alphabet and Alibaba – with the ability to invest and differentiate based on data, analytics and services.

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**The Goldman Sachs Group, Inc.**

**Exhibit 1:**

# Conversations with CTOs

| | DIFFERENTIATORS | AREAS TO IMPROVE |
|---|---|---|
| **Amazon Web Services** | • "AWS has a remarkable lead in terms of revenue, customers and product features" – Enterprise Customer<br>• "AWS will be incredibly hard to catch…we have seen the services grow from pure compute to a best in class full software stack" – Enterprise Customer<br>• "Even if AWS raised prices by 10%, we most likely wouldn't move, due to the time and effort involved" – Public Sector Customer | • "Two years ago there was a wide feature gap between AWS and Azure, but in the last 8 months it is getting smaller as base level services become more commoditized" – Enterprise Customer<br>• "In terms of feature parity, AWS wins big time. But the infrastructure is much better, more stable and performant on Google." – Enterprise Customer<br>• "Reserved instances are just another thing to manage…there is minimal savings...and you can't make the instances bigger" – Enterprise Customer |
| **Microsoft Azure** | • "Azure is the best [public cloud] at running Microsoft's technology, is what my top engineers say" – Enterprise Customer<br>• "Even as powerful as AWS was, we chose Microsoft [Azure] because there was a business relationship there" – Enterprise customer that migrated from on-premise to public cloud in less than 6 months<br>• "We are seeing fast growth in Azure. EA (Enterprise Agreement) customers are getting cloud credits, sometimes $20-30k. They spend $2k with us to figure out how to use it." – Implementation Partner | • "We went with AWS, even though we are primarily a Windows environment" – Public Sector Customer<br>• "We ramped down our Microsoft relationship. It's confusing if you're trying to use Azure for a non-Microsoft stack. We moved our consumer facing Microsoft stack to LAMP (Linux, Apache, MySQL, PHP)." – Enterprise Customer<br>• "Azure doesn't have as many built out services as AWS…but is probably only a year or 18 months behind." – Enterprise Customer |
| **Google Cloud Platform** | • "We are betting that GCP will innovate the most [of AWS, Azure and GCP] in the next five years" – Enterprise Customer<br>• "Google is way ahead, totally…Google has better technology, but Microsoft has a better go to market…We switched to Big Query recently. Google has a big advantage in data analytics" – Enterprise Customer<br>• "Up until now [May 2016] we were not clear how serious Google was for the enterprise…and now we run all of our big data efforts on Google's Cloud" – Enterprise Customer<br>• "Google is better on price" – Enterprise Customer<br>• "TensorFlow [machine learning software] is a break through! As a developer, thank you Google." – Developer | • "Google App Engine was ahead of its time, it is what Force.com is now, but was too early and too fast. They don't understand what we care about and what we need." – Large Enterprise, not a customer<br>• "We asked for a roadmap and they told me to call back in 2 months" – Enterprise Customer<br>• "We signed an enterprise deal with Google in 2013 and we never saw them until a couple weeks ago [May 2016]" – Enterprise Customer<br>• "Amazon has an amazing developer community. Google has to build that somehow" – Enterprise Customer<br>• "Google's feature set is probably a couple years behind" – Enterprise Customer |

*Source: Company data, Goldman Sachs Investment Research.*

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***Contributing authors:*** *Heather Bellini, CFA, Heath P. Terry, CFA, Piyush Mubayi, Nicole Hayashi, Shateel Alam, Peter Callahan, Jack Kilgallen, CFA, Mark Grant, Elsie Cheng.*

# Portfolio manager's summary

## More in the Cloud Platforms Series

We explore the implications of the adoption of enterprise cloud platforms in a series of reports and related research available on our **Cloud Computing** portal:

**Vol. 1:** **Riding the Wave**

**Vol. 2:** **NoSQL**

**Vol. 3:** **Private Cloud**

## Early days in the disruption of a half a trillion dollar market

Cloud computing has revolutionized how corporations utilize technology, starting with Software as a Service (SaaS) and the creation of Salesforce.com and NetSuite back in 1999 and 1998, respectively. This was followed by the dawn of Infrastructure as a Service (IaaS) which was ushered in by the launch of Amazon Web Services (AWS) in 2006 and eventually Platform as a Service (PaaS) with salesforce.com in 2007 and Alphabet and Microsoft in 2008. While the rate of adoption of these new technologies can be slower than initial market expectations as we move past early adopters into those with more main stream IT risk appetites, we nonetheless expect workloads on the cloud to grow from 6% at the end of 2015 to 19% at the end of 2019 (GS surveys) and reach 50% over the next decade.

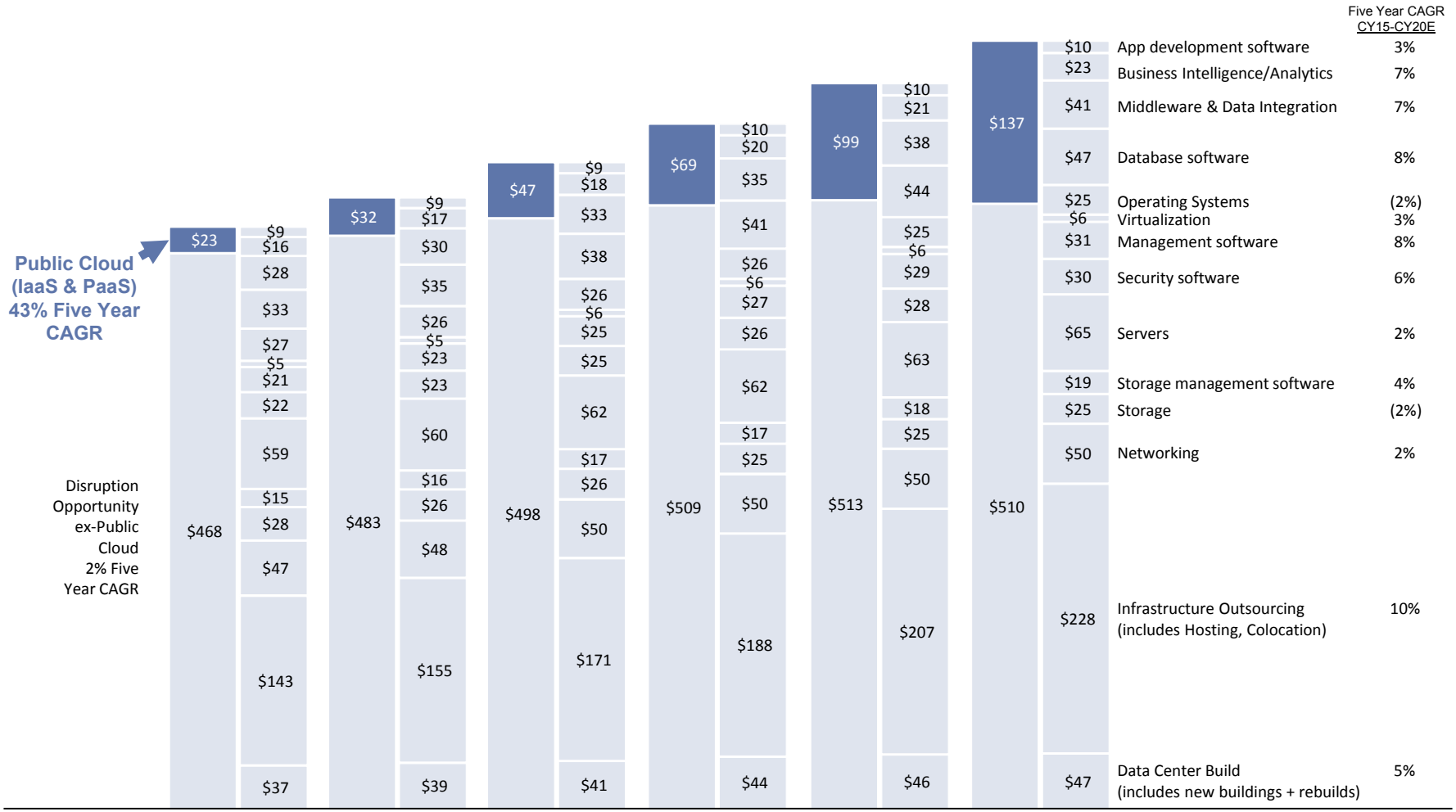
While the public cloud is well publicized and has been at the forefront of CIO's minds since 2007, our conversations with CIOs and CTOs underscore that each company migrates on their own timeline. Our discussions show firms are considering adoption time horizon of as much as 10 years as they decide which workloads to migrate first. As such, the pace of the transition for mission critical, production workloads is likely to take longer than many expect beyond the early adopters. For example, even though the shift from mainframes to client-server occurred over 20 years ago, IBM's mainframe revenue (System Z) still generated $1.9bn in LTM revenue, up from $1.0bn in 2000. Another example is Netflix, which shut down their final data center in January 2016 after spending seven years migrating to the public cloud (Netflix, February 2016).

Today, the vast majority of the public cloud is comprised of new applications in the development and testing phase, not yet the final (in production) applications. While each company is in various stages of their migration to the cloud, over the next 5-10 years, we believe the mix will increasingly shift towards more production and critical applications. As a result, as CIOs migrate applications from their data centers to the cloud, we believe the public cloud market will continue to disrupt multiple industries, including servers, storage, networking, infrastructure software, data center construction and data center outsourcing. We estimate these markets amount to ~$500bn in CY16 and will grow to ~$650bn in CY20, using a combination of Gartner and IDC forecasts (see Exhibit on the following page).

## Sizing the public cloud opportunity

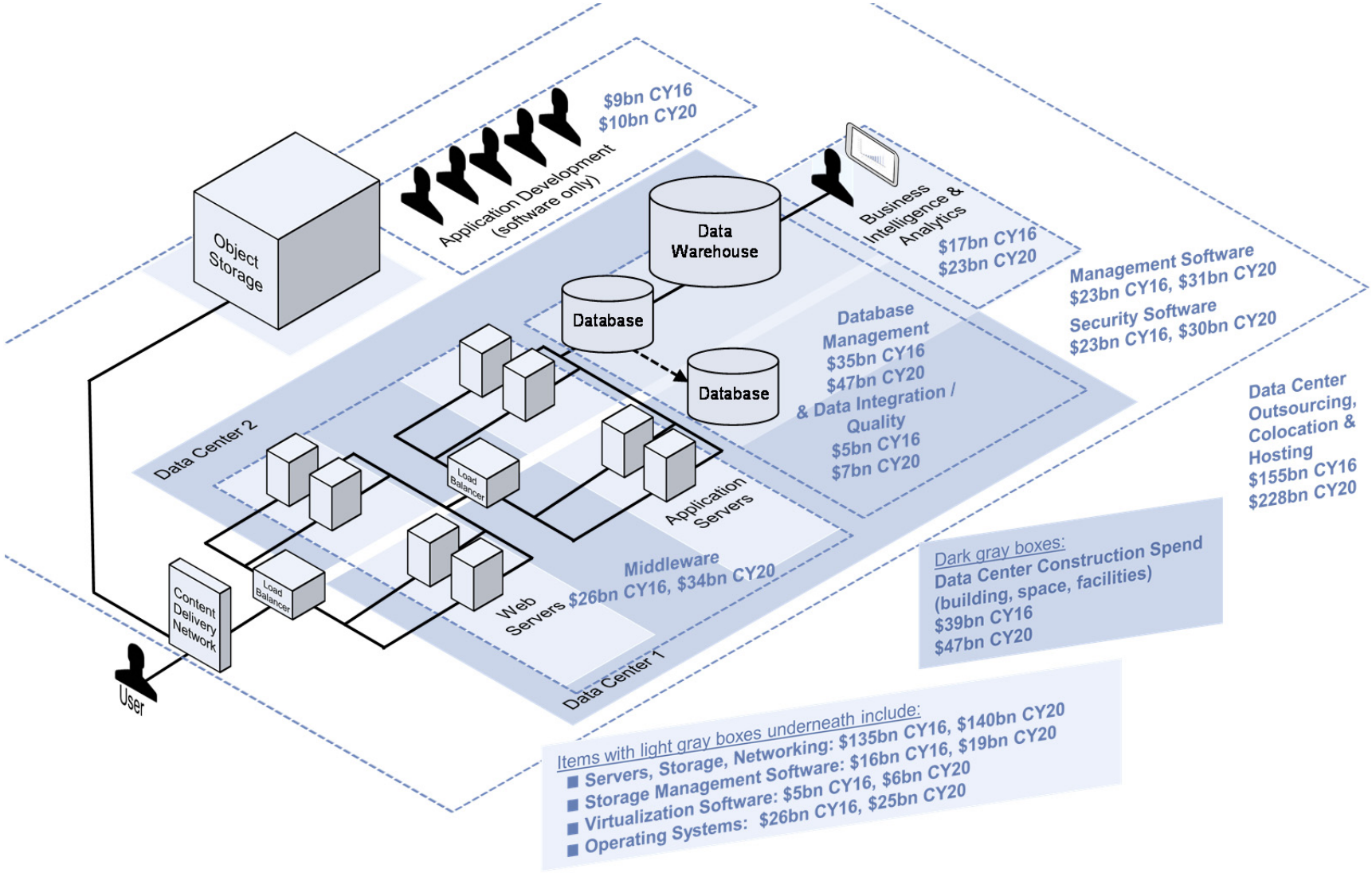
We created a public cloud forecast based on a bottom-up analysis of the market. Our forecast assumes the public cloud market is $32bn in CY16, and we forecast this to quadruple over the next four years to $137bn in CY20 (GSe). This forecast only includes Infrastructure as a Service (IaaS) and Platform as a Service (PaaS) revenue, and does not include Software as a Service (SaaS) due to its packaging of the application layer. If a customer brings their own license (i.e., Oracle, Red Hat, Microsoft), that is also not included in this forecast as public cloud vendors are not paid on the software license under those circumstances, however they do get paid on the underlying compute used, which is included in this forecast.

**Exhibit 2: Public cloud has the potential to disrupt a ~$500bn market in CY16, growing to ~$650bn in CY20**
*Markets identified by GS, market sizes based on Gartner and IDC forecasts*



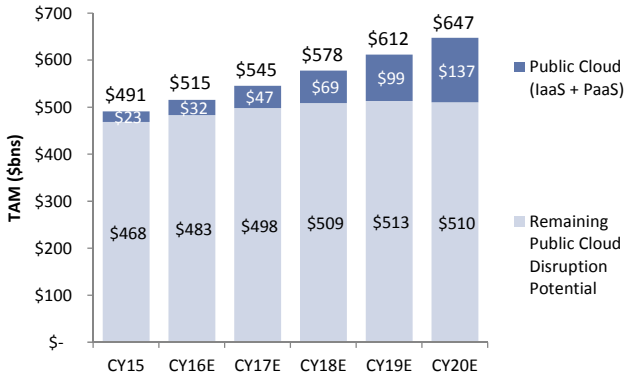

*Source: Goldman Sachs Investment Research Public Cloud TAM, Remaining Public Cloud Disruption Potential is compiled by Goldman Sachs Investment Research from Gartner 3Q16 and IDC May 2016 data.*

**Exhibit 3: Public cloud has the potential to disrupt a ~$500bn market in CY16, growing to ~$650bn in CY20 (sum of components below)**
*Markets overlaid on a typical web application architecture*



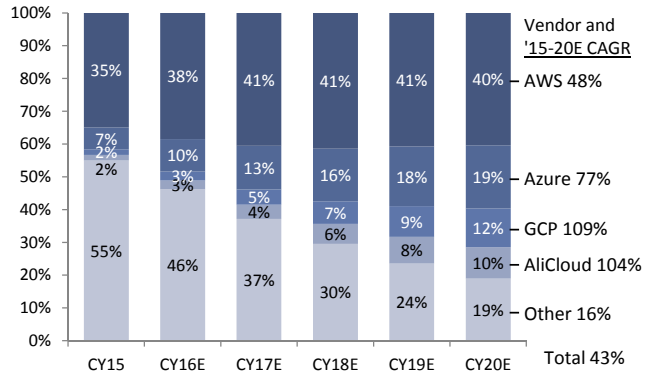

*Source: Goldman Sachs Investment Research Public Cloud TAM, Remaining Public Cloud Disruption Potential is compiled by Goldman Sachs Investment Research from Gartner 3Q16 and IDC May 2016 data. Web application architecture diagram adapted from Amazon's website and slightly adjusted to reflect the data layer. Black dotted line represents data being replicated to a second database in a different data center. This analysis does not include the cost of developers or IT staff.*

**Exhibit 4: GS Public Cloud market share forecast versus its disruption potential ($bns)**




*Source: Company data, Goldman Sachs Investment Research.*

**Exhibit 5: GS Public Cloud market share forecast and five year CAGRs**




*Source: Company data, Goldman Sachs Investment Research.*

We believe that the market structure will evolve similar to other current platform markets such as operating systems and databases over the next five years, where the top four vendors comprise anywhere between 80-100% of the market today. Our CY20E forecast reflects an 81% share for the top four vendors. Our bottom-up forecast, which estimates revenue for each major vendor is higher than market research firm Gartner in out years (2017+). We also note that Gartner estimates have trended upwards over time, most significantly for CY19 between June 2015 and June 2016 where estimates increased $16bn in one year.

**Exhibit 6: Gartner tends to increase their public cloud forecasts over time (IaaS and PaaS, $mns)**

| Gartner Forecast | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| June '12 | $3,481 | $5,174 | $7,419 | $10,829 | $15,600 | $21,325 | $27,362 | | | | |
| June '13 | | $5,380 | $7,526 | $10,775 | | | $27,359 | $3[illegible]400 | | | |
| June '14 | | | $7,974 | $11,732 | | | $27,733 | $35,167 | $43,556 | | |
| June '15 | | | | $11,738 | | | $25,697 | $3[illegible]803 | $40,718 | $49,891 | |
| June '16 | | | | | $15,779 | $21,873 | $30,354 | $40,869 | $52,691 | $65,799 | $80,064 |

In 4 years, Gartner's CY16 forecast increased $3bn

In one year Gartner's CY19E forecast increased $16bn

*Source: Gartner forecasts, date referenced above and Goldman Sachs Investment Research.*

## Evolution of market share trends

**Herfindahl-Hirschman Index (HHI):**

- *Pure Monopoly: Near 10,000*
- *Highly Concentrated: Over 2,500*
- *Moderately Concentrated: 1,500-2,500*
- *Competitive: Less than 1,500*

In the Appendix of this report we discuss our view of how the public cloud will evolve over time. While to date the market has been dominated by Amazon Web Service's (AWS's) (revenue is over 4x larger than its next largest competitor), we estimate AWS is just 38% of the public cloud market in CY16. Using the Herfindahl-Hirschman Index (HHI), the leading vendors have a combined HHI of 1,593 in CY16, an indication that the market is moderately concentrated; this compares to the virtualization software market (e.g., VMware) with an HHI of 8,019, which can be considered close to monopolistic (a pure monopoly has an HHI of nearly 10,000), the database market (e.g., Oracle, Microsoft, IBM) with an HHI of 2,593 which is considered a highly concentrated market (over 2,500), and on the opposite end of the spectrum the business intelligence/analytics industry (e.g., SAP, Oracle, etc.) with an HHI of 721, which is considered a competitive market (less than 1,500).

However, to assess whether the market could evolve into an oligopolistic (highly concentrated) or even a monopolistic market over time, we examined two real-life examples of monopolistic (PC Operating Systems and Desktop Search) and oligopolistic (US Wireless and ETFs) markets. We compared each industry along four key market characteristics: 1) market concentration, 2) pricing power, 3) barriers to entry and 4) product differentiation.

1. **Market concentration.** We expect the market to evolve from moderately concentrated in CY16 towards highly concentrated in CY20 (HHI of 2,234 and four firm concentration ratio of 81% in CY20).
2. **Pricing Power.** While we expect market concentration to increase we do not see pricing power as strong as customers are able to move off of their current public cloud vendor if prices increased significantly.
3. **Barriers to Entry.** While barriers to entry are initially low as anyone that is able to offer space on their home server can compete, to compete at scale we believe it requires significant capital as it can cost billions of dollars to build out data centers and software and hardware in dozens of regions worldwide.
4. **Product differentiation.** Public cloud's core product, IaaS, is largely undifferentiated between vendors in our view, because at its most basic level, IaaS is similar to renting a server (which has a central processing unit or CPU, memory, storage and the underlying networking), which is somewhat consistent between vendors. However, differentiation is starting occur, as vendors are building out higher level services such as machine learning services, serverless computing, and their own databases, which we discuss in detail later in this report.

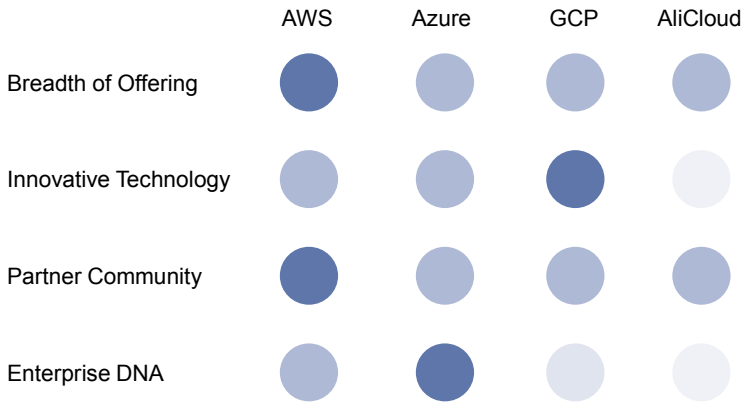
Given the costs required to be a top vendor at scale, absent the entrance of a new large scale player, over time we believe the industry will consolidate around the 4 large-cap technology companies Amazon Web Services, Microsoft Azure, Alphabet's Google Cloud Platform (GCP) and Alibaba's AliCloud, that are aggressively growing their cloud businesses. Vendors to watch in our opinion, but that have yet to demonstrate significant IaaS or PaaS market adoption based on our CIO and CTO conversations are Oracle and IBM. To be a leader in the public cloud market, sunk costs are in the tens of billions of dollars to support millions of customers worldwide. Public cloud companies acquire land, build or rent data center space, pay for servers, storage, and networking hardware, infrastructure software, power, and headcount. In CY16 we estimate Amazon, Microsoft, Alphabet and Alibaba will spend $27bn in capex compared to $58bn for the remaining information technology companies in the S&P.

## Assessing the competitive landscape

We spoke with over a dozen CTOs and industry veterans over the last six months to discuss their public cloud ambitions and competitive differences between platforms. While we discuss the specific differentiators and challenges in detail, overall we found that AWS has the broadest offering and largest community with over one million active customers and a large partner network. Microsoft Azure is gaining momentum based on our partner checks with increased adoption amongst its enterprise agreement customers and those who heavily leverage Microsoft's technology (database, operating systems, etc.). Customers are anticipating that GCP will have the most innovation over the next few years, with many already citing that they have a technical advantage with their container technology (Kubernetes), machine learning options and Big Data offerings (specifically BigQuery). AliCloud continues to be a market leader in China, and is broadening its footprint, announcing key partnerships to expand in other countries (i.e., Softbank in

Japan). Over the next five years, we believe each of these public cloud vendors will look to further differentiate themselves.

**Exhibit 7: Comparison of Public Cloud vendors and how they are differentiated today**
*The darker the circle, the higher the competency*




*Source: Goldman Sachs Investment Research.*

**Exhibit 8: Comparing leading public cloud vendor offerings**

| | AWS | Azure | Google Cloud Platform | AliCloud |
|---|---|---|---|---|
| Compute | | | | |
| IaaS (Instances / Virtual Machines) | EC2 | Virtual Machines | GCE | Elastic Compute Service |
| Container Service | EC2 Container Service | Container Service | GKE | |
| PaaS | Elastic Beanstalk | Web Apps, Cloud Services | GAE | |
| Storage | | | | |
| Object Storage | S3 | Blob Storage | Cloud Storage | Object Storage Service |
| Block Storage | Elastic Block Storage (EBS) | Page Blobs, Premium Storage | GCE Persistent Disks | |
| Cold Storage | Amazon Glacier | Blob Storage | Google Cloud Storage Nearline | |
| File Storage | Elastic File System | File Storage | ZFS / Avere | |
| Physical Data Transfer | Snowball, Import/Export Disk | Import/Export Service | Offline Media Import/Export | |
| Database and Middleware | | | | |
| Relational | RDS | SQL Database | Cloud SQL (MySQL) | RDS |
| NoSQL | DynamoDB, SimpleDB | DocumentDB | Datastore, Bigtable | Table Store |
| Messaging | SNS | Notification Hubs | Pub/Sub | Message Service |
| Big Data and Analytics | | | | |
| Data Warehouse | Redshift | SQL Data Warehouse | BigQuery | |
| Hadoop / Batch Processing | Elastic Map Reduce (EMR) | HDInsight | Dataproc, Dataflow | |
| Machine Learning | Machine Learning | Machine Learning | Machine Learning | |
| Stream Data Processing & Ingest | Kinesis | Stream Analytics, Data Lake, Event Hubs | Dataflow, Pub/Sub | |
| Business Intelligence | QuickSight | PowerBI | Datalab | |
| CDN and Network | | | | |
| Load Balancer | Elastic Load Balancer | Load Balancer, Application Gateway | GCE Load Balancer | Server Load Balancer |
| Content Delivery Network (CDN) | CloudFront | Content Delivery Network | Cloud CDN | AliCloud CDN |
| Domain Name System | Route 53 | DNS | Google Cloud DNS | |
| Peering/Direct Connect | Direct Connect | ExpressRoute | Google Cloud Interconnect | |
| Management Tools | | | | |
| Monitoring | CloudWatch | Visual Studio Application Insights, Portal | Stackdriver Monitoring | |
| Management | CloudFormation | Resource Manager | Deployment Manager | |
| Tracking / Logging | CloudTrail, Config | Log Analytics | Stackdriver Logging | |
| Automation | OpsWorks (Chef) | Automation | 3rd party products (Chef, Puppet, Jenkins) | |
| Serverless | | | | |
| Severless | Lambda | Azure Functions | Google Cloud Functions | |

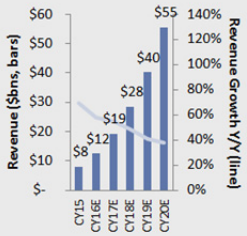
*Source: Company data, Goldman Sachs Investment Research.*

# Summary Stock Takeaways

**For investors looking to invest in this theme today, we recommend Amazon (CL-Buy, covered by Heath Terry), Microsoft (Buy), Alphabet (CL-Buy) and Alibaba (CL-Buy, covered by Piyush Mubayi)** as we view them as poised to evolve into the largest vendors within the public cloud market, as mentioned previously.

**Exhibit 9: GS's view on Amazon AWS and Microsoft Azure**

## Amazon Web Services (AWS)




CY15E Market Share: 38%
CY20E Market Share: 40%

DIFFERENTIATORS

- Created the public cloud market
- Clear leader in revenue
- Broadest offering, developed a full stack
- Serverless computing

INVESTMENT THESIS

While heightened investment will weigh on margins near term, viewed through the lens of Amazon's extremely high returns on cash invested, we believe the payoff of investments in web services, infrastructure, and logistics will create considerable revenue growth, cash flow growth, and value for Amazon shareholders

Amazon (AMZN)

- Rating: CL-Buy
- Twelve Month Price Target: $1,010 (SOTP)
- Key Risks: Macro, competition, investment in earlier stage efforts like hardware.

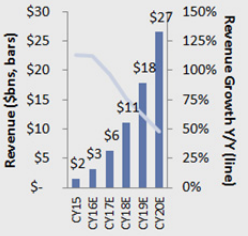
AREAS TO IMPROVE

- Simplifying pricing, particularly around reserved instances
- Other vendors are starting to catch up, however AWS still has a significant lead

PUBLIC CLOUD VIEW

AWS created the public cloud market a decade ago and has established themselves as a clear leader in the space, generating $11bn in LTM revenue, which is over four times the size of the second largest vendor (Microsoft) on an LTM basis. Over the next five years, we believe AWS will continue to be the revenue leader, have the broadest offering, and a strong partner community, as well as innovating in new areas such as serverless computing (Lambda).

## Microsoft Azure




CY15E Market Share: 10%
CY20E Market Share: 19%

DIFFERENTIATORS

- Hybrid cloud
- Excels at running Microsoft software (i.e., SQL Server)
- Able to leverage their current customer base

INVESTMENT THESIS

We upgrade Microsoft to Buy from Neutral and raise our price target from $60 to $68. We raise our revenue and gross margin estimates for the company overall, primarily due to revenue and gross margins increases for Azure. Our upgrade is based on 1) accelerating growth in gross profit dollars driven by its cloud transition, 2) an inflection in incremental operating margins as cloud profitability ramps and operating expense growth remains muted, and 3) upside potential to consensus out year EPS forecasts.

Microsoft (MSFT)

- Rating: Buy (from Neutral)
- Twelve Month Price Target: $68 (from $60, DCF, EV/FCF, P/E)
- Key Risks: Adoption of hybrid cloud, Windows and Office performance, IT spending and macro trends

AREAS TO IMPROVE

- Continue to build out its feature set, referenceable customers and partner ecosystem

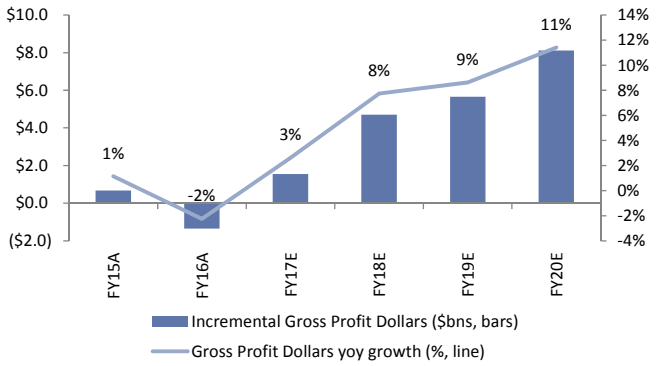
PUBLIC CLOUD VIEW

Azure is the #2 market share vendor in this space, and has grown 100% or more yoy eight of the last ten quarters, and in fact growth accelerated in C3Q16. With a large Microsoft customer base and strong C-level relationships, we believe Azure can continue to grow revenue and improve margins over time. Our views are supported by channel partners, who have commented recently that they are seeing strong uptake of Azure amongst enterprise customers, particularly as it relates to hybrid cloud.

*Source: Goldman Sachs Investment Research.*

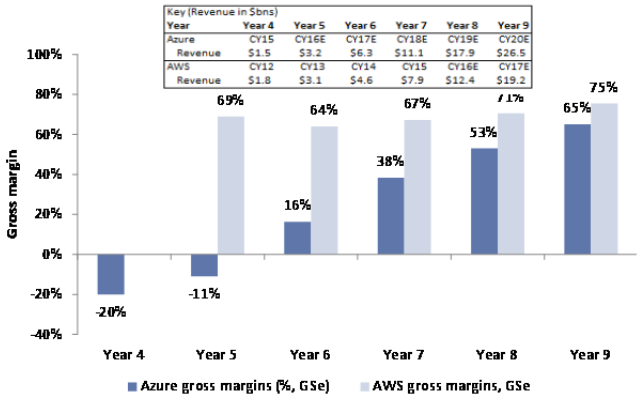
# Upgrading Microsoft to Buy: Our Thesis in Six Charts

### Exhibit 10: As cloud margins ramp, so will gross profit growth



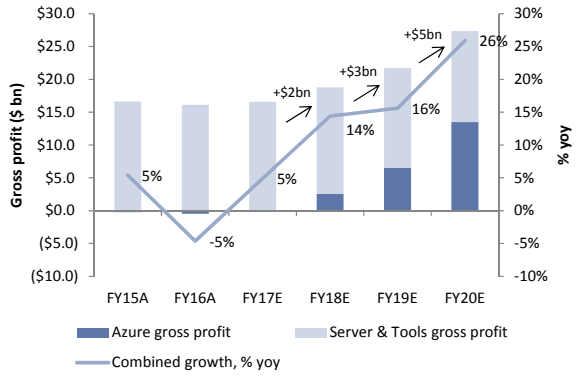

*Source: Company data, Goldman Sachs Investment Research.*

### Exhibit 11: Our Azure gross margins estimates are still below AWS when comped on the same revenue scale



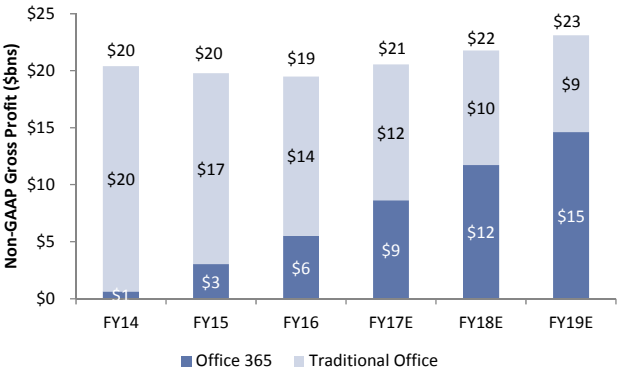

*Source: Company data, Goldman Sachs Investment Research. *AMZN started disclosing AWS in 1Q15. AWS uses actual depreciation Years 5-7, GSe 9-10.*

### Exhibit 12: Within Intelligent Cloud, we expect Azure to drive gross profit increases of $2-5bn from FY18-FY20…



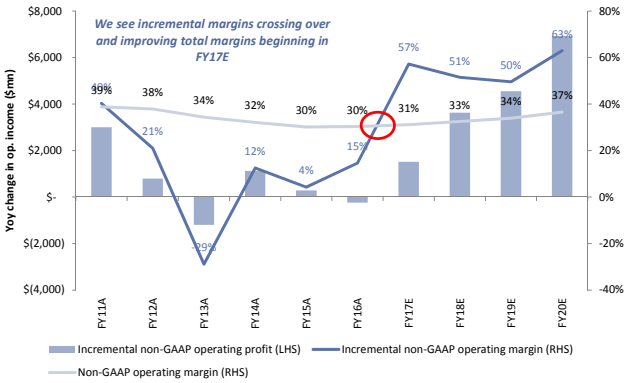

*Source: Company data, Goldman Sachs Investment Research.*

### Exhibit 13: …and Office 365 is on the path to representing 50%+ of Office gross profit



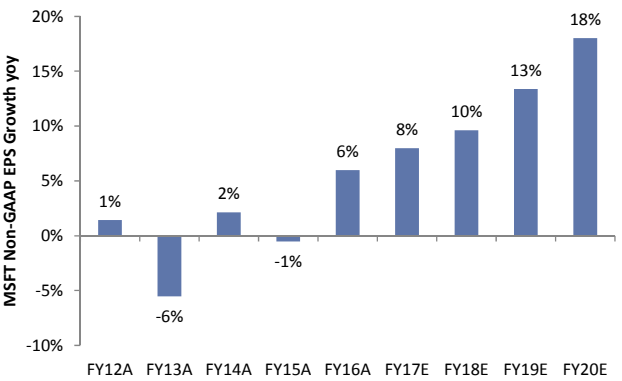

*Source: Company data, Goldman Sachs Investment Research.*

### Exhibit 14: Gross profit growth + controlled opex is driving incremental operating margins above corporate for the first time since FY11



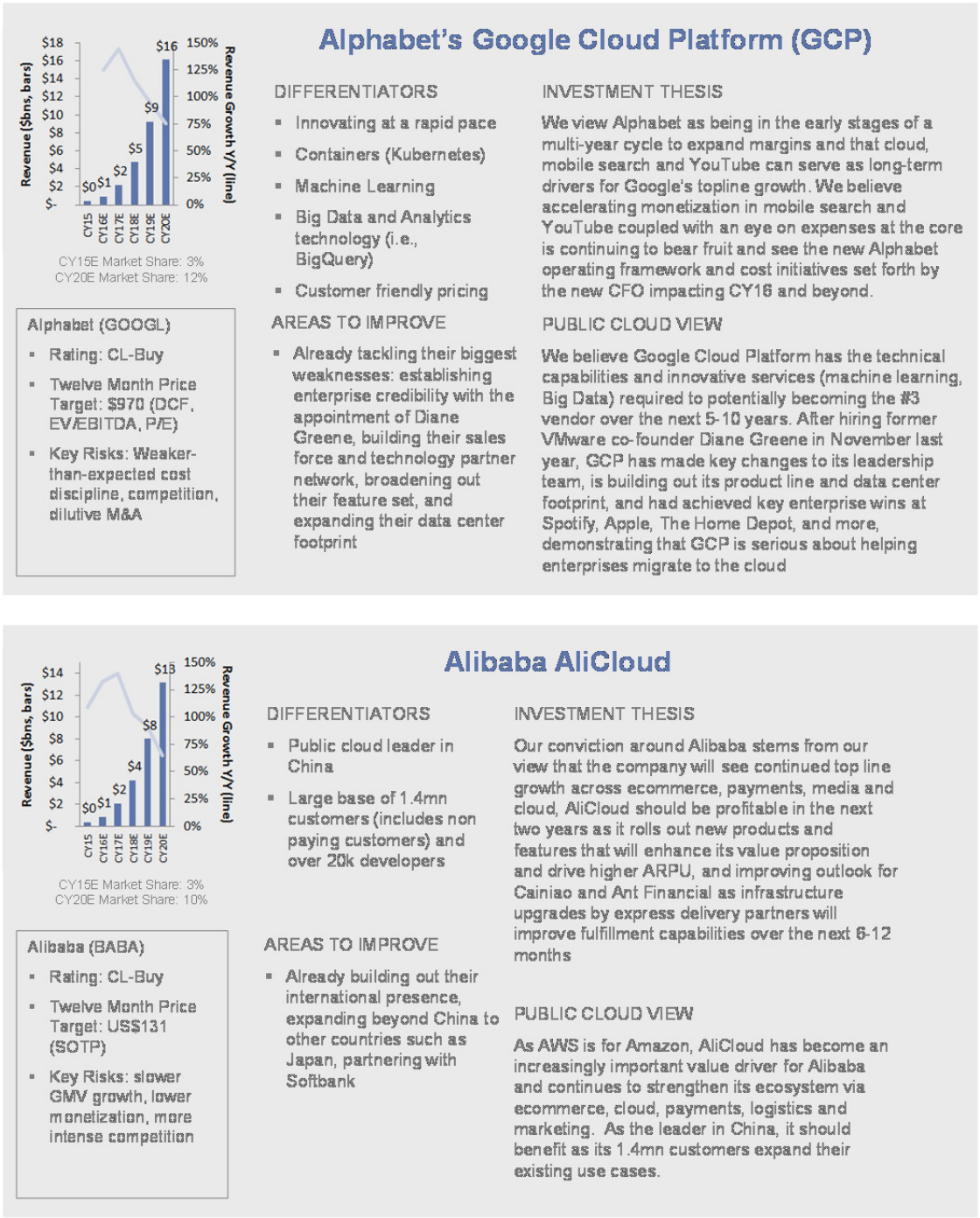

*Source: Company data, Goldman Sachs Investment Research.*

### Exhibit 15: We believe the confluence of these profitability factors can drive sustainable double digit EPS growth




*Source: Company data, Goldman Sachs Investment Research.*

**Exhibit 16: GS's view on Alphabet's Google Cloud Platform and Alibaba AliCloud**




*Source: Goldman Sachs Investment Research.*

## Public Cloud's potential impact to non-GAAP EPS and valuation

We summarize the potential impact of the public cloud to each public cloud vendor below and in detail later in this report.

- **Amazon AWS –** AWS represents 48% of our total Sum of the Parts (SOTP) valuation for Amazon, ($483 per share based on our $1,010 target). This value implies a 34x P/E multiple on our CY20 AWS EPS estimate of $18 discounted back to CY17. The P/E multiple is implied by our AWS SOTP valuation of 12x CY17E EV/Sales based on the growth and margin expectations in our estimates. We expect AWS operating income to grow at a 55% CAGR through 2020.
- **Microsoft Azure -** We estimate that Microsoft Azure will contribute $0.94, or 19% of Microsoft's total CY20 non-GAAP EPS of $4.83, and potentially $19 per share (23% of total estimated value) assuming a multiple of 25x and discounting back to CY17. Backing into our $68 price target, this implies Microsoft excluding Azure is valued at a 15x P/E multiple.
- **Alphabet's Google Cloud Platform -** We estimate that Alphabet's GCP will contribute $5.46, or 7% of Alphabet's total CY20 non-GAAP EPS, and potentially $103 per share (10% of total estimated value) assuming a multiple of 25x P/E and discounting back to CY17. Backing into our $970 price target, this implies Alphabet excluding GCP is valued at a 20x P/E multiple.
- **Alibaba AliCloud -** AliCloud represents 11% of our total SOTP valuation for Alibaba, or $14 per share. At this price it implies a 25x P/E multiple on our CY20 AliCloud EPS estimate of $0.79 discounted back to CY17.

**Exhibit 17: Public Cloud's potential impact to non-GAAP EPS and value per share for each public cloud vendor**

### Amazon Web Services (AWS)

| Potential Valuation Impact | | |
|---|---|---|
| CY20E AWS non-GAAP EPS | $ | 18.44 |
| Discount rate | | 9% |
| Discounted AWS EPS | $ | 14.24 |
| P/E | | 34x |
| AWS Value per share | $ | 483 |
| Amazon ex-AWS non-GAAP EPS | $ | 3.68 |
| P/E | | 143x |
| Amazon ex-AWS Value per share | $ | 527 |
| Amazon price target (SOTP) | $ | 1,010 |
| Upside to 11/15 close | | 36% |

### Microsoft Azure

| Potential Valuation Impact | | |
|---|---|---|
| CY20E Azure non-GAAP EPS | $ | 0.94 |
| Discount rate | | 8% |
| Discounted Azure EPS | $ | 0.75 |
| P/E | | 25x |
| Azure Value per share | $ | 19 |
| Microsoft ex-Azure non-GAAP EPS | $ | 3.19 |
| P/E | | 15x |
| Microsoft ex-Azure Value per share | $ | 49 |
| Microsoft price target | $ | 68 |
| Upside to 11/15 close | | 16% |

### Alphabet's Google Cloud Platform

| Potential Valuation Impact | | |
|---|---|---|
| CY20E GCP non-GAAP EPS | $ | 5.46 |
| Discount rate | | 10% |
| Discounted GCP EPS | $ | 4.10 |
| P/E | | 25x |
| GCP Value per share | $ | 103 |
| Alphabet ex-GCP non-GAAP EPS | $ | 42.56 |
| P/E | | 20x |
| Alphabet ex-GCP Value per share | $ | 867 |
| Alphabet price target | $ | 970 |
| Upside to 11/15 close | | 25% |

### Alibaba AliCloud

| Potential Valuation Impact | | |
|---|---|---|
| CY20E AliCloud non-GAAP EPS | $ | 0.79 |
| Discount rate | | 12% |
| Discounted AliCloud EPS | $ | 0.56 |
| P/E | | 25x |
| AliCloud Value per share | $ | 14 |
| Alibaba ex-AliCloud non-GAAP EPS | $ | 4.06 |
| P/E | | 29x |
| Alibaba ex-AliCloud Value per share | $ | 117 |
| Alibaba price target (SOTP) | $ | 131 |
| Upside to 11/15 close | | 44% |

*Source: Goldman Sachs Investment Research. See text above and in each company's respective sections for more detail on assumptions.*

**Exhibit 18: Data Center zones* announced by each public cloud vendor (timeline differs by vendor, see blue box at the bottom of this Exhibit)**


| | AWS | Azure | Google Cloud Platform | AliCloud |
|---|---|---|---|---|
| Current | 14 regions, 38 zones | 30 regions/zones* | 5 regions, 15 zones | 7 regions, zones not disclosed |
| Planned | 4 regions, 9 zones by CY17 | 8 regions/zones* (no timeline) | 11 regions (9 disclosed) by CY17, 25 zones disclosed thus far | 2 regions, zones not disclosed |
| **Total** | **18 regions, 47 zones** | **38 regions/zones*** | **16 regions, total zones not disclosed** ***(40 zones disclosed thus far)*** | **9 regions, zones not disclosed** ***(12 zones disclosed thus far)*** |
| **Definitions:** | **Region:** A separate geographic area. **Zone:** Each region has multiple, isolated locations known as Availability Zones. | **Region:** An area within a geography containing one or more data centers. | **Region:** A region is a specific geographical location where users can run resources. **Zone:** Each region has one or more zones | **Region:** Refers to Alibaba Cloud service region. |

*Source: Company data, Goldman Sachs Investment Research. As of October 3, 2016. *Microsoft defines regions differently from other vendors. For comparison purposes, we identify Azure regions as zones in the chart above. **We disclose the number of AliCloud regions, not zones. We note that the circles add up to 43 zones, not the 44 disclosed, as Amazon did not disclose where the last zone would reside and we assumed each disclosed planned region (Montreal, Ohio, Ningxia, UK) would have at least two zones each.*

# Current State of the Market

## 10th anniversary of public cloud

Amazon initiated the public cloud movement in 2006 when they opened up the same web-scale application infrastructure they use for Amazon.com to external users. This business, Amazon Web Services (AWS), has maintained its first mover advantage over the last decade and continues to be the clear leader in the public cloud space by revenue. AWS generated $11.1bn in LTM revenue ($12.9bn run rate as of 3Q16), over 4x their second largest competitor, Microsoft Azure, and has over one million active customers. The business is still growing quickly, at 61% yoy LTM and is profitable with 29% operating margins LTM (FX adjusted, ex-stock based compensation).

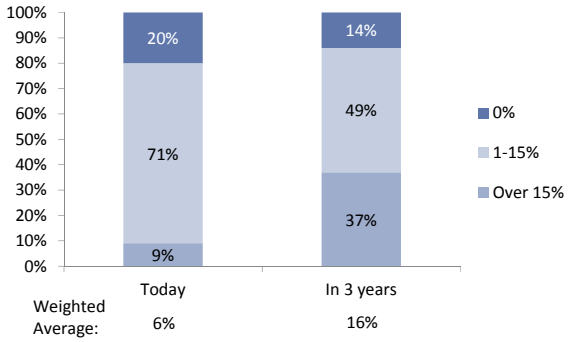
Since 2006, over a dozen large cap technology vendors started building or buying their own public cloud services. Each vendor chose to take different approaches, with AWS choosing to offer IaaS first, and then PaaS in 2011. Meanwhile, Alphabet and Microsoft started offering higher margin PaaS services, but later offered IaaS in 2013.

## Much discussed but a market still in its infancy

In addition to our public cloud forecast mentioned previously, our survey and market checks also indicate that the market is still early. For the past few years, we have administered periodic surveys to assess the sentiment towards public cloud spending and the overall technology sector, particularly what proportion of their applications CIOs have moved to public cloud platforms today and what they expect that proportion will be three years from now (IaaS and PaaS excluding SaaS, Exhibits 19 & 20).

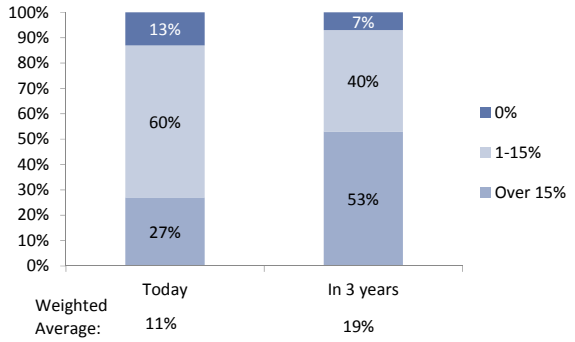
We are excluding SaaS due to its packaging of the application layer. Excluding SaaS, our latest June 2016 survey shows that while only 11% of workloads are run in public clouds today, CIOs expect this figure will move closer to 19% by June 2019. This is an uptick compared to our December 2015 survey, when an estimated 6% of workloads had been in the cloud (4% in our December 2014 survey), with the expectation that it would increase to 16% in three years (9% in our December 2014 survey). Including SaaS, our conversations with ten CTOs from diverse industries suggests that a quarter of workloads will be hosted in a cloud by the end of CY16, reach ~60% in 5 years and ~80% in 10 years.

**Exhibit 19: What percent of your applications have you moved to public cloud platforms today and what do you expect three years from now?**
December 2015




*Source: Goldman Sachs Global Investment Research. By comparison, Gartner estimates 2%(IaaS only) workloads are in the public cloud for CY15 and will grow to 12% by 2017.*

**Exhibit 20: What percent of your applications have you moved to public cloud platforms today and what do you expect three years from now?**
June 2016



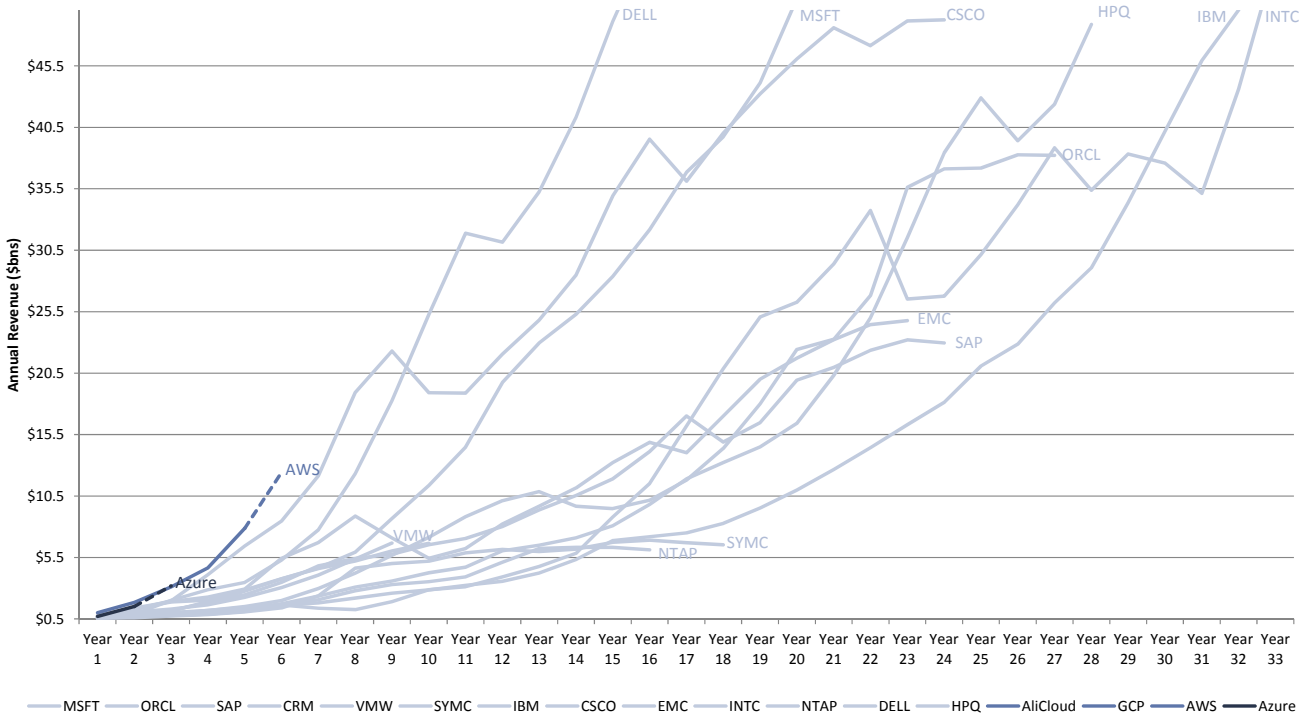

*Source: Goldman Sachs Global Investment Research.*

## Ten years to $10 billion

To illustrate how rare of an accomplishment it is to surpass $10bn in revenue in 10 years, we compared AWS and other public cloud vendor's revenues since founding to current public technology companies. We found that public cloud businesses, particularly AWS and Azure, are growing faster than existing large enterprise software companies.

We then analyzed the potential for public cloud businesses over the next decade, profiling how long it took enterprise technology companies to generate $50bn in revenue after generating $500mn annually. Thus far we have found that AWS and Azure are generating revenue faster than peers and have potential to outpace prior enterprise technology companies (see Exhibit below).

**Exhibit 21: AWS is generating revenue at a faster pace than prior enterprise technology companies. This exhibit displays the years it took enterprise technology companies to reach $50bn after generating $500mn in annual sales**



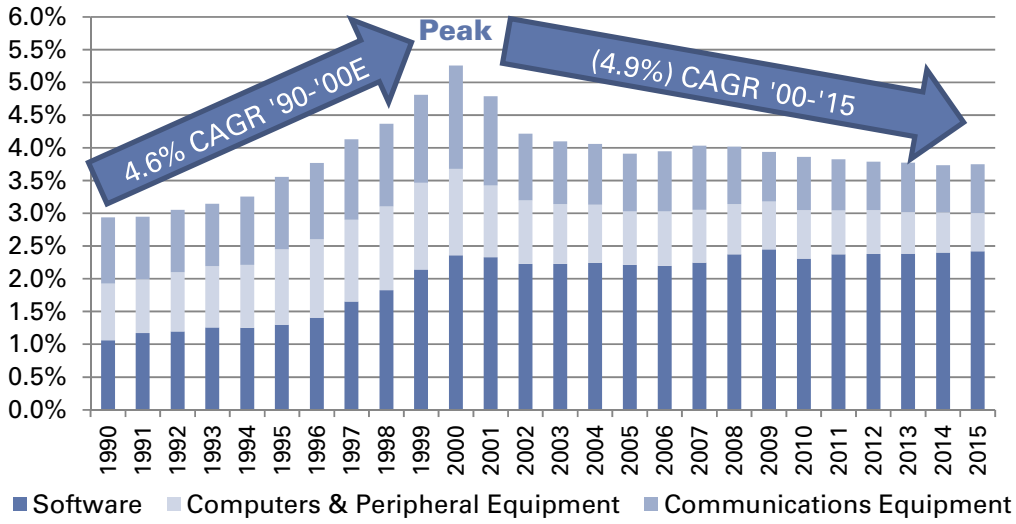

*Source: Company data, Bloomberg, FactSet, Compustat, Goldman Sachs Investment Research. We show CY16 estimated revenue for AWS and Azure using a dotted line, the solid line represents actual revenue generated annually. We note that GCP and AliCloud are expected to surpass the initial $500mn threshold for this chart for the first time in CY16, therefore their CY15 revenue does not show up on this chart.*

## A deflationary pressure on IT Spend

We see public cloud as having a deflationary impact to the IT spending market. While CTOs noted that cost is generally not a top three reason they adopted public cloud (top reasons include a faster time to market, scale and agility), public cloud drives efficiency in infrastructure spend. First, before the public cloud, companies would have to build their data centers and pay for the related software to handle peak capacity, even when it was not being utilized 90% of the time. Now enterprises can use the public cloud to absorb those spikes, while seeing significant savings from only having to build out what they need on a normal basis. An example of cost savings from migrating data centers is News Corp (parent company of Dow Jones) as it expects to save $100mn by migrating 75% of its data centers to AWS (AWS re:Invent, November 2013). Second, vendors in this space have gone

out of their way to continually lower prices for public cloud IaaS, helping customers save even more on their public cloud deployment (see page 21 for more information). Finally, we estimate that public cloud can be roughly one third the cost of hosting in house for a small to mid-sized company building continuous-use applications (See *Cloud Platforms Volume One, January 13, 2015* for the full analysis).

**Exhibit 22: IT Spend (Software, Computers and Peripheral Equipment, Communications Equipment) as a % of Non-Farm Business GDP**




*Source: Department of Commerce, Goldman Sachs Global Investment Research. Note: Computers and communications equipment is adjusted for estimated changes in net imports.*

# Speaking to the experts – Conversations with over a dozen CTOs

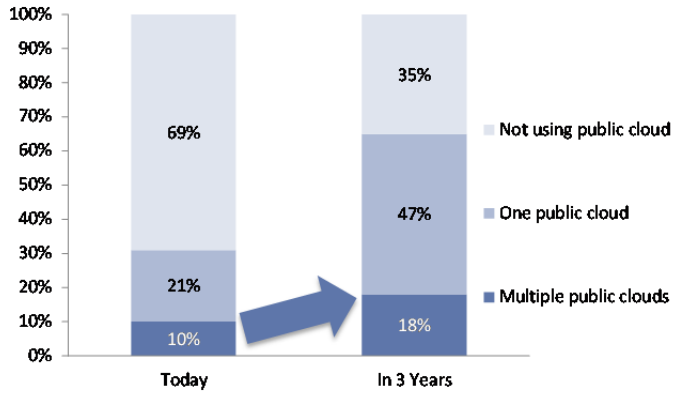
We spent the last six months discussing public cloud trends with over a dozen CTOs and industry veterans and summarize our key takeaways below.

## Multiple clouds usage becoming more prevalent

**We are seeing a trend towards organizations using multiple public clouds, which helps show that basic compute and storage offerings can be substituted between vendors.**

- **The majority of organizations are likely to use at least one public cloud over the next few years.** Most in the industry refer to multi-cloud as an organization either experimenting or starting to run one or more workloads outside of their traditional data center environment. This could be as simple as a developer using their credit card to purchase at least one instance on any public cloud or a company with over 90% of their workloads in public cloud. Our December 2015 survey of 100 CIOs found that 31% of respondents are using at least one public cloud today and will grow to 65% in three years (see Exhibit 23 below). However, we have seen surveys that show responses for customers using multiple clouds as high as 82%, which includes hybrid cloud, multiple public and multiple private clouds (RightScale 2016 State of the Cloud Report). We note that our survey found that the vast majority of respondents expect to only use one public cloud in the next three years (47%), likely helping AWS's given its first mover advantage.
- **Of the organizations we surveyed in December 2015, 10% responded that they were using multiple clouds today, and 18% responded that they expect to use multiple clouds in three years.** While the industry focus has been on the initial adoption of public cloud, we are focused on examining the next phase of the market – the use of multiple public clouds. We found that respondents who do not use public cloud today expect to use AWS, GCP and Rackspace in three years. Respondents who use one cloud today (mostly AWS and Azure) expect to add Azure (if they weren't using it already) and Rackspace in three years. Finally, the four respondents who already use multiple clouds expect to add or switch to AWS.

**Exhibit 23: 18% of respondents expect to use multiple clouds in 3 years, up from 18% today**




*Source: Goldman Sachs Investment Research Survey, December 2015.*

- **While the use of public cloud is still early, there are over a handful of well-known companies using multiple public clouds, including Apple, Coca-Cola, Spotify, General Electric, Domino's Pizza, News Corp and Wix.** Most of those customers, however, are using one public cloud for a majority of their workloads and another public cloud is used for a specific use case. For example, General Electric is primarily migrating workloads to AWS, but also uses Azure for a handful of GE Healthcare division's apps. And Domino's Pizza is using Azure for their ecommerce site, but their marketing department also uses GCP to improve their marketing programs. In the exhibit below, based on public disclosures we list a selection of customers, and indicate those who use multiple public clouds.

**Exhibit 24: Public Cloud customers by vendor, highlighting those that use multiple clouds (based on public disclosures)**

| AWS | Azure | GCP | Oracle IaaS & PaaS | AliCloud |
|---|---|---|---|---|
| Adobe | Adobe | Apple | Avaya | BlogMint |
| Apple | 3M | Best Buy | Brinks | Philips |
| City of McKinney, Texas* | Boeing | Brightcove | ClubCorp | Quixey |
| Coca-Cola | BMW | Coca-Cola | Comcast | Schneider Electric |
| Conde Nast | DocuSign | Disney Interactive | Dubai Airports | WorkTile |
| FINRA* | General Electric | Evernote | General Electric | |
| Hertz* | Heineken | Evite | Gilead | |
| Intuit* | Honeywell | Feedly | Grant Thorton | |
| Johnson & Johnson | Jet.com & Walmart | Home Depot | KPN | |
| Juniper* | Johnson & Johnson | HTC | Manchster Airport | |
| Kempinski* | Land O' Lakes | Kaplan | Mazda | |
| Land O' Lakes | Lufthansa | Khan Academy | Motorola | |
| Netflix* | Mazda | Land O' Lakes | Outfront Media | |
| News Corp | McKesson | News Corp | Pfizer | |
| Nippon Express* | Nissan | Snapchat | Riot Games | |
| Pfizer | Pearson | Spotify | Samsung | |
| Spotify | Rockwell Automation | The New York Times | Skanska | |
| Suncorp* | Rolls Royce | Ubisoft | State Bank of India | |
| Schneider Electric | Samsung | Udacity | T-Mobile | |
| Time* | Schneider Electric | U.S. Cellular | Tippett Studio | |
| Trek | Toyota | Wix | Toyota | |
| University of Notre Dame* | Trek | Workiva | Trek | |
| Wix | Uber | Zulily | UK Government | |

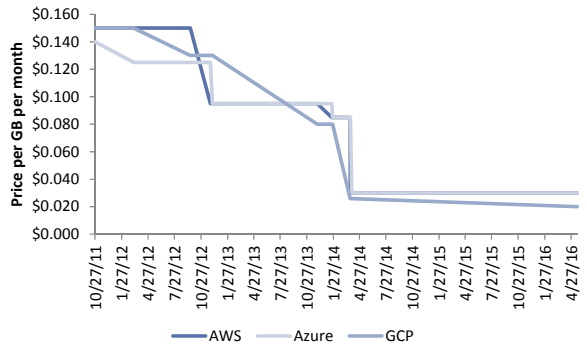
*Source: Company data, Goldman Sachs Investment Research. *Indicates a customer that is all in on AWS, as defined by Amazon at their Re:Invent conference 2015. This list did not include six organizations that were listed as all-in customers on AWS (AOL, Clark, Magazine Luiza, Fast Retailing, Met Global, The Guardian, Smiles, Talen Energy and NDI).*

# Follow the Leader – Public Cloud price dynamics

**Price cuts from one vendor impacting the price of other vendors has slowed, but is still prevalent to specific services**. Typically, Google has initiated a wave of price cuts, which have been closely followed by Amazon and Microsoft. For example, in March 2014 Google cut the price of Google Compute Engine (GCE) 32% and committed to follow Moore's Law, passing on savings from 20-30% annual decreases in underlying hardware costs to customers. Within a week, Amazon reduced AWS EC2 prices by 40% and Microsoft reduced Azure compute prices by up to 35%. While price cuts had been less drastic in CY15, we still saw price reductions from one vendor followed by pricing cuts by other vendors in May/June 2015.

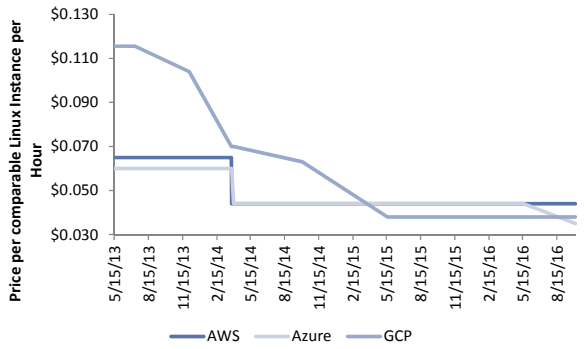
In 2016, not all vendors have responded and matched price cuts, as demonstrated in January and August/October. In January 2016, we saw Amazon and Microsoft cut pricing for specific compute instances, while GCP waited. Then in August 2016 GCP cut pricing for pre-emptible virtual machines and Microsoft followed in early October with up to 50% cuts of their A1 and A2 virtual machines, new 36% lower Av2 virtual machines, and up to 15% discounts on their Dv2 and F series instances (see Exhibits below). Public cloud vendors are still 1/3 the price of on-premise options (based on our analysis from Volume 1 of this series comparing the price of public cloud versus on-premise for a mid-sized company building continuous-use applications).

**Exhibit 25: IaaS object storage pricing per GB per month**



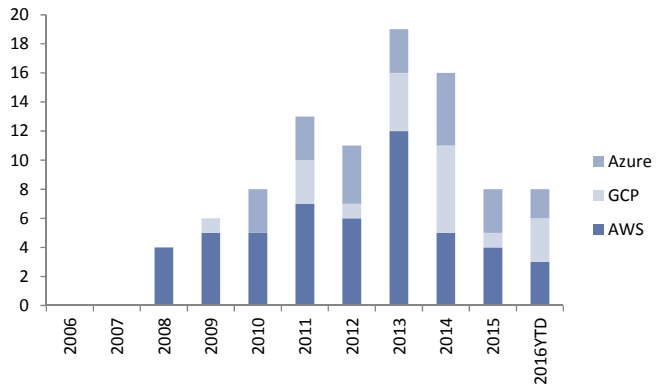

*Source: Goldman Sachs Investment Research and publicly available data. Based on pricing for the first terabyte of data stored.*

**Exhibit 26: IaaS on-demand compute pricing per hour**




*Source: Source: Goldman Sachs Investment Research and publicly available data. Based on pricing for similar small instances on one vCPU.*

**Exhibit 27: The volume of price cut announcements peaked in CY13**




*Source: Goldman Sachs Investment Research and publicly available data. Includes the announcements of limited time offers.*

### Pricing comparison between vendors

As mentioned previously, GCP is often cited by customers as cheaper than competitors as their on-demand instance list prices are per-minute instead of rounding up to the nearest hour while they also automatically apply volume discounting (unlike AWS). Beyond typical on-demand pricing, GCP offers preemptible VMs, which have similar savings to AWS spot instances (up to 80% less than regular instances), but that's where the comparison stops. This service offers the same machine types as on-demand instances, however at any time Google can terminate (preempt) the user's instance if Google requires those resources for other uses. Therefore this service is typically used for fault-tolerant workloads or batch jobs.

With Azure, customers can pay typical on-demand pricing as a prepaid subscription or as an enterprise agreement. On-demand pricing, like GCP, is also per minute (was per hour prior to June 2013). Microsoft's compute pre-purchase plans are similar to reserved instances. Customers can pay a year in advance (minimum of $6k) and receive a 5% discount. Customers with an enterprise agreement can add Azure by making an upfront commitment on spend. This allows customers to get the best pricing on infrastructure and they can pay annually within certain thresholds.

**Exhibit 28: AWS reserved and spot instance savings vs. on-demand pricing and GCP preemptible instance savings vs. on-demand pricing**

Sample of three different instance types per each cloud vendor. Types below do not match between vendors.

| AWS Instance | OnDemand | Spot Pricing | | Reserved Pricing | | |
|---|---|---|---|---|---|---|
| Type | US East Linux Pricing | US East Linux Pricing | Savings vs. OnDemand | US East Linux All Upfront, 1 Year | Effective Hourly Pricing | Savings vs. OnDemand |
| m3.medium | $ 0.067 | $ 0.0120 | 82% | $ 353 | $ 0.040 | 40% |
| c3.large | $ 0.105 | $ 0.0173 | 84% | $ 542 | $ 0.062 | 41% |
| i2.2xlarge | $ 1.705 | $ 0.1938 | 89% | $ 11,104 | $ 0.423 | 75% |

| GCP Instance | OnDemand | Preemptible Pricing | | Reserved Pricing |
|---|---|---|---|---|
| Type | US Full Price | US Pricing | Savings vs. OnDemand | |
| n1-standard-1 | $ 0.050 | $ 0.0100 | 80% | Not Available |
| n1-standard-2 | $ 0.100 | $ 0.0200 | 80% | |
| n1-standard-32 | $ 1.600 | $ 0.3200 | 80% | |

| Azure Instance | OnDemand | Spot/Preemptible Pricing | Reserved Pricing |
|---|---|---|---|
| Type | East US Linux Price | | |
| A1 Basic | $ 0.035 | Not Available | For enterprise agreement customers, compute pre-purchase plans offer discounts up to 63% off for upfront pre-purchase of 12 months |
| A2 Basic | $ 0.079 | | |
| A3 Basic | $ 0.176 | | |

*Source: Company websites, analysis completed in September 2016.*

# Stock Takeaways and Public Cloud Differentiators

## Amazon Web Services (AWS)

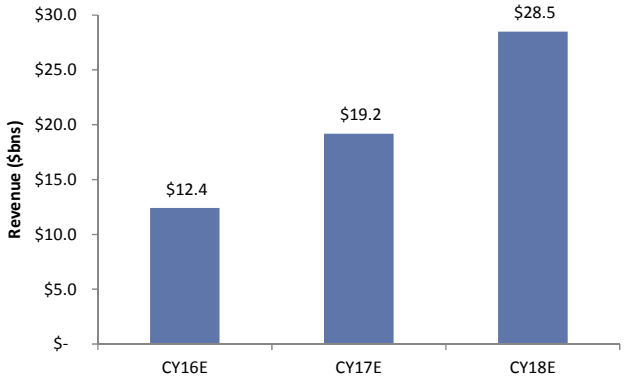
*Amazon is covered by Goldman Sachs Analyst Heath Terry*

***We believe AWS will continue to be the public cloud share leader by revenue (35% of the public cloud market in CY15 to 40% in CY20), and extend further into their large base of over one million active customers. AWS has been successful in their early attempts to get customers to move up their stack, as customers take on new Amazon built services such as Aurora (MySQL database), Redshift (data warehouse), and Lambda (serverless computing). Despite competitors Azure and GCP aggressively building out their public cloud feature sets to catch up to AWS, with an increasing amount of features being built annually by AWS, we believe it will take years before they are able to reach parity.***

### What public cloud could mean to numbers

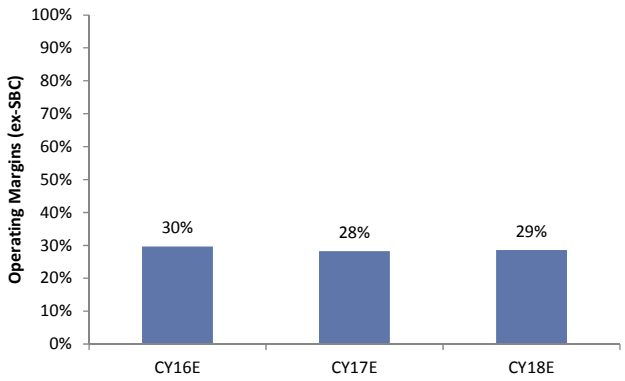
**Revenue and margin forecasts:** We are modeling AWS revenue of $12.4bn in CY16E, up 57% yoy. We expect growth to slowly decelerate to 55% yoy in CY17E and 49% yoy in CY18E to reach $28.5bn in AWS revenue in CY18E. Meanwhile, we expect AWS operating margins to stay roughly flat over the next two years.

**Exhibit 29: GSe AWS revenue estimates CY16-18E ($bns)**




*Source: Goldman Sachs Investment Research.*

**Exhibit 30: GSe AWS Operating Margin (ex-SBC) estimates CY16-18E**




*Source: Goldman Sachs Investment Research. Assumes 45% of total annual D&A is allocated to AWS, similar to our valuation analysis.*

**Valuation:** We note that AWS is a key component of the valuation framework for Amazon. While the business contributes 9% of Amazon's LTM revenue, we believe it contributes nearly half of the company's enterprise value, as we value the business on a 12x EV/Sales multiple.

**Exhibit 31: Amazon Sum of the Parts Valuation**
$mns, except per share data

| 2017 | Revenue | Margin | Op Profit | D&A | EBITDA | EV/EBITDA | EV/Sales | Value | '15-'18 Revenue | '15-'18 Op Inc. |
|---|---|---|---|---|---|---|---|---|---|---|
| **Core business** | | | | | | | | | | |
| North America | 98,794 | 4.9% | 4,808 | 3,724 | 8,532 | 27.0x | 2.3x | 230,351 | 23% | 33% |
| International | 53,887 | -2.6% | (1,382) | 2,031 | 649 | 32.0x | 0.4x | 20,784 | 21% | NM |
| AWS | 19,186 | 28.3% | 5,421 | 4,708 | 10,129 | 22.7x | 12.0x | 230,229 | 53% | 64% |
| **Total** | **171,866** | **5.1%** | **8,847** | **10,463** | **19,310** | | | | | |
| **Enterprise value** | | | | | | | | **481,364** | | |
| Net debt (cash) | | | | | | | | (7,813) | | |
| **Equity value** | | | | | | | | **489,177** | | |
| Shares outstanding | | | | | | | | 484 | | |
| **SOTP valuation** | | | | | | | | **$1,010** | | |
| **Current price** | | | | | | | | **$770** | | |
| **Upside/downside** | | | | | | | | **31%** | | |

*Source: Goldman Sachs Investment Research.*

We then backed into the implied valuation of AWS based on our SOTP methodology. We estimate that Amazon's AWS will contribute 53% of non-GAAP operating income in CY20, implying an EPS contribution of $18.44. Our SOTP valuation for AMZN attributes 48% of the company's value to AWS (based on 12X 2017E EV/Sales), which equates to a per-share equity value of $483. Our SOTP attributes the remaining 52% of AMZN's value to the e-commerce business, implying a per share equity value of $527 (based on 27X 2017E EV/EBITDA for North America, and 32X 2017E EV/EBITDA). While our SOTP valuation is based on the EV/EBITDA and EV/Sales multiples discussed here, these imply a P/E multiple for AWS of 34X, while we expect the operating income from AWS to grow at a 5-year CAGR of 55% through 2020. Our 12-month $1,010 target implies 36% upside to the closing price on 11/15.

**Exhibit 32: AWS's potential contribution to valuation**

| Potential Valuation Impact | | |
|---|---|---|
| CY20E AWS non-GAAP EPS | $ | 18.44 |
| Discount rate | | 9% |
| Discounted AWS EPS | $ | 14.24 |
| P/E | | 34x |
| AWS Value per share | $ | 483 |
| | | |
| Amazon ex-AWS non-GAAP EPS | $ | 3.68 |
| P/E | | 143x |
| Amazon ex-AWS Value per share | $ | 527 |
| | | |
| Amazon price target (SOTP) | $ | 1,010 |
| Upside to 11/15 close | | 36% |

*Source: Goldman Sachs Investment Research.*

## Differentiators and Areas to Improve

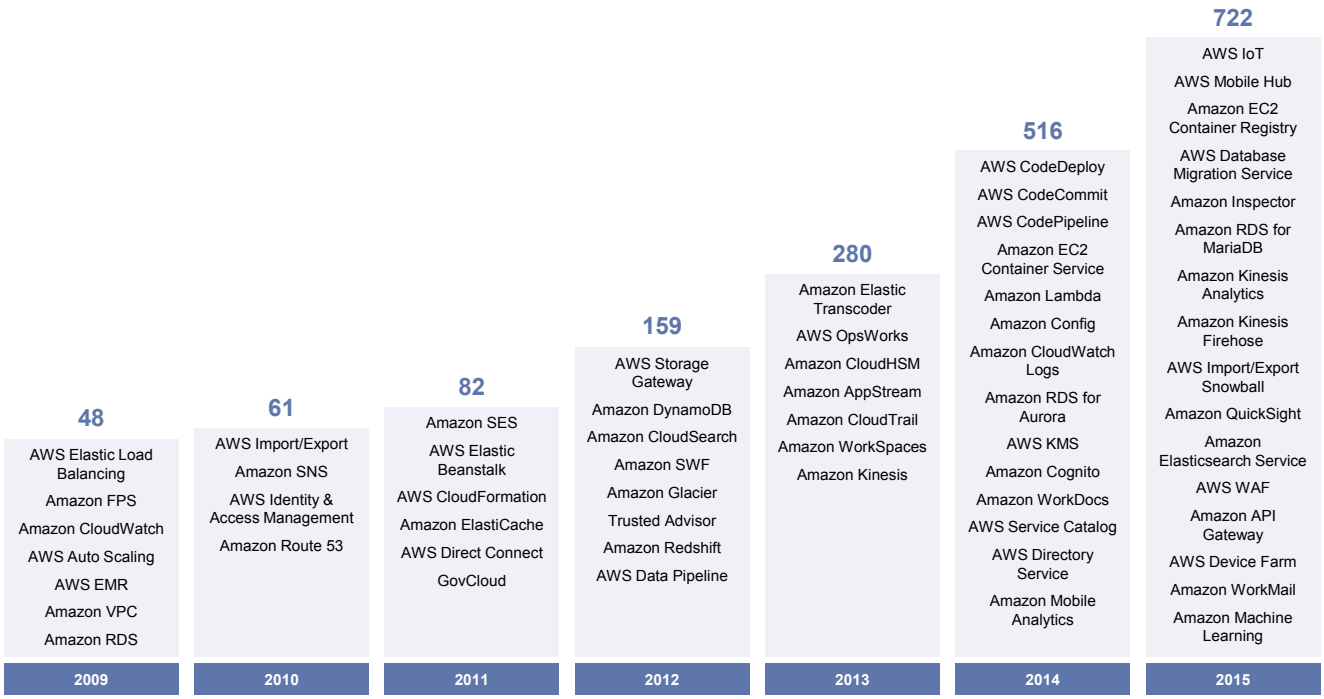
Below we summarize our findings and feedback received from AWS customers pertaining to AWS's key strengths and areas to improve.

| Differentiators | Areas to Improve |
|---|---|
| ***"AWS has a remarkable lead in terms of revenue, customers and product features"*** *– Enterprise Customer* | ***"Two years ago there was a wide feature gap between AWS and Azure, but in the last 8 months it is getting smaller as base level services become more commoditized"*** *– Enterprise Customer* |
| ***"AWS will be incredibly hard to catch…we have seen the services grow from pure compute to a best in class full software stack"*** *– Enterprise Customer* | ***"In terms of feature parity, AWS wins big time. But the infrastructure is much better, more stable and performant on Google."*** *– Enterprise Customer* |
| ***"Even if AWS raised prices by 10%, we most likely wouldn't move, due to the time and effort involved"*** *– Public Sector Customer* | ***"Reserved instances are just another thing to manage…there is minimal savings…and you can't make the instances bigger"*** *– Enterprise Customer* |

## Differentiators

- **AWS created the public cloud market, and has been the clear leader in revenue for a decade. This status and experience has helped customers decide to adopt or standardize on AWS.** Starting in 2006, years earlier than AWS and GCP (especially with IaaS, where AWS has an 8 year advantage over those two vendors), AWS created the public cloud market with the launch of their Simple Storage Service (S3). They have sustained their first mover advantage a decade later, with over 1mn active customers in over 190 countries, and generating ~$11bn in LTM revenue (~$13bn run rate as of 3Q16). For enterprise customers, it is helpful that AWS has a long list of reputable referenceable customers from different industries, have a range of use cases, complexity levels, and different deployment sizes, such as the CIA, Netflix, and Conde Nast (see Exhibit 24 on page 20 for our customer comparison). AWS also has a large ecosystem of system integrators that can help implement customers' visions at scale.
- **The broadest offering.** Besides being the largest public cloud vendor by revenue (~$11bn LTM revenue) and customers, Amazon is known for having the broadest offering, with hundreds of new features and services launched annually across multiple categories, including compute, storage, networking, database, management, and analytics. In 2013, the company launched 280 new features and services, in 2014 they launched 516, and in 2015 they launched 722. See the Exhibit below for more detail on the types of new major services offered each year. While other vendors are launching services at a rapid pace to try and catch up to AWS, customer feedback suggests that AWS still has the broadest feature set.

**Exhibit 33: Amazon AWS: Number of major features and services launched annually (select services in each column)**




*Source: Company data, Goldman Sachs Investment Research. Columns not drawn to scale.*

- **Has developed a full technology stack over the last decade and is seeing positive traction with Amazon branded software.** Over the years, Amazon created their own infrastructure software, including operating systems (Amazon Linux), databases (Aurora and DynamoDB), and data warehouses (Redshift). This software competes with traditional enterprise software vendors, such as Microsoft, Oracle, Red Hat, Pivotal Greenplum and the open source technology, Hadoop.

  We believe their strength in database is with MySQL, where they offer their managed RDS MySQL service and their own MySQL database, Amazon Aurora. For background, Oracle owns MySQL after it acquired its previous parent, Sun Microsystems, in 2010. MySQL has a strong following, with over 5mn users and 35k downloads daily (source: MySQL website). However, most use the unpaid version of the software, resulting in a relatively smaller revenue contribution to Oracle (likely around $100mn). AWS's database migration services make it easier for customers to move their MySQL databases onto AWS MySQL RDS or Amazon Aurora (if running version 8.5, not the latest version at the moment). However, migrating from PL/SQL (Oracle's extension for SQL, which is used in Oracle's database) to Amazon Aurora is challenging and requires significantly more resources to accomplish.

  While it's still very early for both Aurora and Redshift, these have been the fastest growing services on AWS.

  - **Aurora** is AWS's MySQL compatible relational database that has similar performance to an enterprise database, and is currently the fastest growing service on AWS, despite only being available since July 2015. We describe a few customer use cases below:

- **Expedia** had a Microsoft SQL Server based architecture that was growing rapidly in cost. They decided to evaluate and use Aurora. Expedia found that it met their performance and scale requirements at a lower cost than SQL Server.
- **Insurance claims processor, ISCS,** found that Aurora was 70% cheaper than Microsoft SQL Server.
- **Thomas Publishing** migrated certain Oracle databases onto Aurora for specific use cases.

- **Prior to Aurora, Redshift** was AWS's fastest growing service. Redshift is an enterprise data warehouse that is a tenth the cost of many traditional data warehouses and has been broadly available since February 2013.
  - NTT Docomo migrated to Amazon Redshift in 2014, after using Pivotal Greenplum on-premise as their 6 petabyte data warehouse. After migrating, they found that analytical queries ran 10x faster in Redshift and meet security requirements equal to their on-premise environment.

We also note that Amazon partnered with VMware in October, the leading on-premise virtualization software vendor, to provide a new service, VMware Cloud on AWS. The service will run on AWS's bare metal servers, with VMware vSphere, NSX and Virtual SAN technologies and the service will be managed and sold by VMware starting in mid-2017. While we view this partnership as significant for VMware, as it gives them a more competitive hybrid cloud footprint, we believe this is also sign that on-premise production workloads will have a long tail to them given the re-platforming requirements. As such, as Microsoft's Azure messaging is increasingly resonating with customers, we view this as giving AWS a foothold in the hybrid cloud world.

- **Leading the charge in serverless computing. Serverless has the potential to be a future cloud computing architecture.** Serverless computing is a new approach to offering application infrastructure that abstracts away a level of complexity for the end customer. For example, instead of paying for a virtual server, adding layers of infrastructure software, and configuring and managing it for a simple five second task (such as collecting data on where users clicks on a website), customers can sign up for Amazon Lambda, run a simple command, and they're done. The added benefit is that they also only pay only for the five seconds of underlying infrastructure used, rather than the hours or days it took to set it up as a virtual server. To be clear, servers are still being used by public cloud vendors to provide the service, but the end customer doesn't have to manage them.

  Customer feedback suggests that Amazon is the furthest ahead in serverless computing with their serverless compute service, Lambda (launched in November 2014). With Lambda, customers only have to focus on developing their application code, instead of managing the underlying infrastructure (determining the sizes of the servers or instances needed, managing the cluster as it scales up and down and worrying about optimizing the cluster). This is useful for customers who don't want to have control over configuring and managing virtual machines, storage, networking and operating systems. For example, Reuters uses Lambda to automatically transcode and compress images that are uploaded to an S3 bucket. AWS launched Lambda in November 2014. Serverless also has potential to increase the utilization of the customer's overall cloud computing environment.

While it appears AWS has taken an early lead in awareness (most customers are aware of the service and what it can do), serverless is still a relatively new area and all three cloud vendors are now participating in it. Google announced its service, Google Cloud Functions in February 2016, while Microsoft announced its service, Azure Functions, in March 2016.

## Areas to Improve

- **Reserved instances.** Reserved instances allow customers to reserve Amazon EC2 computing capacity for 1 or 3 years, in exchange for a significant discount (up to 75%) compared to typical On-Demand instance pricing. AWS's reserved instance options have had mixed reviews, especially compared to GCP's automatic volume discounts. Many enterprises would like Amazon to abandon reserved pricing or move to a serverless pricing model, which would further improve end user utilization. While a change could help increase demand, it could potentially degrade AWS's current revenue stream, as many customers have excess capacity running on virtual machines that could be more efficient on a serverless environment.

  We found that feedback on reserved instances was mixed, as some customers found reserved pricing complicated and restrictive. One even said that they would need a full time hire to manage the process if they wanted to use reserved pricing. Other customers found reserved pricing simple and used them with workloads that they had confidence would be in use for multiple years.

  **Spot Pricing.** Beyond on demand and reserved instance pricing, AWS has Spot Instances, where customers can bid for unused EC2 capacity. Pricing is set by Amazon and fluctuates based on demand. To acquire an instance, a user places a request for the instance type and number of instances, availability zone, and the highest price they are willing to pay. If this price exceeds the current Spot price then the request is fulfilled (if it equals or is lower than the spot price the request is not fulfilled). Customers can save up to 90% using this method.

- **Other vendors starting to catch up, but AWS still has a significant lead.** With rapid feature innovation, AWS is still well ahead of its peers in terms of feature breadth. However, customers are starting to see little difference between the basic compute and storage services between vendors. Some engineers have commented that they believe GCP is better technically from a network design perspective compared to AWS and Azure. However, one CTO commented that GCP is still approximately two years behind AWS when comparing the breadth of features.

# Microsoft Azure

***We upgrade Microsoft to Buy from Neutral with 16% upside to our new $68 price target. Microsoft shares have posted a choppy 6% YTD return with better performance recently on the back of June and September quarter positive surprises. But we believe the shares are poised to more consistently outperform in the year ahead on the back of sustained traction in its Cloud offerings (Azure and Office 365) overlaid by steady albeit not spectacular performance out of its legacy PC-linked software business.***

Given our field work on the public cloud market, our view of Azure's strong positioning, and our analysis of Microsoft's financials which points to inflecting profitability, we believe Microsoft can sustain double digit EPS growth through FY19 and beyond versus its flat EPS CAGR from FY12-FY16. For the last 4+ years our non-GAAP EPS estimates have been below the Street and reported results typically followed. With this upgrade, we raise our out-year non-GAAP EPS estimates above consensus and see the potential for upside.

Our upgrade is predicated on the following 3 points:

1) A maturing Office 365 subscription-based product cycle that should see a ramp-up in gross profit dollars as it moves away from the initial profit drag phase burdened by start-up and customer transition costs.

2) A strong and growing foothold in hybrid cloud driven by its Azure platform which should provide investors with visibility on a longer-term ramp in margins and absolute profitability for its Intelligent Cloud segment.

3) After four years of forecasting below-consensus non-GAAP EPS, our estimates for FY17-FY19 are now 2% to 4% above the Street.

**Exhibit 34: Changes to Microsoft total revenue and non-GAAP EPS estimates (GSe)**

| | FY15A | FY16A | FY17E | FY18E | FY19E | FY20E |
|---|---|---|---|---|---|---|
| Microsoft Total Revenue ($bns) | | | | | | |
| Current | $94 | $92 | $95 | $102 | $111 | $122 |
| *yoy* | *8%* | *-2%* | *3%* | *7%* | *9%* | *10%* |
| Prior | $94 | $92 | $95 | $101 | $109 | $119 |
| *yoy* | *8%* | *-2%* | *3%* | *7%* | *8%* | *9%* |
| Increase/(Decrease) vs. Prior | | | $0 | $1 | $1 | $3 |
| | | | | | | |
| Microsoft Total non-GAAP EPS ($) | | | | | | |
| Current | $2.63 | $2.79 | $3.01 | $ 3.30 | $ 3.74 | $ 4.41 |
| *yoy* | *-1%* | *6%* | *8%* | *10%* | *13%* | *18%* |
| Prior | $2.63 | $2.79 | $2.95 | $ 3.09 | $ 3.43 | $ 3.88 |
| *yoy* | *-1%* | *6%* | *6%* | *5%* | *11%* | *13%* |
| Increase/(Decrease) vs. Prior | | | $0.06 | $0.21 | $0.31 | $0.53 |

*Source: Goldman Sachs Investment Research. Our non-GAAP EPS estimate includes stock based compensation. The difference between Microsoft's GAAP and non-GAAP estimates is due to its deferral of revenue related to Windows10 that the company adds back to its GAAP results.*

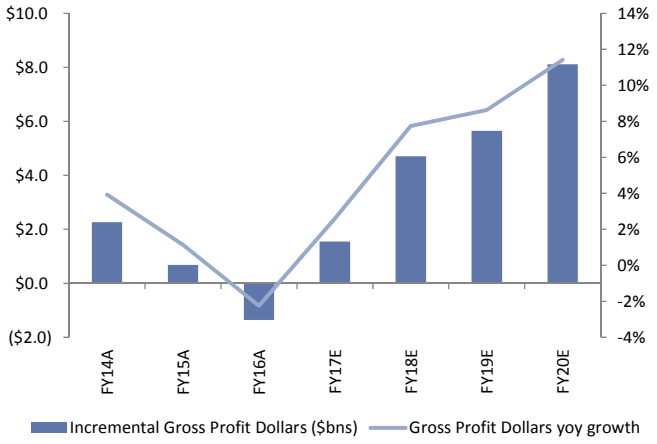
### *Expect sustained growth in gross profit dollars starting in FY17*

After being below consensus on EPS for the last 4+ years, we have raised our estimates to be ahead of the Street on both revenue and non-GAAP EPS. Our estimates fell below consensus due to two primary reasons, both of which impacted the company's gross margins and as such gross profit growth. The first reason was related to the company's cloud transition, as high gross margin for on-premise products started being substituted

for low gross margin (or even negative in the case of Azure) cloud based offerings. The second reason was due to Nokia, which having closed in April 2014 put considerable pressure on corporate gross margins. In fact, with FY15 (ending June 2015) being the first full year post its close, we estimate Nokia generated $7.5bn in revenue but just ~$700mn in gross profit (~9% gross margin). These headwinds have lessened over the years as the company shrunk Nokia's product footprint and as Office 365 gross margins starting ramping as they achieved meaningful scale. While Office 365 has already started to see its gross margins ramp, we believe growth in gross profit dollars will start to follow. Furthermore, over the next few years we see this same trend starting to accrue in the company's Intelligent Cloud segment, driven by Azure.

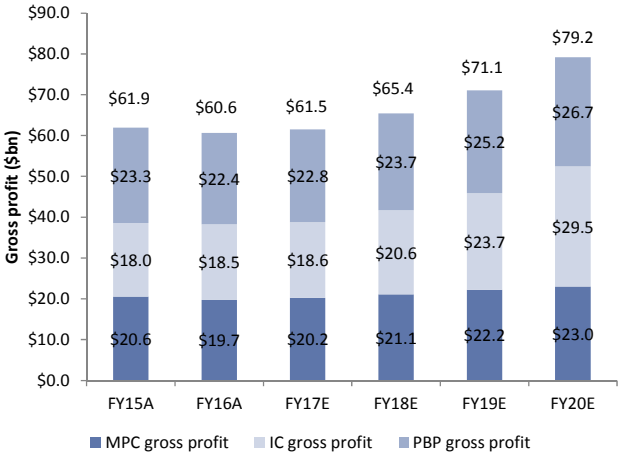
We have high conviction in our above consensus revenue and non-GAAP EPS forecasts for the next few years. In fact, given the improving gross margins in its Office 365 and Azure segments, we believe Microsoft should start to see its growth in gross profit dollars accelerate. For example, after seeing gross profit growth of +1% in FY15 and -2% in FY16, we see growth accelerating from +3% to +11% over the next 5 years (Exhibit 35).

**Exhibit 35: Incremental non-GAAP Gross Profit Dollars**




*Source: Company data, Goldman Sachs Global Investment Research.*

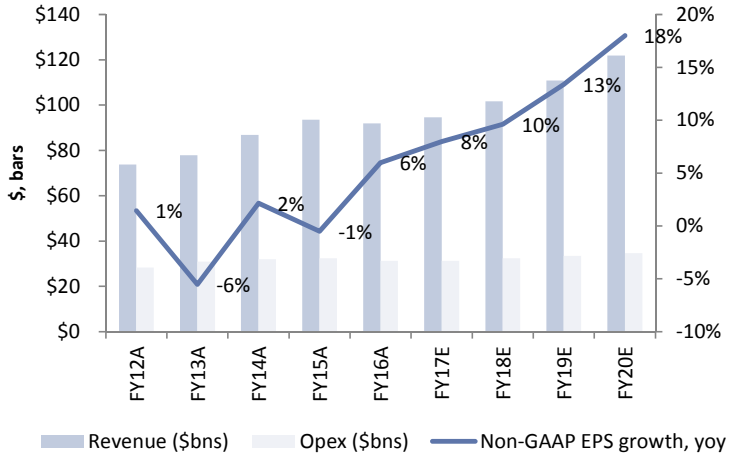
**Exhibit 36: Microsoft total gross profit by segment**




*Source: Company data, Goldman Sachs Global Investment Research.*

When coupled with discipline in operating expenses, which excluding restructuring and integration costs we estimate will be the same in FY18 as they were in FY15, the company is poised to see earnings growth also accelerate for the next 4 years and surpass double digit growth (in FY18) for the first time since FY11.

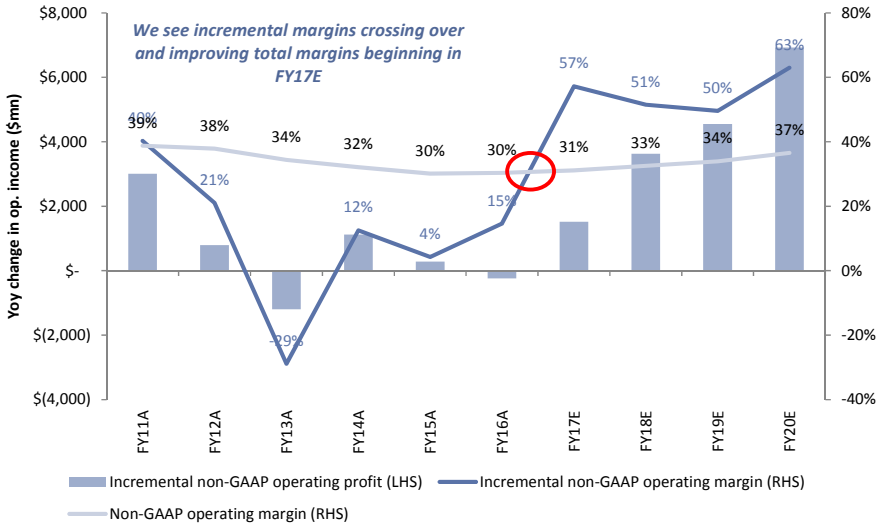
**Exhibit 37: Microsoft revenue, operating expenses, and non-GAAP EPS growth**




*Source: Company data, Goldman Sachs Investment Research.*

The driver of this acceleration in earnings growth can be seen in the exhibit below which highlights Microsoft's incremental non-GAAP operating margins versus reported non-GAAP operating margins. We define incremental operating margin as the absolute dollar change in total non-GAAP revenue over the absolute dollar change in non-GAAP operating profit. We estimate incremental operating margins crossing and starting to benefit corporate non-GAAP operating margins starting in FY17.

**Exhibit 38: Microsoft's incremental non-GAAP operating margins versus total corporate operating margins**




*Source: Company data, Goldman Sachs Investment Research. This chart includes Nokia.*

## Increasing our estimates for Intelligent Cloud

We are increasing our revenue and gross margins estimates for Intelligent Cloud as we see higher Azure revenue growth more than offsetting the decline in on-premise Server and Tools infrastructure software. While we have slightly increased the rate of decline in the

on-premise Server and Tools business, we have left our Enterprise Services forecasts unchanged.

With a large Microsoft customer base and strong C-level relationships, we believe Azure can continue to grow revenue and improve gross margins over time. Our views are supported by channel partners, who have commented recently that they are seeing accelerating uptake of Azure amongst enterprise customers, particularly as it relates to hybrid cloud.

**Exhibit 39: Changes to Intelligent Cloud revenue and gross profit estimates (GSe)**

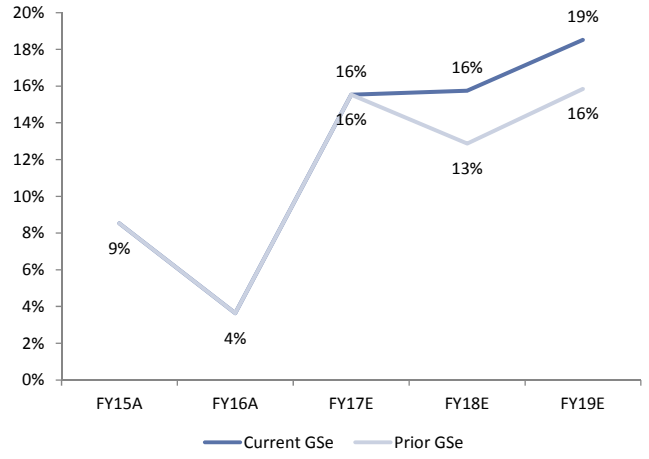
| | FY15A | FY16A | FY17E | FY18E | FY19E | FY20E |
|---|---|---|---|---|---|---|
| Azure Revenue ($bns) | | | | | | |
| Current | $1.0 | $2.1 | $4.6 | $8.5 | $14.5 | $22.5 |
| *yoy* | *101%* | *113%* | *116%* | *85%* | *70%* | *55%* |
| Prior | $1.0 | $2.1 | $4.6 | $7.8 | $12.6 | $18.2 |
| *yoy* | *101%* | *113%* | *116%* | *70%* | *60%* | *45%* |
| Increase/(Decrease) vs. Prior | | | $0.0 | $0.7 | $2.0 | $4.3 |
| | | | | | | |
| Server & Tools Revenue ($bns) | | | | | | |
| Current | $17.9 | $17.4 | $18.0 | $17.6 | $16.5 | $15.1 |
| *yoy* | *6%* | *-3%* | *3%* | *-2%* | *-6%* | *-9%* |
| Prior | $17.9 | $17.4 | $18.0 | $17.7 | $17.0 | $16.5 |
| *yoy* | *6%* | *-3%* | *3%* | *-2%* | *-4%* | *-3%* |
| Increase/(Decrease) vs. Prior | | | $0.0 | ($0.0) | ($0.5) | ($1.4) |
| | | | | | | |
| Total Intelligent Cloud Revenue ($bns)[1] | | | | | | |
| Current | $23.7 | $25.0 | $28.2 | $32.2 | $37.5 | $44.6 |
| *yoy* | *9%* | *6%* | *13%* | *14%* | *17%* | *19%* |
| Prior | $23.7 | $25.0 | $28.2 | $31.5 | $36.1 | $41.7 |
| *yoy* | *9%* | *6%* | *13%* | *12%* | *14%* | *16%* |
| Increase/(Decrease) vs. Prior | | | $0.0 | $0.6 | $1.5 | $2.9 |
| | | | | | | |
| Total Intelligent Cloud Gross Profit ($bns)[1] | | | | | | |
| Current | $18.0 | $18.5 | $18.6 | $20.6 | $23.7 | $29.5 |
| *yoy* | *7%* | *3%* | *0%* | *11%* | *15%* | *24%* |
| Prior | $18.0 | $18.5 | $18.6 | $19.6 | $21.4 | $24.5 |
| *yoy* | *7%* | *3%* | *0%* | *6%* | *9%* | *15%* |
| Increase/(Decrease) vs. Prior | | | $0.0 | $1.0 | $2.3 | $4.9 |

*Source: Goldman Sachs Global Investment Research. [1]Total Intelligent Cloud Revenue and Gross Profit includes Enterprise Services, which isn't shown separately as our estimates did not change.*

Microsoft has commented in the past that it believes a reasonable growth rate for the company's Server products and cloud services (Server and Tools + Azure revenue) is the low double digits. However, the rapid adoption of Azure and the company's hybrid cloud positioning causes us to believe that growth is likely to be in the 15-20% range for the next few years. Due to increased revenue scale, we have also increased our gross margin forecast for Azure. We maintain our Azure gross margin estimate for FY17 and raise FY18 by 10pts to 30% and FY19 to 15pts to 45%.

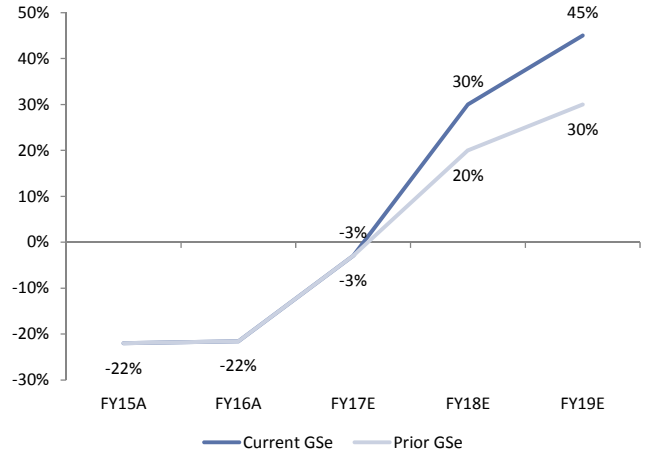
These changes are highlighted in the two exhibits below.

**Exhibit 40: Server products and cloud services revenue growth yoy (current vs. prior)**




*Source: Company data, Goldman Sachs Investment Research.*

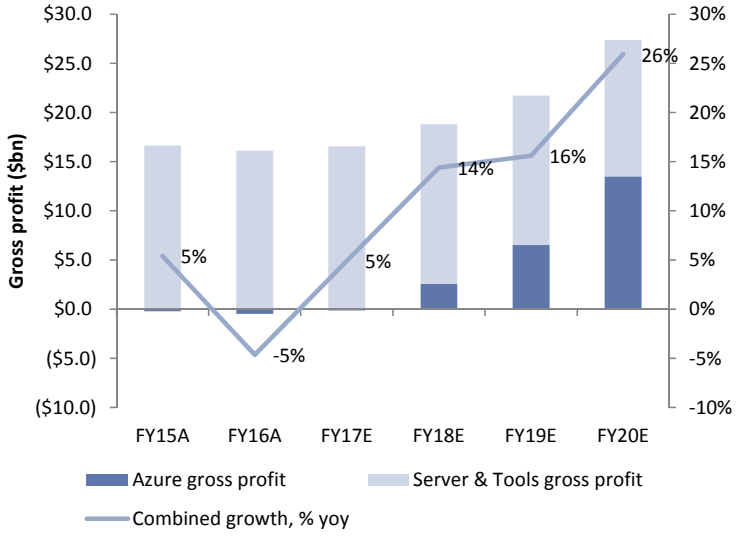
**Exhibit 41: Azure gross margins (current vs. prior)**




*Source: Company data, Goldman Sachs Investment Research.*

With these increases in our gross margin assumptions for Azure, we now forecast Intelligent Cloud gross profit dollars to grow at an accelerating rate for the foreseeable future. In fact, after being flat at ~$18bn in FY15 to $18.5bn in FY17E, we see the incremental change in gross profit dollars rising from $2bn in FY18 to ~$7bn in FY20.

**Exhibit 42: Gross profit for Intelligent Cloud sub-segments**



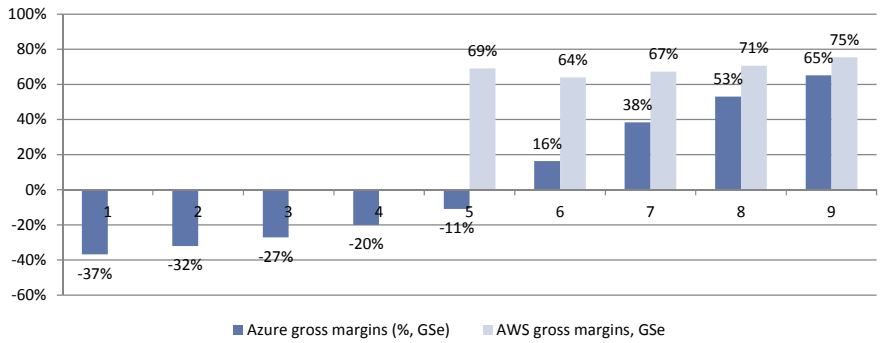

*Source: Company data, Goldman Sachs Global Investment Research.*

Our FY19 Azure revenue estimate of $14.5bn compares to AWS's CY16 revenue forecast of $12.4bn and our gross margin forecast of 45%. As such, we see our gross margin estimates for Azure relatively conservative versus AWS and compare the revenue and profitability of both platforms in the exhibit below.

Below we compare our estimates for Azure gross margins compared to AWS at a similar revenue size. We have display our Microsoft forecasts on a CY basis to make it on par with

Amazon's FY end. For example, in CY16, we expect Azure to expand to negative 11% non-GAAP gross margins, which compares to AWS in CY13 (where they had similar revenue of $3bn), which we believe generated up to 69% gross margins. We discuss how we arrived at AWS's gross margins in the AWS section of this report.

**Exhibit 43: GSe Azure non-GAAP gross margins compared to our estimated non-GAAP gross margins for AWS at a similar level of revenue***



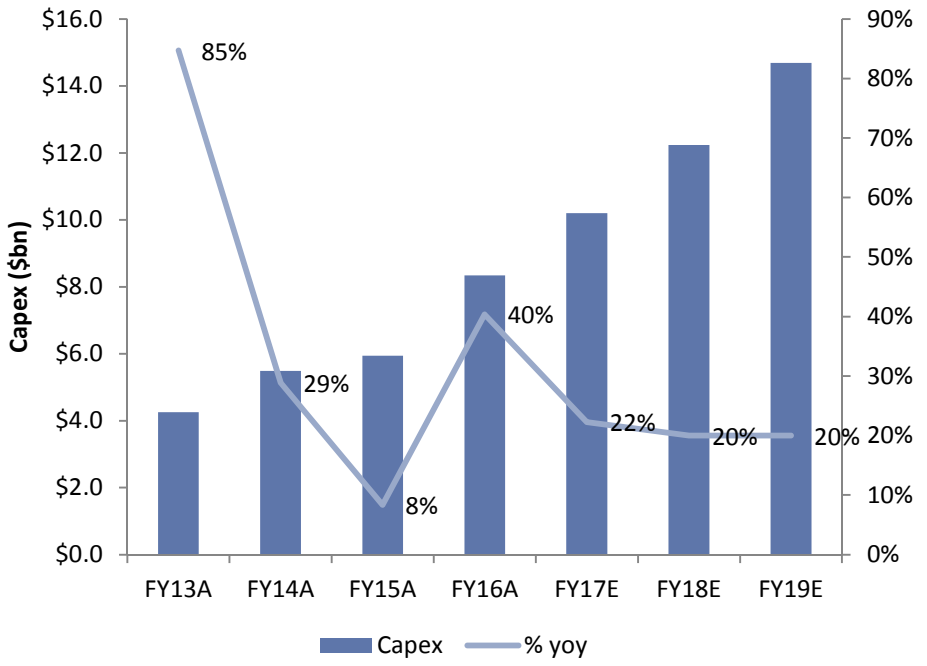

| Key (Revenue in $bns) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Year** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** |
| Azure | CY12 | CY13 | CY14 | CY15 | CY16E | CY17E | CY18E | CY19E | CY20E |
| Revenue | $0.1 | $0.3 | $0.7 | $1.5 | $3.2 | $6.3 | $11.1 | $17.9 | $26.5 |
| AWS | CY09 | CY10 | CY11 | CY12 | CY13 | CY14 | CY15 | CY16E | CY17E |
| Revenue | $0.2 | $0.5 | $1.0 | $1.8 | $3.1 | $4.6 | $7.9 | $12.4 | $19.2 |

*Source: Company data, Goldman Sachs Investment Research. AWS gross margin calculation discussed in the AWS section of this report. *Amazon started disclosing AWS financials in 1Q15,with historicals going back to 1Q14, therefore this Exhibit shows actual revenue in CY14 and CY15, and GS estimates prior to CY14. Amazon disclosed annual depreciation in their recent 10-K for CY13-CY15, which was used to back into the gross margin calculations above.*

As mentioned previously, our CIO discussions and surveys indicate Microsoft's hybrid cloud message is increasingly resonating with customers, with many accelerating spend on Azure. And, unlike the type of applications already on the public cloud today, which are net new or test and development workloads, applications that customers are looking to migrate over are enterprise applications that are stickier, and more difficult to move off once they transition over to public cloud. This feedback has started to show up in results, as Microsoft reported Azure revenue growth inflecting to 116% yoy vs. 102% the quarter before, as Azure compute usage more than doubled versus the prior year. One area of competitive differentiation that Microsoft can leverage is its existing enterprise agreement spending contracts with its large customer base. Our field work highlights that Microsoft is leveraging these existing customer relationships to increase adoption of Azure. We note that Microsoft has been issuing enterprise agreement customers credits to use Azure, incentivizing customers to use, and eventually renew and expand their usage and spend on public cloud (more detail later in this section).

As mentioned previously, we have raised our gross margin forecasts for Azure. While there are certain fixed costs, such as data center space, servers and networking equipment that are built out in advance, these do not scale directly proportionate to the amount of revenue generated. Next, as growth in capex starts to slow, this leads to lower D&A, resulting in higher gross margins. Management noted that after growing capex 40% yoy in FY16, they expect growth to moderate in FY17.

**Exhibit 44: Microsoft capex**




*Source: Company data, Goldman Sachs Global Investment Research.*

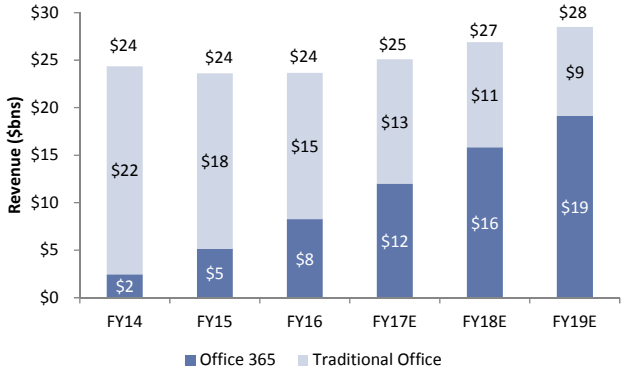
## A closer look at the Office transition

Microsoft has been transitioning users from traditional Office (perpetual license) to Office 365 (subscription) in earnest since FY12. While there are many variables involved, at a very high level, this transition has placed pressure on corporate gross margins as one dollar of traditional revenue at a 90% plus gross margin was being replaced by one dollar of Office 365 revenue at a margin of 5% in FY12, increasing to a 67% gross margin we estimate in FY16. These two product lines create the vast majority of the company's Productivity and Business Processes segment, representing 89% of segment revenue and 87% of gross profit in FY16.

Unlike Azure, gross margins for Office 365 have already ramped considerably given the revenue scale. That having been said, we see a similar trend occurring in this segment as we see in Intelligent Cloud, whereby the absolute change in gross profit dollars from year to year turns positive for the first time since FY15 and accelerates from there. For example, we model an absolute change in gross profit in FY17 of $1bn increasing to $1.5bn in FY20. While this is not as significant as what we are forecasting in Intelligent Cloud, it remains a tailwind nonetheless.

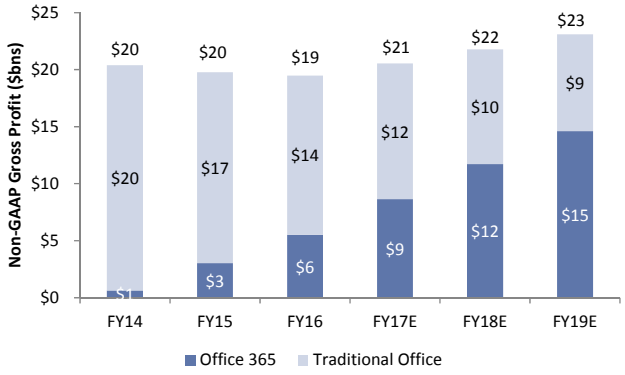
For example, in Exhibit 45 below, in FY16, Office 365 increased revenue by $3bn, while Traditional Office revenue decreased $3bn, netting zero incremental revenue in FY16. However, because Office 365 has lower gross margins, Office 365 gross profit increased $2.5bn, while traditional gross profit decreased $2.8bn, netting negative $0.3bn in incremental gross profit in FY16. So while on a dollars basis Office 365 has been a tailwind to revenue and gross profit dollars, on a net basis with traditional Office, it pressured combined incremental gross profit dollars down by $0.6bn in FY15 and $0.3bn in FY16.

**Exhibit 45: Combined Office Revenue ($bns, Traditional Office plus Office 365)**




*Source: Company data, Goldman Sachs Investment Research.*

**Exhibit 46: Combined Office Gross Profit Dollars ($bns, Traditional Office plus Office 365)**

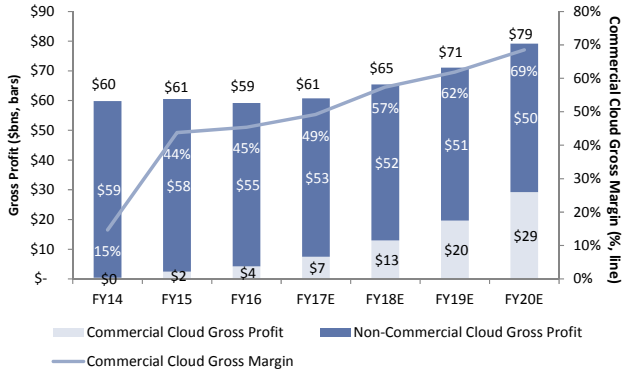



*Source: Company data, Goldman Sachs Investment Research.*

***Commercial Cloud gross margins set for meaningful expansion***

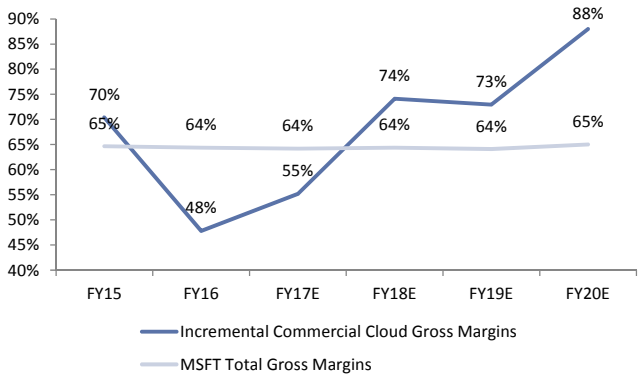
As Commercial Cloud related revenue grows from 11% of total company sales in FY16 to 29% in FY19 and 35% in FY20, gross margins for this segment of revenue will also ramp. Commercial cloud, which is a combination of Azure plus Office 365 commercial plus Dynamics CRM online, will help improve corporate gross margins, as gross profit dollars increase from $4bn in FY16 to $29bn in FY20E and incremental gross margins increase from 48% in FY16 (below the corporate average of 64%) to 88% in FY20E (above the corporate average of 65%).

**Exhibit 47: Commercial Cloud gross profit dollars are growing as a proportion of total gross profit**




*Source: Company data, Goldman Sachs Investment Research.*

**Exhibit 48: Commercial Cloud incremental gross margins**




*Source: Company data, Goldman Sachs Investment Research.*

## What public cloud could mean to numbers

***Azure's potential contribution to EPS***

We then examined the potential impact of Azure to Microsoft's per share value using our updated revenue and gross margin estimates. For CY20, at $27bn of revenue, we estimate Azure reaches 35% operating margins, compared to AWS at 29% operating margins (FX-adjusted ex-SBC and other) over the last twelve months at less than half the size (AWS

generated LTM revenue of $11bn). Using the same tax rate and shares as overall Microsoft, we estimate Azure represents $0.94 of non-GAAP EPS in CY20.

Discounting Azure's CY20 EPS estimates back to CY17 (at an 8% rate) and using a 25x P/E multiple (in line with our assumption for Alphabet's GCP and which we see conservative versus other high growth infrastructure software companies at 30x), we calculate an Azure value of $19 per share. Backing into our price target of $68, this implies Microsoft excluding Azure is valued at a 15x P/E compared to its CY17E P/E of 19x using Microsoft's closing price as of 11/15.

**Exhibit 49: Azure's potential contribution to valuation**

| Potential Valuation Impact | | |
|---|---|---|
| CY20E Azure non-GAAP EPS | $ | 0.94 |
| Discount rate | | 8% |
| Discounted Azure EPS | $ | 0.75 |
| P/E | | 25x |
| Azure Value per share | $ | 19 |
| | | |
| Microsoft ex-Azure non-GAAP EPS | $ | 3.19 |
| P/E | | 15x |
| Microsoft ex-Azure Value per share | $ | 49 |
| | | |
| Microsoft price target | $ | 68 |
| Upside to 11/15 close | | 16% |

*Source: Goldman Sachs Investment Research.*

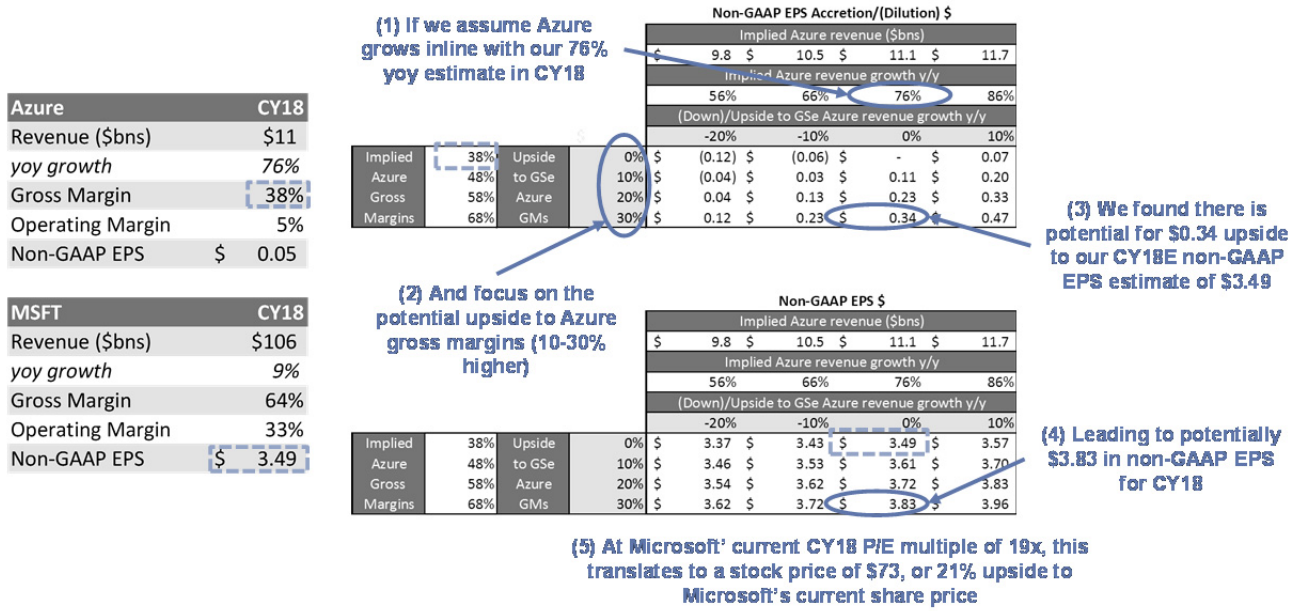
### Sensitivity to Azure gross margins

We created a scenario analysis that would help determine the potential impact Azure would have on non-GAAP EPS at different gross margin levels. Our current yoy revenue growth rate for Azure in CY18 of 76% yoy to $11.1bn reflects a higher growth rate than what AWS grew at a similar revenue size (AWS grew 70% yoy at $8bn in revenue and 57% yoy at $12bn in revenue). However, our Azure gross margin estimate for CY18 is 38%, lower than what we estimate AWS's gross margin rate was when it was at a lower revenue level (we estimate AWS had up to a 67% gross margin when it generated $8bn in sales). We make the following assumptions:

- Our sensitivity analysis assesses the non-GAAP EPS impact to CY18 if Azure's revenue growth rate was 20% lower to 10% higher - this implies +56% to +86% yoy growth versus AWS's revenue growth of 55-70% at a similar size
- Gross margins are the same to 30% higher than what we are estimating today – this implies 38% to 68% gross margins compared to our estimate of a maximum of a mid to high 60%s gross margin for AWS at an $8bn revenue rate

Based on these assumptions, if we assume Azure grows revenue in line with our estimate, and focus on what the potential upside to Azure gross margins are, we found that there is potential for $0.34 of upside to our CY18E non-GAAP EPS estimate of $3.49 to $3.83. At Microsoft's current CY18 P/E multiple of 19x, this translates to a valuation of $73, or 21% upside to Microsoft's current share price (see Exhibit below).

**Exhibit 50: Accretion/(dilution) to CY18E non-GAAP EPS based on sensitivity to CY18E Azure revenue growth and gross margins**




*Source: Goldman Sachs Investment Research.*

## Differentiators and Areas to Improve

In the following section we summarize our findings and feedback we received from Azure customers pertaining to Azure's key strengths and areas to improve.

| Differentiators | Areas to Improve |
|---|---|
| ***"Azure is the best [public cloud] at running Microsoft's technology, is what my top engineers say"*** *– Enterprise Customer* | ***"We went with AWS, even though we are primarily a Windows environment"*** *– Public Sector Customer* |
| ***"Even as powerful as AWS was, we chose Microsoft [Azure] because there was a business relationship there"*** *– Enterprise customer that migrated from on-premise to public cloud in less than 6 months* | ***"We ramped down our Microsoft relationship. It's confusing if you're trying to use Azure for a non-Microsoft stack. We moved our consumer facing Microsoft stack to LAMP (Linux, Apache, MySQL, PHP)."*** *– Enterprise Customer* |
| ***"We are seeing fast growth in Azure. EA (Enterprise Agreement) customers are getting cloud credits, sometimes $20-30k. They spend $2k with us to figure out how to use it."*** *– Implementation Partner* | ***"Azure doesn't have as many built out services as AWS…but is probably only a year or 18 months behind."*** *– Enterprise Customer* |

## Differentiators

- **Hybrid Cloud.** Hybrid cloud is simply defined as a combination of public and private clouds. Similar to mainframes, which are still used by many of the Fortune 500 today, we do not believe that most enterprises will move 100% off of their current infrastructure in the next decade, if at all, and therefore hybrid cloud will likely be the most popular architecture for enterprises over the next ten years. Microsoft believes and, we concur, that they have a competitive advantage in hybrid cloud for those running significant Windows workloads. The company created Azure Stack, a hybrid cloud platform, that provides a standardized architecture both on-premises and in the Azure public cloud, including the same application model and tools. This allows customers to easily move workloads between their on-premise data center to the public cloud easier, for test and development or workloads that require the company to scale during specific times of the year. Microsoft stated that demand for hybrid cloud help lead them to double digit annuity growth within their server products and cloud services line in F4Q16 (June 2016).

  Lately, we believe consumption patterns have started to favor Azure, with many in the channel seeing accelerating revenue growth as customers see Azure's hybrid capabilities as a differentiator. Many see this strength continuing as most enterprises expect to have a hybrid model in the future.

- **Leveraging vast base of enterprise relationships as hybrid messaging resonates.** As one of the largest technology providers in the world, Microsoft can leverage its vast number of existing enterprise relationships with C-level executives and partners to grow its Azure footprint. While 12-18 months ago many discussed the cloud credits they were receiving to try its technology, we now have partners and customer discussing how their usage has been exceeding commitment levels.

- **Excels at running Microsoft software.** Not surprisingly, multiple CTOs have mentioned that Microsoft runs their own software better than any other cloud. That includes Microsoft's database (SQL Server) and operating system (Windows Server). We note that several years ago, the only place to run a Windows workload in the cloud was on AWS, which gave Amazon the opportunity to cross-sell adjacent technologies into Microsoft's installed base. With the rise in Azure adoption, Microsoft now has the ability to capture that cross-sell opportunity.

## Areas to Improve

- **Continue to build out its feature set, referenceable customers and partner ecosystem.** We believe Azure needs to continue to build out its referenceable customer base (after successfully working with customers like BMW, Formula One, and Jet.com), continue to catch up to AWS by broadening its feature set, and continuing to build out its ecosystem of partners who can help customers optimally implement Azure.

### Valuation

We are raising our 12-month price target from $60 to $68 on our raised estimates and higher multiples. Our price target is based on equal-weighted valuations based on DCF, EV/FCF and P/E. We use a CY17 EV/FCF multiple of 18x (16x prior), slightly below large cap technology companies given slightly slower FCF growth yoy. We use a CY17 P/E of 22x (20x prior), which represents a P/E multiple which is within the range of its large cap technology peers. Alphabet is trading at 23x CY17E on a GAAP EPS basis and 18x on a non-GAAP basis and note that Microsoft's EPS is most comparable to Alphabet's GAAP

EPS as both of these would include stock based compensation). Our DCF uses a 3% FCF perpetuity growth rate (unchanged).

In the Exhibit below, we show debt adjusted free cash flow in addition to free cash flow (FCF) to examine multiples that exclude the impact of different levels of debt. We define debt adjusted free cash flow as cash flow from operations minus the change in working capital (except for deferred revenues) minus tax adjusted net interest income/(expense) minus capital expenditures.

- On a CY17 enterprise value to debt adjusted free cash flow valuation, Alphabet trades at 19x. If we apply Microsoft's debt adjusted free cash flow of $27bn, it implies a $73 per share value, or 24% upside to Microsoft's closing price on 11/15 and 7% upside to our price target.
- However, we note that Alphabet is expected to grow at a faster pace CY16E-18E, with debt adjusted FCF growth of 40% yoy in CY16 (Microsoft +3%), 11% in CY17 (Microsoft 9%) and 22% in CY18 (Microsoft 3%). Adjusting for growth, on an EV/debt adjusted free cash flow to growth basis, we found that at each stock's closing price on 11/15, Microsoft and Alphabet trade at roughly the same multiple, 1.67x for Microsoft and 1.70x for Alphabet.

**Exhibit 51: Comps ($mns, except per share data)**

| Company | Rating | Price | Price Target | CY17E EPS (incl. SBC) | CY17E P/E (EPS incl. SBC) | CY17E EPS (ex. SBC) | CY17E P/E (EPS ex. SBC) | CY17E EV/FCF | EV/Debt Adjusted FCF CY17E | EV/Debt Adjusted FCF Growth CY17E | CY17E FCF Growth yoy | CY17E Revenue Growth^ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **LargeCap Tech** | | | | | | | | | | | | |
| **Alphabet** | Buy* | $775.16 | $970 | $33.98 | 23x | $43.05 | 18x | 18x | 19x | 11% | 9% | 21% |
| **Amazon** | Buy* | $743.24 | $1,010 | $5.95 | 125x | $9.50 | 78x | 29x | 40x | 43% | 33% | 25% |
| **Apple** | Buy | $107.11 | $124 | $9.80 | 11x | $10.42 | 10x | 4x | 11x | 8% | 33% | 7% |
| **Cisco** | Neutral | $31.70 | $32 | $2.04 | 16x | $2.45 | 13x | 9x | 10x | -2% | 1% | 3% |
| **Facebook** | Buy | $117.20 | $162 | $4.04 | 29x | $5.31 | 22x | 28x | 27x | 18% | 13% | 36% |
| **Oracle** | Buy* | $39.17 | $47 | $2.32 | 17x | $2.75 | 14x | 13x | 12x | -11% | -13% | 2% |
| **Mean** | | | | | **37x** | | **26x** | **17x** | **20x** | **11%** | **13%** | **16%** |
| | | | | | | | | | | | | |
| **Microsoft** | Buy | $58.87 | $68 | $3.06 | 19x | $3.35 | 18x | 15x | 15x | 9% | 16% | 5% |

*Source: Company data, FactSet, Goldman Sachs Investment Research. *Amazon, Alphabet and Oracle are CL-Buy. ^Alphabet is using net revenue.*

# Alphabet's Google Cloud Platform

***We believe that Google Cloud Platform has the technical capabilities and innovative services (machine learning, Big Data) required to potentially increase market share from 3% in CY16 to 13% in CY20, becoming the #3 vendor over the next 5-10 years. After hiring former VMware co-founder Diane Greene in November last year, GCP has made key changes to its leadership team, is building out its product line and data center footprint, and had achieved key enterprise wins at Spotify, Apple, The Home Depot, and more, demonstrating that GCP is serious about helping enterprises migrate to the cloud, one of the biggest misperceptions about the service prior to Ms. Greene's appointment.***

***Our analysis suggests that GCP can lift Alphabet's revenue growth 100-400bps annually from CY17-20E to 20% yoy in CY17, 19% in CY18, 19% in CY19 and 19% in CY20, while diluting margins just 30-60bps to 34.0% in CY17, 34.4% in CY18, 34.8% in CY19 and 35.3% in CY20. On CY17 basis, we believe GCP could potentially be worth ~$100 per share, valuing Alphabet at over $1,000 compared to our current price target of $970.***

We estimate that Alphabet will grow from having 2% market share in CY15 to 13% in CY20, becoming the third largest vendor in 2020. There are multiple catalysts driving this change. First, Alphabet appointed new leadership, most notably, Diane Greene in December 2015, the former co-Founder of VMware and Alphabet board member, to run the newly branded Google Cloud (Google Cloud Platform (GCP) and G Suite (formerly Google for Work)) with Urs Holzle, Google's eighth employee. Since then Ms. Greene appointed new heads of sales, marketing and professional services.

Second, Alphabet is in an extremely unique situation, able to leverage its years of knowledge managing over a million servers, scaling applications such as Google Search to over a trillion searches annually, and operating multiple products with over a billion users such as Gmail, Android, Chrome, Maps and YouTube. Along the way, Alphabet has created their own software to handle these unique challenges, and eventually productized them under GCP. This includes BigQuery (data warehouse), Kubernetes (container management), and their machine learning services. We have received positive feedback on these unique services; with users often commenting on how technically advanced the software is compared to other public cloud competitors, and as a reason they chose to migrate workloads to GCP. As enterprises start to migrate more complex workloads over to the public cloud we believe these products have the opportunity to attract more enterprises to adopt GCP.

Finally, Alphabet is already aggressively tackling their biggest weaknesses and responding well to feedback from customers and the channel, building out its enterprise sales force, fleshing out GCP's features and adding new regions. For example, GCP is expected to have over 40 zones (up from 15) by the end of CY17 compared to AWS's 44 by the end of CY16 and Azures 36 announced regions. Alphabet has also ramped capex spending 12x, from $810mn in CY09 to $10bn in CY15 and our estimated $9bn in CY16. In addition, GCP is often cited by customers as cheaper than competitors (Exhibit 57), although we note price is not a top 3 reason when choosing a public cloud vendor.

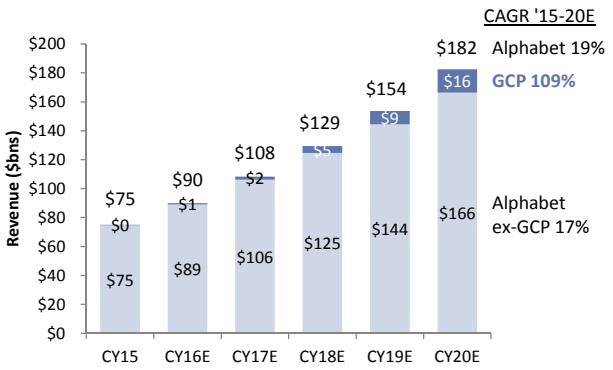
This approach has already started to pay off with wins at Apple, Spotify and The Home Depot (Apple was reported by multiple new sources but unverified by Alphabet). Through our checks, we believe this is just the start of a wave of customers that will adopt GCP, as enterprises are citing that the platform's technology is ahead of competitors, particularly around Big Data and machine learning, while pricing is lower. Furthermore, many believe

that GCP will innovate the most over the next five years. That having been said, we would caution that significant cultural change to become more enterprise focused is required as we move forward for GCP to fully benefit from the cloud computing wave.

## What public cloud could mean to numbers

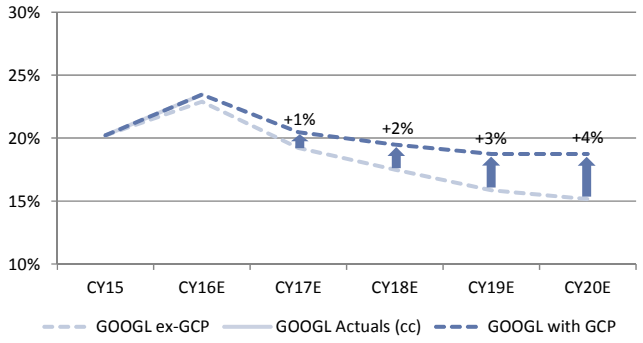
We believe public cloud could potentially help GCP add 100-400bps of revenue growth annually from CY17-CY20, as we estimate GCP grows from a $900mn revenue business in CY16 to a $16bn business in CY20 (106% CAGR).

**Exhibit 52: Impact to Alphabet's 2015-20E revenue CAGR**




*Source: Goldman Sachs Investment Research.*

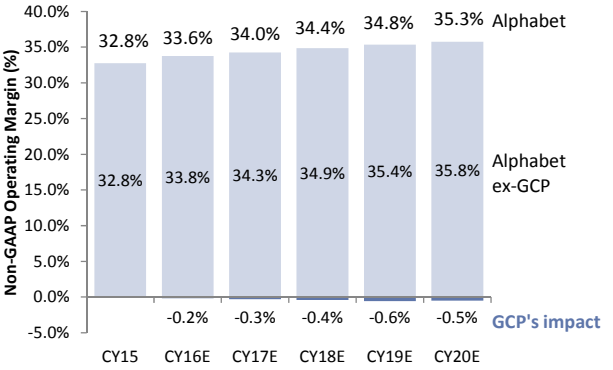
**Exhibit 53: We estimate GCP is driving 100-400bps of incremental Alphabet revenue growth CY17-20E**




*Source: Goldman Sachs Investment Research.*

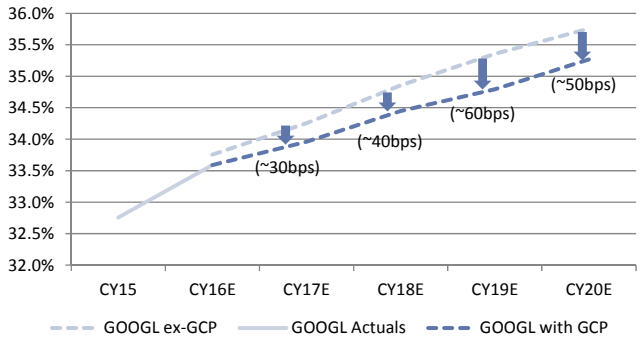
We then calculate operating margins for the business. While some investors are concerned that this business could be heavily dilutive to margins, we estimate GCP's impact is only roughly 30-60bps dilutive annually from CY17-CY20. This is due to our estimate of expanding non-GAAP operating margins of 17% in CY16 to 30% in CY20 for GCP.

**Exhibit 54: We estimate GCP is driving just 30-50bps of non-GAAP operating margin compression CY17-20E**




*Source: Goldman Sachs Investment Research.*

**Exhibit 55: This is in part due to our assumption that GCP's non-GAAP operating margins expand from 17% in CY16 to 30% in CY20**




*Source: Goldman Sachs Investment Research.*

We then examined the potential impact of GCP to Alphabet's valuation. Discounting GCP's CY20 EPS estimates back to CY17 (at 10%) and using a 25x P/E multiple (in line with the multiple we assume for GCP and which we see conservative versus other high growth infrastructure software companies at 30x), we estimate a GCP is value of $103 per share.

Using our price target of $970, it implies the remainder of the business (Alphabet excluding GCP) is valued at 20x P/E based on the company's closing price on 11/15.

**Exhibit 56: GCP's potential contribution to valuation**

| Potential Valuation Impact | | |
|---|---|---|
| CY20E GCP non-GAAP EPS | $ | 5.46 |
| Discount rate | | 10% |
| Discounted GCP EPS | $ | 4.10 |
| P/E | | 25x |
| GCP Value per share | $ | 103 |
| | | |
| Alphabet ex-GCP non-GAAP EPS | $ | 42.56 |
| P/E | | 20x |
| Alphabet ex-GCP Value per share | $ | 867 |
| | | |
| Alphabet price target | $ | 970 |
| Upside to 11/15 close | | 25% |

*Source: Goldman Sachs Investment Research.*

## Differentiators and Areas to Improve

In the following section we summarize our findings and feedback we received from GCP customers pertaining to GCP's key strengths and areas to improve.

| Differentiators | Areas to Improve |
|---|---|
| ***"We are betting that GCP will innovate the most [of AWS, Azure and GCP] in the next five years"*** *– Enterprise Customer* | ***"Google App Engine was ahead of its time, it is what Force.com is now, but was too early and too fast. They don't understand what we care about and what we need."*** *– Large Enterprise, not a customer* |
| ***"Google is way ahead, totally…Google has better technology, but Microsoft has a better go to market…We switched to Big Query recently. Google has a big advantage in data analytics"*** *– Enterprise Customer* | ***"We asked for a roadmap and they told me to call back in 2 months"*** *– Enterprise Customer* |
| ***"Up until now [May 2016] we were not clear how serious Google was for the enterprise…and now we run all of our big data efforts on Google's Cloud"*** *– Enterprise Customer* | ***"We signed an enterprise deal with Google in 2013 and we never saw them until a couple weeks ago [May 2016]"*** *– Enterprise Customer* |
| ***"Google is better on price"*** *– Enterprise Customer* | ***"Amazon has an amazing developer community. Google has to build that somehow"*** *– Enterprise Customer* |
| ***"TensorFlow [machine learning software] is a break through! As a developer, thank you Google."*** *– Developer* | ***"Google's feature set is probably a couple years behind"*** *– Enterprise Customer* |

## Differentiators

***For a deep dive on artificial intelligence and machine learning, including the ecosystem of enabling companies and the disruptive potential of AI-as-a-service, see our Profiles in Innovation report***

- **Innovating at a rapid pace, with Machine Learning as an area of differentiation.** Google CEO, Sundar Pichai, believes machine learning is an area of differentiation for GCP. While machine learning is a long-term investment for Google and it is still very early in the adoption cycle, the company believes they are uniquely capable to thrive in this area. We believe GCP is uniquely qualified with one of the largest information databases in the world to test their platform with, designing their own chips specifically for machine learning (although we note that Microsoft has designed its own field-programmable gate array (FPGA) chips for artificial intelligence tasks and Amazon has announced a P2 instance type with a GPU (graphics processing unit) chip also for compute intensive workloads like artificial intelligence), and the most fiber (networking) of any other cloud vendor.

  Google's machine learning offerings help developers instantly add difficult functionality to their applications with their four Machine Learning APIs (we briefly describe each below), while their Google's Cloud Machine Learning Platform allows users to easily build and test their own machine learning modules.

  - Google Cloud Vision API can detect faces, landmarks, text within images
  - Google Cloud Speech API converts audio to text in 80 languages
  - Google Natural Language API analyzes sentiment and syntax
  - Google Cloud Translate API translates text into different languages

  In addition, developers have been applauding Google for open sourcing their TensorFlow software library. Developers who know Python and C++ can quickly and easily create machine learning computations without a deep background in data science. Users have said TensorFlow is a "break-through". TensorFlow is being used today in Google search, Gmail, Google's speech recognition systems, and Google Photos.

- **Better technology in certain areas (according to customers), including GCP's Big Data and analytics services by enterprises**. We have seen an increasing number of large enterprises adopting Google's Big Data products, particularly BigQuery. BigQuery is GCP's low cost data warehouse that is fully managed by Google. In addition to the quotes in the beginning of this section, CTOs have said the following about Google's BigQuery software:

  *"An astonishing, powerful database"*

  *"BigQuery was more advanced, had the technical lead [over other public cloud offerings], so we switched over"*

  *"We rely heavily on Big Query"*

  *"[Amazon] Redshift can't match BigQuery"*

  We have heard positive feedback on both Amazon Redshift and Google BigQuery, so while there are some edge cases where customers have replaced one or the other (mostly to standardize), we believe both have very strong momentum. The technology that is being replaced most often, however, is primarily Hadoop clusters, and often existing data marts or data warehouses.

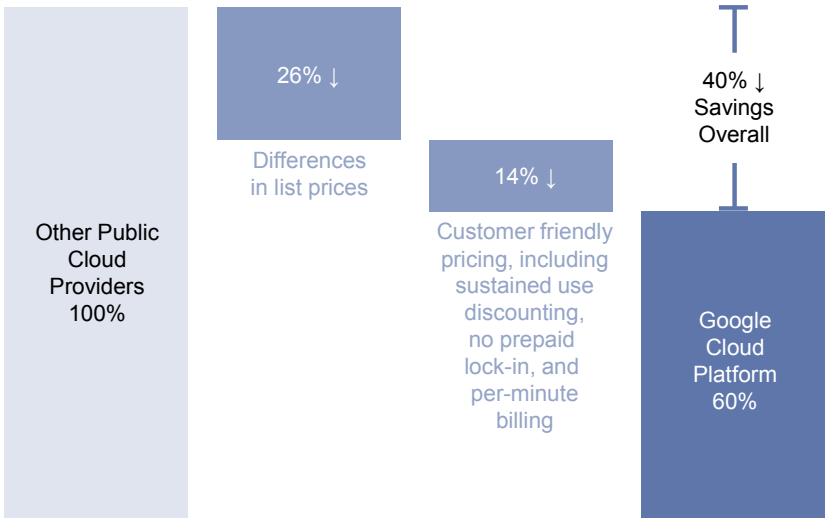
  We view this as a differentiator for Google. Google has a long history in the Big Data space, as their research team wrote the original white paper that inspired the creation of Hadoop (about MapReduce).

- **GCP has also led the charge providing software that manages containers, a technology that has become popular with developers over the past few years.** A container is infrastructure software that allows software developers to package their application code in a standard unit, similar to the concept of placing items in physical shipping containers for transport. In addition to application code, within each container is the software required for the application to run, such as system libraries, runtime and system tools. A top benefit of writing software code in containers is faster time to market. Within a standardized framework, containers can be used to break down an application into many components, or micro services. This allows multiple developers to work on different components of the application at the same time, without locking the application into one platform, software language, or where each component is in its development lifecycle.

  Alphabet has innovated in this area, developing Kubernetes, infrastructure software that is used by developers to manage the containers in their organization. While the use of containers is still early, Alphabet's technology has quickly started to become a standard for container orchestration. On Alphabet's 3Q16 earnings call, Google CEO Sundar Pichai noted that customers don't want to be locked into any single vendor, and Kubernetes can manage their applications written in containers across on-premise data centers and public clouds.

- **Customer friendly pricing, and often the low cost leader.** As discussed previously, unlike AWS's pricing models (on-demand, reserved instance, spot), GCP's pricing is straightforward and is often 40-50% less than competitors. GCP automatically gives volume discounts, no prepaid lock-in, charges per minute instead of per hour, and gives the option for configurable virtual machines, which should improve utilization, and therefore pricing.

**Exhibit 57: Google Cloud Platform is 40% less than other public cloud providers for many workloads**

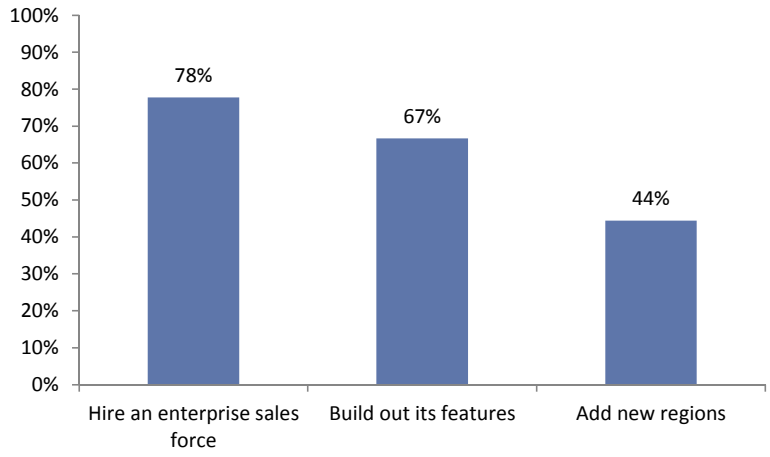



*Source: Google website, Goldman Sachs Investment Research.*

## Areas to Improve

**Alphabet is already aggressively tackling their biggest weaknesses, as identified by our CTO checks and survey.** We surveyed technology executives to determine areas Google can improve upon to gain further enterprise adoption. Similar to our diligence feedback with CTOs, the top there responses were: 1) hire an enterprise sales force, 2) build out GCP's features and 3) add new regions. We detail each below.

**Exhibit 58: In our conversations with ten CTOs from diverse industries, we found that the top three things Google needs to do to move their enterprise commitment further along was: hire an enterprise sales force, build out its feature set and add new regions**



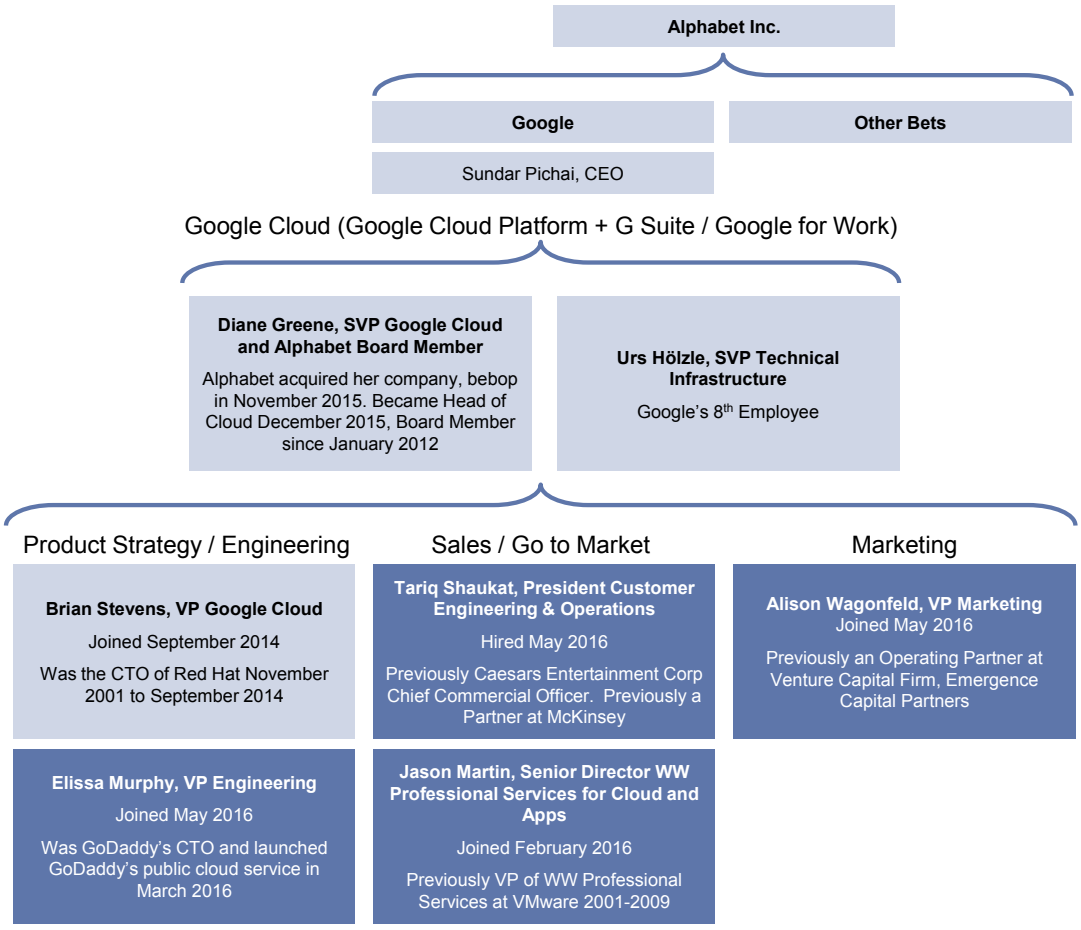

*Source: Goldman Sachs Investment Research.*

**Establishing their enterprise credibility with the appointment of Diane Greene as head of cloud, and customer wins at Spotify, The Home Depot, Coca-Cola, Evernote and Apple.** Alphabet has seen stronger momentum in the enterprise since they hired VMware Co-Founder and Alphabet Board member, Diane Greene as their head of cloud (though the acquisition of her company Bebop in late 2015). Since then, GCP has won multiple high profile enterprise accounts, including Spotify, The Home Depot, Coca-Cola, Evernote and Apple (Apple was reported by multiple news sources including CRN, but unverified by Google. They reported Apple is spending $400-500mn on Google Cloud).

**Google has been building out its cloud leadership team and enterprise sales force. We believe its vertical focus will be a differentiator for GCP.** Google has been fleshing out its Cloud Platform leadership team in 2016, hiring key executives for GCP, including the head of sales, head of marketing, and head of professional services. Recall that Google already hired Brian Stevens in September 2014, the former CTO of Red Hat, to lead product strategy for GCP. We outline key personnel involved with GCP in the Exhibit below.

As mentioned earlier, Alphabet rebranded its cloud efforts in September 2016 into a new business unit named Google Cloud, led by Diane Greene. Google Cloud includes GCP as well as G Suite, their application suite formerly named Google for Work.

**Exhibit 59: Google's Cloud Platform at Alphabet and key Cloud Platform leadership (new hires YTD in dark blue)**




*Source: Company information, Goldman Sachs Investment Research. This chart excludes Prabhakar Raghavan, VP of Apps and Nan Boden, Head of Global Technology Partners. We note that Diane Greene is the Head of Google Cloud, however in this chart we include Urs Holzle, as he is also a SVP and is heavily involved with Google Cloud.*

The company has also been focused on building out and improving its enterprise sales force. Diane Greene hired Tariq Shaukat, the former Chief Commercial Officers at Caesars Entertainment and McKinsey Senior Partner in May 2016, to run GCP's go to market, including sales. Mr. Shaukat is also responsible for Google Apps, an area that was run by Amit Singh (previously spent 20 years at Oracle) who is now the VP of Business and Operations for Virtual Reality at Google. We note that because public cloud is a complicated sale, public cloud requires more sales engineers in their sales force compared to a typical enterprise software company.

We believe a differentiator for GCP will be its vertical specific capabilities. This should help sales bring on new customers with specific requirements pertaining to banking, supply chain, retail and more.

Since Diane Greene took the position as head of cloud, she is not only building out GCP's enterprise sales force, but has been building out its partner network (see below) and is still starting to flesh out its reseller channel, with a new head of professional services hired in February 2016. GCP already has a strong support organization, staffed by site reliability engineers and dedicated customer support engineers.

She also addressed some of the smaller, but more problematic issues that made it more cumbersome for enterprises to use GCP, such as eliminating the need to have a Gmail

email address to use the service, improving identity and encryption management, and as mentioned previously, appointing a new head of sales/go to market. While these changes are less dramatic, customers feel like someone is finally listening to their issues.

**Technology partner network is being fleshed out, but is still missing Oracle -** We have also seen more vendors join GCP's Platform Partner Program (ClearDB and Datos IO most recently), enabling GCP to offer more technologies to customers. GCP has also been working with large enterprise vendors such as Red Hat, and in January 2016 they announced that they would support Red Hat OpenShift (PaaS) on GCP. GCP is also building its technology platform out through acquisitions, announcing in September 2016 they would acquire Apigee, a provider of API (Application Programming Interface) management software. The company plans to leverage Apigee's API solutions to help customers accelerate their move to the cloud, making it easier for APIs to be implemented and published.

GCP supports many popular third party and open source technologies, such as Microsoft, Red Hat, Ubuntu, MySQL, and MongoDB. However, we note that Google is still missing its certification for Oracle, the market leader in databases. We note that Amazon and Microsoft both have certification on Oracle's databases, as well as a number of other databases including SQL Server.

**Quickly broadening its feature set, some CTOs say GCP will be more innovative than AWS and Azure over the next few years.** As described earlier, we have received positive feedback from CTOs on GCP's recent and potential future pace of innovation. This includes innovating heavily in machine learning, Big Data and analytics and container management. Over the last year, GCP has also solved some of the obvious areas that needed to be addressed, such as giving customers encryption keys and meeting compliance requirements of certain customers such as HIPAA (Health Insurance Portability and Accountability Act of 1996).

**GCP is rapidly expanding its data center footprint.** Data center regions are locations where customers can run their resources (compute, storage, etc.). Each region contains at least one zone, which is isolated from failures in other zones. At GCP's conference in March 2016, Google announced they would add 12 regions by the end of CY17, triple the four regions they had at the announcement, US Central, US East, Asia East and Europe West. Since then Google has added one region (US West), and disclosed eight of the remaining locations (Northern Virginia, Sao Paulo, Singapore, Mumbai, London, Finland, Frankfurt and Sydney). We note that GCP intends to partner with vendors for data center space, having the 12 regions include a mix of GCP owned data centers and third party data centers. Adding the 12 regions would amount to a total of 16 GCP regions by CY17 (zones not disclosed) compared to 17 AWS regions and 44 zones by the end of CY16.

We note that each region has anywhere from one to five zones, making it difficult to compare both vendors on an apples to apples basis. Microsoft claims they have the most regions of any public cloud vendor with 30 regions versus AWS at 13 and GCP at 5 currently, with plans for 36 regions (announced 10/3, no timeline of general availability). However, Microsoft defines regions differently than AWS and GCP, where an Azure region (an area within a geography containing one or more data centers) is similar to a zone, and an Azure geography (area of the world that has at least one region) is closer to the definition of an AWS or GCP region. Therefore, Microsoft's 36 regions compares to AWS's 44 zones by the end of CY16 (17 regions) and GCP's 40 zones disclosed thus far by the end of CY17 (16 regions). We compare AWS, Azure, GCP and AliCloud's data center regions and/or zones in Exhibit 18 on page 15.

# Alibaba's AliCloud

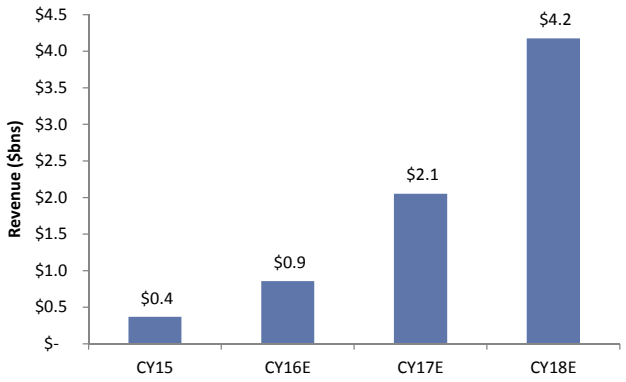
*Alibaba is covered by Goldman Sachs Analyst Piyush Mubayi*

***Alibaba launched their Cloud Computing service in September 2009, AliCloud (also called Aliyun), and is now the public cloud market leader in China, servicing 1.4mn cloud customers (577k paying customers as of June 2016) directly, and over 20k developers. While we estimate cloud computing in China lags the US by four years, we believe that spending on cloud will be the fastest growth area within the China Internet sector.***

## What public cloud could mean to numbers

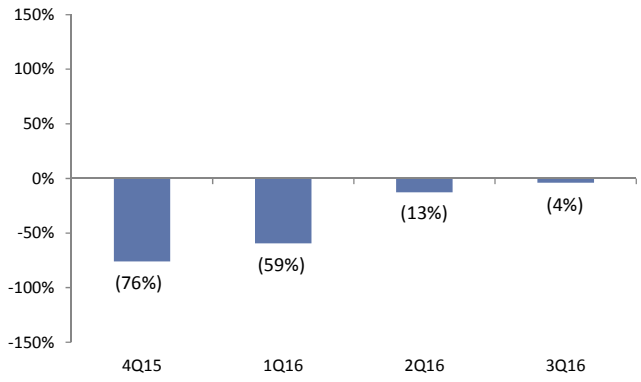
**Revenue and margin forecasts:** We are modeling AliCloud revenue of US$0.9bn in CY16E, up 132% yoy. We expect growth to slightly accelerate in CY17E 139% yoy and then decelerate to 103% yoy in CY18E to reach $4.2bn in revenue in CY18E. Meanwhile, we expect AliCloud operating margins slowly improve, as they have over the last four quarters, from (76%) in 4Q15 to (4%) in 3Q16.

**Exhibit 60: GSe AliCloud revenue estimates CY16-18E ($bns)**




*Source: Goldman Sachs Investment Research.*

**Exhibit 61: GSe AliCloud operating margins (ex-SBC and amortization of intangibles) 4Q15-3Q16**




*Source: Goldman Sachs Investment Research.*

**Valuation:** We note that AliCloud is a key component of our valuation framework for Alibaba. While the business contributes 4% of Alibaba's LTM revenue, we believe it contributes 11% of the company's enterprise value, as we value the business on a 9x EV/Sales multiple.

**Exhibit 62: Alibaba Sum of the Parts Valuation**
$mns, except per share data

| in US$ mn | Description | FY19E rev. | NOPAT | EV / Rev. | PE | Value | To BABA | Value to BABA | US$/sh | % of NAV | Comment |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **CORE** | | | | | | | | | | | |
| 1 China commerce | Taobao, Tmall | 25,992 | 12,606 | 9.7 | 20 | 252,126 | 100.0% | 252,126 | 92.7 | 71% | 48.5% net margin, 20x P/E of Global Big Cap Internet (>US$50bn Mcap) |
| 2 International commerce | | 2,399 | | 6.8 | | 16,236 | 97.8% | 15,879 | 5.8 | 4% | |
| Lazada | ASEAN ecomm. | 675 | | 1.6 | | 1,071 | 66.7% | 714 | 0.3 | 0% | DCF |
| Others | | 1,723 | 689 | 8.8 | 22 | 15,165 | 100.0% | 15,165 | 5.6 | 4% | 40% net margin, 22x on superior growth outlook |
| 3 Youku Tudou | Online video | 3,041 | | 1.8 | | 5,446 | 100.0% | 5,446 | 2.0 | 2% | DCF |
| 4 Cloud Computing, other | | 5,972 | | 8.4 | | 50,144 | 100.0% | 50,144 | 18.4 | 14% | |
| Cloud Computing | Aliyun | 4,771 | | 9.0 | | 42,936 | 100.0% | 42,936 | 15.8 | 12% | 9x revenue, as with AWS |
| Other (incl. UC Web, Autonavi) | | 1,201 | | 6.0 | | 7,208 | 100.0% | 7,208 | 2.7 | 2% | 6x revenue |
| **Total, Core** | | | | | | | | **323,595** | **119.0** | **91%** | |
| **Associate/investments** | | | | | | | | | | | |
| **Total Assoc./Inv.** | | | | | | **201,113** | | **50,000** | **18.4** | **14%** | |
| **Net cash** | | | | | | | | 22,707 | 8.4 | 6% | As of FY19 |
| **Total** | | | | | | | | **396,302** | **145.8** | **111%** | |
| **Less holdco discount** | | | | | | | **10%** | 39,630 | 14.6 | 11% | |
| **NAV** | | | | | | | | **356,671** | **131.0** | 100% | |
| #s of diluted shares | | | | | | | | 2,719 | | | |

*Source: Goldman Sachs Investment Research.*

We then backed into the implied valuation of AliCloud based on our SOTP methodology. Our SOTP implies a $14 CY17E value for AliCloud. Discounting AliCloud's CY20 EPS estimate back to CY17 (at a 12% rate, same as GS's China Internet Coverage WACC), this implies a 25x P/E multiple, in line with our multiples for AWS and Azure. The remainder of Alibaba's business is valued at $117 per share. Using our CY17 EPS estimate ex-AliCloud of $4.06, our SOTP implies a 29x P/E multiple.

**Exhibit 63: AliCloud's potential contribution to valuation**

| Potential Valuation Impact | | |
|---|---|---|
| CY20E AliCloud non-GAAP EPS | $ | 0.79 |
| Discount rate | | 12% |
| Discounted AliCloud EPS | $ | 0.56 |
| P/E | | 25x |
| AliCloud Value per share | $ | 14 |
| | | |
| Alibaba ex-AliCloud non-GAAP EPS | $ | 4.06 |
| P/E | | 29x |
| Alibaba ex-AliCloud Value per share | $ | 117 |
| | | |
| Alibaba price target (SOTP) | $ | 131 |
| Upside to 11/15 close | | 44% |

*Source: Goldman Sachs Investment Research.*

**Opportunity in China and beyond:** Cloud computing has been a focus area of China's government in the 2011-2015 five year plan and is one of 11 priority technology sectors for the government. The cloud opportunity in China is still nascent, and accounted for only 2% of the US public cloud market. The driver of growth in cloud services is enterprise demand, and the sharp growth in 4G smartphone take up. By 2019, cloud apps will account for 90% of mobile data traffic, vs. 81% in 2014 according to IDC. Outside China AliCloud has two data centers in Silicon Valley, and its international expansion is looking into Singapore, Japan, Europe and Middle East. In Japan specifically, Alibaba and Softbank jointly announced the launch of SB Cloud in May 2016 to address the underserved market.

**Competitors:** China Mobile, China Unicom, China Telecom, Baidu, Tencent, and ZTE are among the other large, well-resourced, and technically-savvy Chinese companies offering (or preparing to offer) some sort of cloud service. For context, Tencent is the 2nd-largest

cloud computing company in China, but well behind the early mover Alibaba. Tencent continues to be aggressive in investing in data center and bandwidth, and the company's need to own fiber capacity to cater to new game peak download demand has led the company to own fiber capacity

**Competitive advantage for Chinese based cloud companies:** Non-Chinese companies may be required to hand over proprietary source code by 2020. Were that to happen, the government would remove foreign vendors of both hardware and software from SOEs. Nevertheless this does not rule out partnerships, such as AWS with Sinnet Tech, Microsoft with Tencent and 21Vianet, HP with Beijing UnionRead Information Technology, and IBM with 21Vianet.

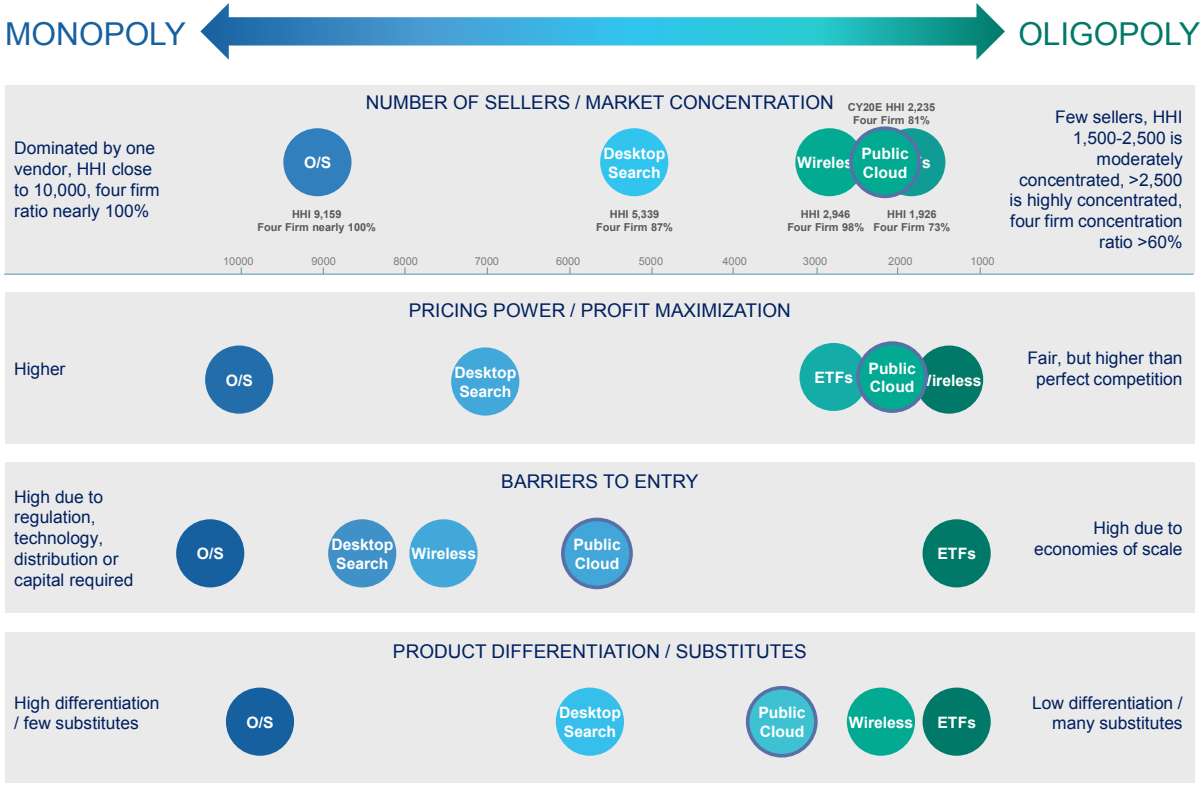
**Customers:** Alibaba has signed cloud agreements ranging from developing cloud storage solutions to helping provinces gather and crunch data to optimize its traffic lights. These agreements cover more than a dozen Chinese provinces and cities including Hainan, Guangdong, Tianjin and Shanghai. It also works with the China Meteorological Administration, China Central Government Procurement Centre, and the State Railway Service Centre.

In April 2015, AliCloud announced a deal with state oil and gas giant China Petroleum & Chemical Corporation, known as Sinopec, to create a cloud system that tracks its production and emissions (Source: Reuters, April 17, 2015). The company also has an agreement with the City of Dalian to build a cloud computing center and provide online government services.

# Appendix: Heading towards a four horse race

In the following pages, we evaluate the HHI, four firm ratio, pricing power, barriers to entry, and product differentiation of two markets considered more monopolistic (operating system and desktop search) and two markets considered more oligopolistic (US wireless and ETFs). We then determine which market structure the public cloud market most resembles based on those characteristics to help determine the future of the public cloud market.

**Exhibit 64: Comparison of Monopolistic and Oligopolistic markets with industry examples versus Public Cloud**




*Source: Goldman Sachs Investment Research.*

# Assessing market structure through the lens of HHI

***Amazon was the first to enter the public cloud market in 2006 and we expect the company to garner 38% share in CY16. While many investors we have spoken to believe that the market will continue to be dominated by primarily one vendor, we believe it makes sense to evaluate the potential for the industry to evolve into a more competitive (but still concentrated) market over time.***

As such, we spent time evaluating key market characteristics that would help define how concentrated the public cloud industry might become: market concentration, pricing power, barriers to entry and product differentiation.

## A closer look at the four market structures

1) **A monopoly**, which is a market dominated by one firm, has extremely high barriers to entry, high product differentiation and can set prices.
2) **An oligopoly** is a market dominated by few firms, has power to set prices but to a lesser extent than monopolies, has high barriers to entry due to scale and low product differentiation.
3) **Monopolistic competition** is a market with many competitors creating differentiated products; they have some control over price and have few barriers to entry.
4) **Perfect competition** is a market where unlimited vendors compete with no barriers to entry, no pricing power and has undifferentiated products that are perfect substitutes for one another.

**Herfindahl-Hirschman Index (HHI):**
- *Pure Monopoly: Near 10,000*
- *Highly Concentrated: Over 2,500*
- *Moderately Concentrated: 1,500-2,500*
- *Competitive: Less than 1,500*

**Four Firm Concentration Ratio:**
- *Monopoly: Nearly 100%*
- *Oligopoly: Over 60%*
- *Competitive: Below 40%*

**We utilize the Herfindahl-Hirschman Index (HHI) and the four firm concentration ratio as an objective way to determine market concentration**

The HHI serves as a standard and comparable gauge of consolidation levels. It is calculated by taking the sum of the squares of the leading firm's market shares. A pure monopoly would require a score near 10,000. An oligopolistic structure would have score between 1,500 and 10,000, which indicates a moderately or highly concentrated market. The four firm concentration ratio is the sum of the leading four market participants' market shares. A monopoly should have a ratio of nearly 100%, while an oligopoly requires a ratio above 60%.

**We examined these market characteristics through four real life examples of monopolistic and oligopolistic markets**

The PC Operating Systems and Desktop Search are dominated by one vendor and often characterized as monopolies. The US Wireless and ETFs markets are dominated by few vendors and are often categorized as oligopolies. Exhibit 64 on page 52 summarizes our findings. Below we compare the public cloud market based on the same the four characteristics (market concentration, pricing power, barriers to entry and product differentiation) to determine its possible longer-term industry structure.

## Market Concentration/Number of Sellers

**We evaluate market concentration using the Herfindahl-Hirschman Index (HHI) and the four firm concentration ratio**

The HHI is a measure of market concentration recognized by bodies such as the US Federal Trade Commission and the European Commission. The HHI is calculated by summing the squares of each competing firm's market share. The HHI approaches zero when a market is occupied by a large number of firms of relatively equal size, and maxes out at 10,000 in a pure monopoly. US regulatory agencies generally consider markets with an HHI of 1,500 to 2,500 as moderately concentrated, and markets with an HHI in excess of 2,500 as highly concentrated.

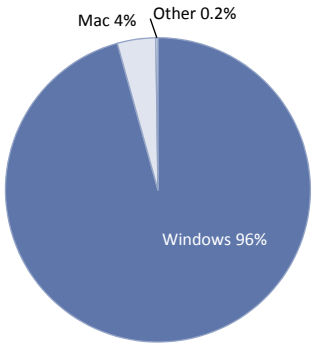
The four firm concentration ratio is the sum of the largest four firms' revenue market shares. The ratio ranges from near zero for a highly competitive industry, and nearly 100% for a pure monopoly. A ratio above 60% represents an oligopoly, while a ratio below 40% represents a competitive market.

Before looking at the public cloud market we first went back and analyzed four markets where we believe the market might perceive certain similarities to a monopoly and an oligopoly.

**Operating Systems and Desktop Search: Highly concentrated markets dominated by one vendor**

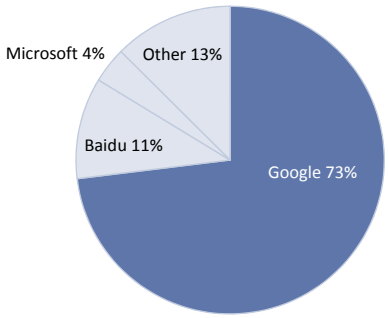
- The operating system and desktop search markets have HHI levels of 9,159 and 5,339 for the largest firm in each industry, well over the 2,500 threshold for a highly concentrated market. Share is dominated by one vendor, 96% for Microsoft in operating systems and 73% for Google in desktop search. With four firm concentration ratios closer to 100% for both PC operating systems (roughly 100%) and desktop search (87%), the ratios indicate that both markets are monopolistic.

**Exhibit 65: Worldwide PC operating systems share (excludes servers), 2015 revenue**
HHI for MSFT = 9,159, four firm ratio = Nearly 100%




*Source: Gartner March 2015, Goldman Sachs Investment Research.*

**Exhibit 66: Worldwide desktop search share, 2015 revenue**
HHI for Google = 5,339, four firm ratio = 87%




*Source: Goldman Sachs Global Ad Forecast, February 2016.*

**US Wireless: Highly concentrated market across few sellers**

- The HHI for the US wireless market is also highly concentrated; however the majority of the market is split across the top four vendors (totaling 2,946 HHI) instead of one. In addition, its four firm concentration of 98% is nearly 100%,

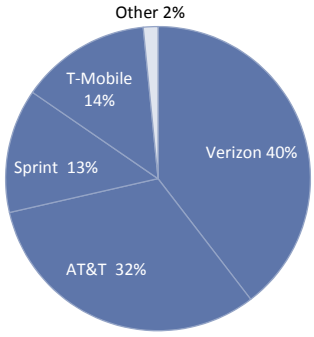
technically indicating that the market is a monopoly. However, we point out there is no one dominating vendor in this market.

**ETFs: Moderately concentrated market across few sellers**

- The ETF market's HHI is 1,926, indicating a moderately concentrated market (1,500-2,500) and has a four firm concentration of 73%, again above the threshold of 60%, indicating that the market is oligopolistic. Similar to US wireless there is not one vendor that has dominant share over the other vendors.

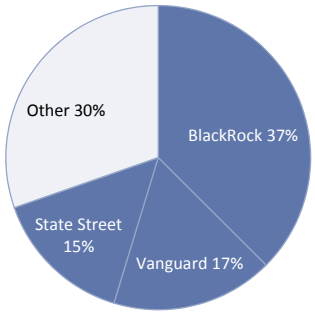
  For the purpose of this report, we use market data on Exchange Traded Product (ETPs), which includes Exchange Traded Funds and Exchange Traded Notes. However, we often refer to ETPs as Exchange Traded Funds (ETFs), which make up the bulk of the market and are recognized more widely by the investment community.

**Exhibit 67: US wireless share, 2015 revenue**
HHI for the top 4 vendors = 2,946, four firm ratio = 98%




*Source: Company data, Goldman Sachs Investment Research.*

**Exhibit 68: ETF share by assets under management**
HHI for the top 3 vendors = 1,926, four firm ratio = 73%




*Source: ETP data from BlackRock December 2015, Goldman Sachs Investment Research.*

## Pricing Power and Profit Maximization

### Top Operating System and Desktop Search vendors are able to generate higher revenue per unit

In both the operating system and desktop search markets, the largest vendor generates higher revenue per unit. For example, Microsoft was able to generate $59 per PC operating system shipped compared to $33 for the remaining vendors (Source: Gartner, May 2015). This compares to Google, which we estimate generated roughly three and a half cents per query compared to the remaining vendors at two and a half cents or less (Source: GS desktop search revenue divided by ComScore worldwide desktop query data).

**Exhibit 69: PC Operating Systems Market Pricing**

| | Market Share By Revenue 2014 | Units PC Shipments | Revenue/ Unit Revenue per Shipment | Market Share By Unit 2014 |
|---|---|---|---|---|
| Windows | 96% | 290.8 | $58.68 | 93% |
| Other | 4% | 22.9 | $33.49 | 7% |
| Total | 100% | 313.7 | $56.84 | 100% |

*Source: Gartner, May 2015 and 1Q16 update.*

**Exhibit 70: Desktop Search Market Pricing**

| | Market Share By Revenue 2015 | Units Desktop Queries (mns) | Revenue/ Unit Revenue per Query | Market Share By Unit 2015 |
|---|---|---|---|---|
| Google | 73% | 1,124,796 | $0.034 | 52% |
| Baidu | 11% | 349,587 | $0.016 | 16% |
| Microsoft | 4% | 80,257 | $0.025 | 4% |
| Other | 13% | 670,933 | $0.010 | 31% |
| Total | 100% | 2,145,316 | $0.025 | 100% |

*Source: Goldman Sachs Global Ad Forecast, February 2016. ComScore unit data. This analysis includes desktop search revenue and queries only.*

**For ETFs, the largest firms charge users similar or less than smaller firms. For US Wireless, the largest firms generate higher profits per unit, while the largest ETFs generate higher revenue per unit**

- **ETFs:** The three leading ETFs vendors charge less per unit (ETF), with net expense ratios ranging from 9-20bps compared to the remaining vendors at 50bps. However, despite charging less per ETF, the top three vendors are generating significantly more revenue per ETF (the expense ratio charged to investors) as the lower charges are more than offset by higher volume, ranging from 2.2-3.5x the remaining vendors. In addition, we have seen leader BlackRock reduce fees for its low cost ETFs over time (2012 and recently in October 2016), somewhat similar (though albeit less frequently) to how public cloud vendors have cut prices over time.
- **US Wireless:** Unlike ETFs, there is not a pattern around the amount of revenue charged per subscriber (also known as Postpaid ARPU). However, the amount of EBITDA per subscriber generated at the largest vendors is $19-30 per subscriber, or 2.3-3.5x the combined remaining vendors at $9 per month.

**Exhibit 71: US Wireless Market Pricing and Profits**

| | Market Share By Revenue 2015 | Revenue/Unit Monthly Revenue/Sub | Profit/Unit Monthly Profit/Sub | Market Share By Profit 2015 |
|---|---|---|---|---|
| Verizon | 40% | $52 | $30 | 47% |
| AT&T | 32% | $57 | $30 | 34% |
| Sprint | 13% | $55 | $21 | 9% |
| T-Mobile | 14% | $47 | $19 | 9% |
| Other | 2% | $55 | $9 | 1% |
| Total | 100% | $53 | $27 | 100% |

*Source: Company data, Goldman Sachs Investment Research. Profit represents Wireless EBITDA.*

**Exhibit 72: ETF Market Pricing ($mns)**

| | Market Share By ETF AUM 2015 | Price/Unit Net Expense Ratio | Revenue/ Unit Revenue per ETF ($mns) |
|---|---|---|---|
| BlackRock | 37% | 0.27% | $6.4 |
| Vanguard | 17% | 0.09% | $6.3 |
| State Street | 15% | 0.20% | $4.1 |
| Other | 30% | 0.50% | $1.8 |
| Total | 100% | 0.27% | $3.0 |

*Source: BlackRock December 2015, Simfund April 2016, Goldman Sachs Investment Research.*

## Barriers to Entry

**Operating Systems and Destkop Search: High Barriers to Entry due to technology, high capital requirements, government regulation or patents**

- **PC operating systems have very high barriers to entry based on distribution relationships, scale and/or R&D intensity.** Because software operating systems are typically pre-installed on hardware devices, a new entrant would have to either convince hardware vendors (OEMs) to install their operating system on existing models, create new hardware devices for them (i.e., Google Chromebooks), or create their own hardware and operating system together (i.e., Apple). All options require scale, strong distribution relationships and/or high levels of capital. In addition, OEMs would be expending high amounts of capital themselves for unpredictable sales levels of a product that is unproven in the market, making it unlikely that the OEM would produce significant quantities initially. Another approach to the market is creating an operating system that users can either replace their existing PC operating system or use the operating system as a second desktop by installing it on a virtual image on their PC or in the data center.

  We also note that operating system vendors with the largest reach attracted the most software developers. Those developers would write applications on that platform, which would attract more developers to the platform, creating a barrier to entry.

- **The Desktop Search market has high barriers to entry due to technology and significant capital requirements.** In desktop search, users typically gravitate towards search engines that produce the most accurate results, which is typically a combination of the vendor's search algorithm and its underlying database of information. Search vendors have algorithms that rank web page results by calculating the number, relevance, distance and popularity (quality) of other web pages that link to it, like Google's PageRank and Microsoft Bing's algorithm. This is done by aggregating and sifting through trillions of web pages, which requires significant capex for the data center space, storage, servers, and networking gear. For the first time since 2008, in March 2013 Google announced that they aggregate data on 30 trillion web pages, which is 100mn gigabytes worth of data.

**US Wireless and ETFs: High Barriers to Entry (to compete with top vendors at scale) based on Economies of Scale**

As discussed in the previous section, the top ETFs and US Wireless vendors are able to generate outsized revenue or profit per unit compared to the remaining vendors due to economies of scale. We discuss each market below:

- **US Wireless has extremely high barriers to entry, requiring billions of dollars in capital. The market requires economies of scale to be profitable.** The barriers to entry are high, as new entrants would need to purchase enough spectrum to provide suitable coverage to subscribers, build out the towers and stations, and continually update the network. This has cost the top four market leaders an average of $4-11bn annually over the last three years (see Exhibit below).

  With very high sunk costs (capex described above), it requires tens of millions of subscribers to breakeven. The largest four vendors have 31-107mn subscribers and had EBITDA margins ranging from 29-55% in CY15. We note that EBITDA margins are higher for the biggest vendors as the business requires very high sunk costs, but relatively low marginal costs to add one additional subscriber.

**Exhibit 73: US wireless capex spend for the largest four vendors have been in the billions**

| | Wireless Capex | | | | | | | | Units | | Profit | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CY13 | CY14 | CY15 | CY16E | Average | Y/Y Growth | | | Subscribers | | Wireless EBITDA Margin | |
| | ($mns) | ($mns) | ($mns) | ($mns) | CY13-15 | CY14 | CY15 | CY16E | CY15 (mns) | CY16 (mns) | CY15 | CY16E |
| Verizon | $9,425 | $10,515 | $11,725 | $11,955 | $10,555 | 12% | 12% | 2% | 107 | 110 | 55% | 60% |
| AT&T | $11,191 | $11,383 | $9,471 | $9,700 | $10,682 | 2% | -17% | 2% | 77 | 78 | 47% | 49% |
| Sprint | $6,833 | $5,176 | $5,030 | $2,253 | $5,680 | -24% | -3% | -55% | 31 | 31 | 29% | 39% |
| T-Mobile | $4,240 | $4,317 | $4,724 | $4,650 | $4,427 | 2% | 9% | -2% | 32 | 35 | 30% | 37% |
| Other | $872 | $558 | $284 | $261 | $571 | -36% | -49% | -8% | 4 | 4 | 13% | 13% |
| Total | $32,561 | $31,949 | $31,234 | $28,819 | $31,915 | -2% | -2% | -8% | 250 | 259 | 45% | 49% |

*Source: Company data, Goldman Sachs Investment Research. We note that Sprint's capex declined in 2016 due to a delayed start to a network 'rebuild' program that was supposed to hit in late 2015/early 2016.*

- **While initial barriers entry are low (costs to setup an ETF are relatively minimal), ETFs require economies of scale to offer the lowest net expense ratios to attract customers.**

  The ETF market has low initial barriers to entry, as the sunk cost of setting up a single ETF with a trust bank is $175k (WisdomTree). As well, marginal costs for each new ETF share are very low, as the trust bank charges a small fee based on the total assets under management. Therefore, the largest vendors are able to generate profits at higher levels than smaller vendors. According to the GS Capital Markets and Exchange team, this industry generates 75-85% gross margins, with the largest vendors above 85% and smallest vendors below 75%.

The ETF market also has high barriers to entry due to economies of scale. For example, in order for a new entrant to compete effectively against the top three market vendors with an ETF that mirrors the S&P 500, this new company would have to offer competitive rates against State Street's 9bps net expense ratio, BlackRock's 7bps and Vanguard's 5bps expense ratio. If we use the midpoint of 7bps as an example, the new fund would have to attract $250mn in assets just to pay for the $175k in custodial fees.

To show how high the barriers to entry are, in assets, the top three ETFs control a combined $2.1tn or 70% of the total ETF assets under management. To show how large $2.1tn is, it would be the 7th largest country by GDP, after France and before India (Source: IMF World Economic Outlook Database).

## Product Differentiation / Substitutes

### Operating Systems and Desktop Search: High Product Differentiation

- **Operating Systems:** Operating Systems have very high product differentiation, because, for the most part, it is tied to the underlying hardware. Year to date 2016, over 90% of all PCs shipped were Windows devices. There are fewer substitutes for operating systems, as practically all desktop operating systems are shipped with the underlying hardware.
- **Search:** As discussed previously, there is product differentiation between search engines, as different vendors sometimes produce very different search results. We would argue that while the differentiation isn't extremely high between vendors, there is still a high level of product differentiation, as 48% of the 500+ iPhone and iPad users we surveyed in April 2015 responded that they would switch the default search engine back to Google if it was changed to Yahoo! or Bing.

### US Wireless and ETFs: Low Product Differentiation

- **US Wireless:** Once a wireless network is past the initial (albeit steep) hurdle of building out enough coverage for users, comparable data speeds, and similar quality of voice and data services to competitors, there is little product differentiation between vendors. In addition, there is a lack of substitutes as four vendors control 98% of the market by revenue.
- **ETFs:** At its most basic level, there is little differentiation between each ETF from a consumer's perspective, as the purpose of an ETF is to closely resemble the underlying index, market or commodity. However, as discussed previously, there are differences in fees paid for fund expenses. Unlike the US Wireless market, there are multiple substitute products for widely followed indexes and markets, such as the S&P 500, gold, oil and more.

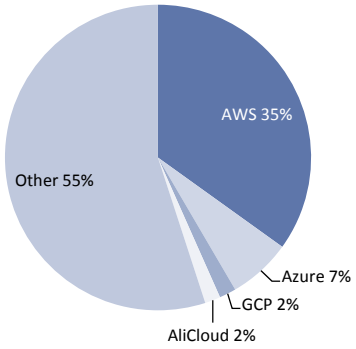
# Public Cloud through the lens of HHI

## Public Cloud: Number of Sellers / Market Concentration

**Using the HHI and four firm concentration ratio, the public cloud market was considered competitive in CY15, but we expect it to be more concentrated by CY20.**

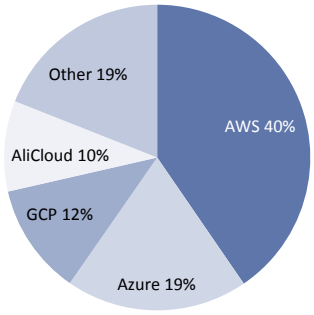
- **HHI -** Based on a 1,264 HHI level in CY15 (for the top two largest vendors AWS and Azure), the public cloud market was defined as competitive by HHI standards. By CY20, we expect the market to further concentrate into a moderately concentrated market, with a HHI of 2,235 (HHI range 1,500-2,500).
- **Four firm concentration ratio –** In CY15, the public cloud market's four firm concentration ratio was 45%, classifying it between a competitive and an oligopolistic market. However, we expect this ratio to grow to 81% by CY20, which would categorize public cloud as oligopolistic.

**Exhibit 74: Public Cloud (IaaS and PaaS) Share, 2015**
HHI for the top 2 vendors = 1,264, Four Firm Ratio = 45%
HHI for AWS, Azure, GCP, AliCloud = 1,270




*Source: Gartner 2Q16, Goldman Sachs Investment Research. For comparison purposes, excludes IBM, Salesforce.com and other public cloud vendors.*

**Exhibit 75: We expect public cloud to further concentrate by 2018, estimated share of top vendors**
HHI for the top 2 vendors = 2,004, Four Firm Ratio = 81%
HHI for the top 4 vendors = 2,235




*Source: Gartner 2Q16, Goldman Sachs Investment Research.*

## Public Cloud: Pricing Power and Profit Maximization

**Pricing power and profit maximization for public cloud is closer to an oligopoly than a monopoly.**

- **Like ETFs (oligopolistic), the largest vendors charge customers similar or less than smaller vendors.** Unlike most new technologies that are performing well and are not pressured to lower prices, public cloud vendors have gone out of their way to continually lower their list prices, passing savings that the companies gain on hardware and efficiencies onto its customers.

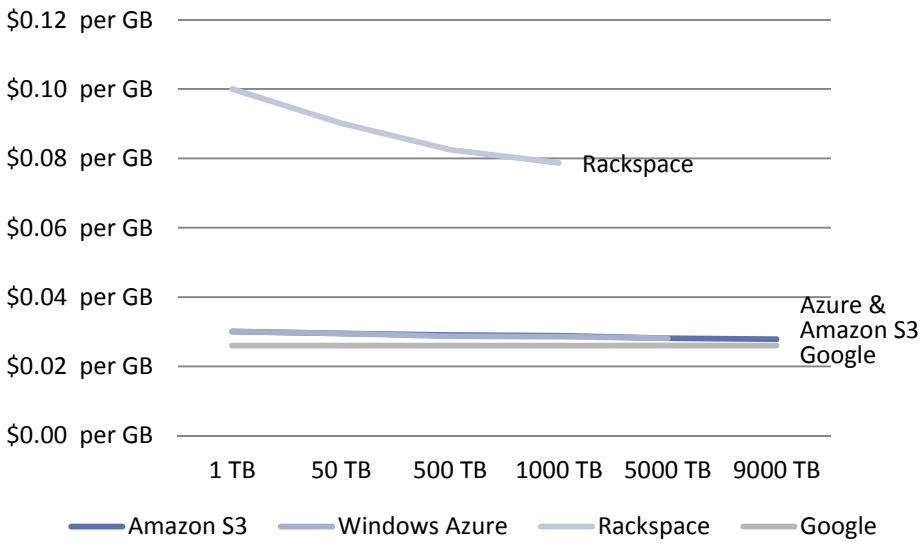
  In fact, Google announced their cloud platform would move to Moore's Law pricing in March 2014, which meant that the company intends to drop the pricing of core infrastructure in line with Moore's Law (roughly 20-30% annually).

  In addition, both Amazon and Microsoft have publicly stated that they are committed to offering lower prices in the future. In early September 2014, the EVP of Microsoft's Cloud and Enterprise group said "This kind of hyperscale footprint

really enables immense scale economics to the point where we can basically continually cut our prices for customers, and we can basically run an operation that is just cheaper than pretty much everyone else on the planet" (Microsoft website, September 2014). Oracle also announced it would price its IaaS product competitively with AWS, Microsoft, and others during its annual OpenWorld conference in 2014.

We illustrate how cloud storage list prices of the largest public cloud vendors are roughly in line or cheaper than smaller vendors.

**Exhibit 76: Price of cloud storage is in line to cheaper for the largest vendors (price per GB per month)**

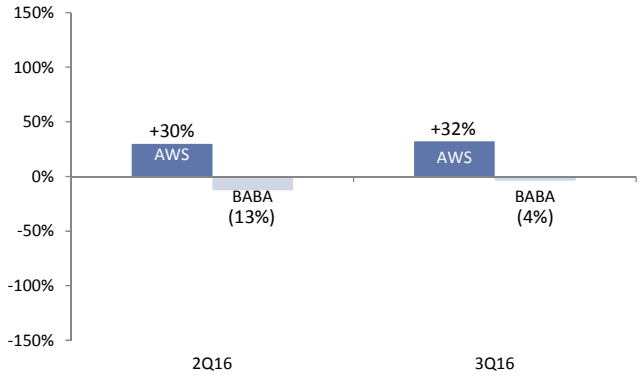



*Source: Company data as of 8/16/16.*

- **We don't view pricing power as strong as a monopoly, as our CTO discussions suggest customers would be willing to move off of their current public cloud vendor if prices increase significantly. And unlike monopolistic examples (e.g., operating systems) that have been able to maintain prices, public cloud prices have decreased over time.** Based on our CTO conversations with ten CTOs from diverse industries, we found that roughly 20% of them would start moving workloads off of their current public cloud vendor if it raised prices 5%, and nearly half of would start moving workloads off if it raised prices over 10%. In addition, none said they would stay with their primary vendor at any sized price increase.
- **Over half of the CTOs we spoke with have deployed multiple clouds in the attempt to avoid vendor lock in and significant price increases.** Similar to traditional enterprise software, many CTOs have chosen to use more than one public cloud as a strategy to keep their current public cloud vendor from exerting too much power, mostly in the form of prices increases. These CTOs chose to mostly utilize each public vendors basic services (compute, storage) in the event they would need to switch workloads onto another vendor. A few others found it responsible to use multiple clouds in the event their primary vendor had a major power outage, particularly if they were hosting a critical workload.

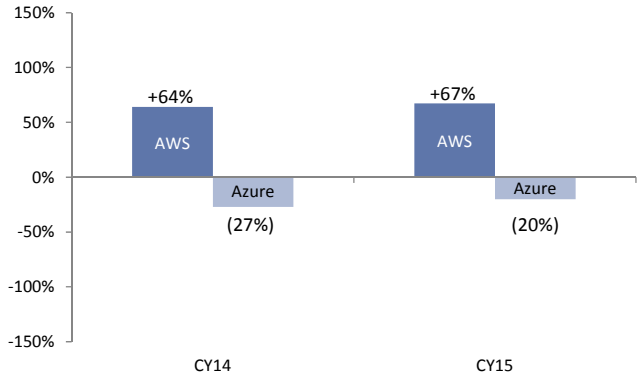
- **Profit Maximization: Similar to the US wireless industry (oligopolisitic), we believe the largest vendor (AWS) has higher profit margins than smaller vendors.** While most cloud vendors do not report both gross and operating margins for their cloud businesses, AWS and Alibaba report operating margins and we estimate Azure gross margins. On an FX-neutral operating margin basis excluding stock based compensation (SBC) and other, AWS reported positive 32% operating margins in 3Q16, 30% in 2Q16 and 27% in 1Q16. Alibaba reported negative 4% operating margins excluding SBC and amortization of intangible assets in 3Q16, negative 13% in 2Q16 and negative 59% in 1Q16 for their AliCloud business. We also estimate Azure is running at negative gross and operating margins but they are improving. We modeled negative 20-25% gross margins in calendar 1Q16 and 2Q16, and negative 5% in 3Q16.

**Exhibit 77: Operating margin comparison shows AWS (FX-neutral, ex-SBC and other) was +30% and +32%, compared to AliCloud (ex-SBC and amortization of intangibles) at (13%) and (4%) in 2Q16 and 3Q16**




*Source: Company data, Goldman Sachs Investment Research. SBC = stock based compensation*

**Exhibit 78: Our estimated non-GAAP gross margin comparison shows AWS is as high as the mid 60%s, while Azure is likely in the negative 20-30% range in CY14 and CY15**




*Source: Company data, Goldman Sachs Investment Research.*

Also, while Amazon does not disclose AWS's gross margins, it discloses AWS related depreciation expense. After subtracting depreciation, AWS's implied gross margins would be 67% in CY15, 64% in CY14 and 69% in CY13. However, this overstates gross margins, as it does not include multiple other expenses that would go into COGS, including the costs of power, cooling, customer support, and data center staff. This calculated figure is also much higher than what we estimate for Azure, at negative 20% in CY15 and negative 27% in CY14.

**Exhibit 79: Estimated non-GAAP gross and reported operating margins for Amazon AWS appear to be higher than peers ($mns, see explanation on the gross margin calculation in the text above)**

| | AWS CY13 | AWS CY14 | AWS CY15 | AWS CY16E |
|---|---|---|---|---|
| AWS Revenue | $ 3,108 | $ 4,644 | $ 7,880 | $ 12,411 |
| yoy | 69% | 49% | 70% | 57% |
| | | | | |
| D&A | $ 963 | $ 1,673 | $ 2,576 | $ 3,651 |
| Other COGS | $ - | $ - | $ - | $ - |
| Total COGS | $ 963 | $ 1,673 | $ 2,576 | $ 3,651 |
| Gross Profit | $ 2,145 | $ 2,971 | $ 5,304 | $ 8,759 |
| **Gross Margin** | **69%** | **64%** | **67%** | **71%** |
| | | | | |
| Implied Operating Expenses | $ 1,472 | $ 2,311 | $ 3,441 | $ 5,078 |
| yoy growth in opex | | 57% | 49% | 48% |
| Operating Income, ex-SBC | $ 673 | $ 660 | $ 1,863 | $ 3,681 |
| Operating Margin | 22% | 14% | 24% | 30% |
| | | | | |
| Benefit from FX | $ (38) | $ (41) | $ (264) | ND |
| Operating Income, FX adjusted | $ 635 | $ 619 | $ 1,599 | $ 3,681 |
| Operating Margin, FX adjusted | 20% | 13% | 20% | 30% |

*Source: Company data, Goldman Sachs Investment Research. AWS operating income excludes stock-based compensation and Other operating expense (income), net, which consists primarily of marketing-related, contract-based, and customer-related intangible asset amortization expense and expenses related to legal settlements (Amazon 10-K).*

## Public Cloud: Barriers to Entry

**Public cloud is most similar to ETFs (oligopolistic), where initial barriers to entry are low but to compete at scale, it requires significant economies of scale. Furthermore, capex requirements to compete at scale are extremely high in this business, similar to the US Wireless industry (oligopolistic).**

At its most basic level, almost any organization or person can offer a cloud service by purchasing one server, installing open source software and allowing customers to rent a virtual machine. Therefore initial barriers to entry are low. However, very few companies in the world can sustain the costs required to be a top vendor at scale.

### *Sunk costs are in the tens of billions of dollars to support millions of customers worldwide*

To compete at scale, market players will need to invest billions of dollars to effectively compete. Vendors would spend capex on acquiring land, building a data center, including the costs involved for building out efficient power and cooling. Alternatively, a provider could rent space from a colocation vendor such as Equinix. At extreme scale, if the vendor has the resources it could be more cost effective to build out their own data centers; however to pay for servers, storage, networking and infrastructure software, the cost could be over $1bn per data center.

Each of the four main cloud vendors has dozens of data centers (purchased or leased) in regions around the world. We compare each in the following Exhibit, as well as discuss it in more detail in the GCP section.

After the initial outlay of capital, servers and storage are then typically replaced every 3 years, while networking gear is replaced every 3-5 years, which, in addition to power, building improvements and headcount would add up to the ongoing costs to run the data center (see Exhibit below for more information, source: company 10-K's).

**Exhibit 80: Estimated useful lives of property and equipment (years, from 10-K's)**

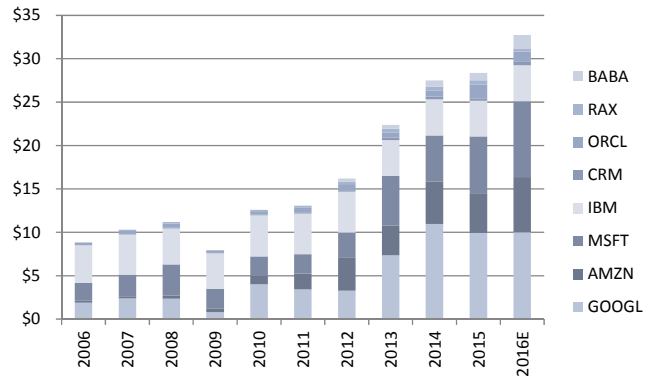
| | GOOGL | MSFT | AMZN | FB |
|---|---|---|---|---|
| Buildings | 25 | 5-15 | 40 or less | 3-30 |
| Software | ND | 3-7 | 2 | 3-5 |
| Servers | ND | ND | 3 | ND |
| Computer Equipment | ND | 2-3 | ND | ND |
| Networking Equipment | ND | ND | 5 | 3-5 |
| Overall | 2-5 | ND | ND | ND |

*Source: Company data (10-K's), Goldman Sachs Investment Research.*

In the Exhibits below, we show the amount of capex (and free cash flow) by public cloud vendor spent between 2006 and 2016E. We note that because most vendors do not disclose the percent of capex spent on their public cloud businesses, these charts reflect total capex by vendor.

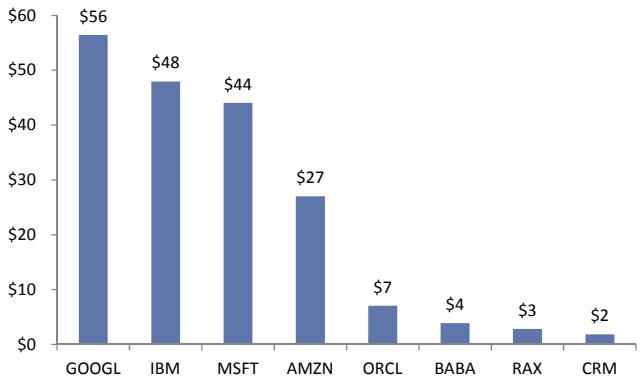
Between 2007 and 2015, total capex by all leading cloud vendors has risen at a 14% CAGR over the last 10 years, from $8.8bn in 2006 to $32.7bn in 2016E.

**Exhibit 81: Capex spent by leading cloud vendors 2006-2016E ($bns)**




*Source: Company data, Goldman Sachs Investment Research.*

**Exhibit 82: Capex by leading cloud vendor 2006-2016E ($bns)**

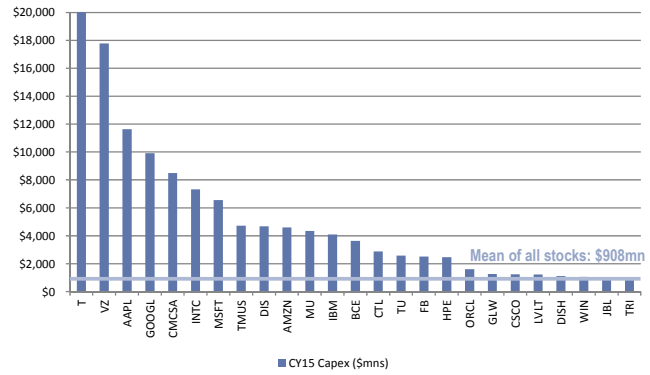



*Source: Company data, Goldman Sachs Investment Research.*

By vendor, Exhibit 82 above shows that Alphabet has spent the most cumulatively over the last 10 years, totaling $56bn in capex, followed by IBM at $48bn, Microsoft at $44bn and Amazon at $27bn. Again, we note that this includes non-public cloud capex, but it helps show the magnitude of how large the vendors are that compete in public cloud.

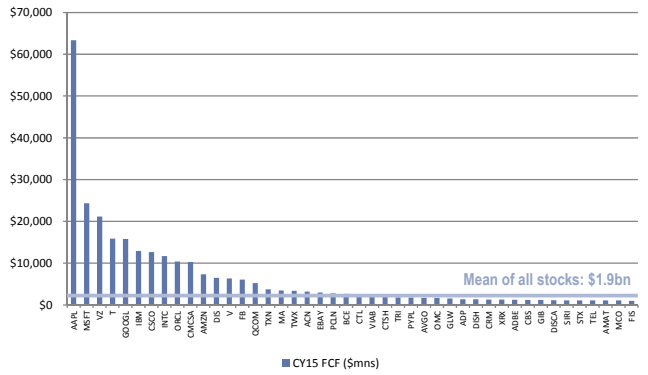
We note that there are very few companies in technology, media and telecommunications (TMT) that are able to spend at a similar level of magnitude as these companies. The exhibits below show the amount of capex and FCF spent by each TMT stock covered by Goldman Sachs. We found that only 18 of the roughly 170 TMT stocks covered, or 11% are expected to spend over $2.7bn in capex in CY16, or the average annual capex spent by Amazon over the last 10 years. Of the 18, five of those companies are already competing in the public cloud space.

**Exhibit 83: Only 25 companies spent over $1bn in capex in CY15 ($mns)**




*Source: Company data, Goldman Sachs Investment Research, based on TMT stocks covered by Goldman Sachs.*

**Exhibit 84: Only 44 companies generated over $1bn in FCF in CY15 ($mns)**




*Source: Company data, Goldman Sachs Investment Research based on TMT stocks covered by Goldman Sachs.*

**We also note that scale is important for public cloud. Vendors with less scale in public cloud are exiting the space.** Hewlett-Packard Enterprise and Verizon exited their public cloud businesses, while Rackspace publicly stated that they expected a slowdown in public cloud growth in CY16 – signs that vendors with less scale will have trouble competing against the current incumbents.

## Public Cloud: Product Differentiation / Substitutes

**While each leading public cloud vendor offers dozens of services, the public cloud's core product, IaaS (referred to as instances or virtual machines), is largely undifferentiated in our view (but quickly starting to differentiate as explained later in this report), similar to oligopolies, due to the following:**

- We conducted a survey, asking CTOs whether they viewed public cloud compute and storage a commodity, and found that 78% of respondents viewed those services as such, while 22% did not.
- Based on feedback from public cloud developers and system administrators, there is little to no difference between the basic compute instances offered by AWS, Azure or GCP.
- Underlying instances provided by AWS, Azure and GCP have similar components, and are mostly run on Intel chips, white box hardware, the vendor's own version of virtualization software (based on open source software), and a Linux or Microsoft Windows operating system. In addition, Alphabet has started to design its own chips, TPUs or Tensor Processing Units, customized for machine learning applications.
- AWS, Azure and GCP also offer multiple similar products also used in the public cloud, including relational and NoSQL databases, load balancers and content delivery networks (see Exhibit 8 on page 10).
- We note, however, that there are differences between the vendors' offerings, which we detail later in this report, especially as vendors move up the stack to PaaS.

# Components of public cloud

## Basic components of public clouds and pricing models

Companies also typically overprovisioned their application hosting environment to support peak workloads, even if they only utilize 10% of their total environment most of the time. In public cloud, however, customers only pay for what they use, helping to save the costs associated with over provisioning. There are two main categories of public cloud, aside from SaaS: Infrastructure as a Service (IaaS) and Platform as a Service (PaaS):

- **Infrastructure as a Service (IaaS) –** The two main IaaS services are compute and storage. For compute (i.e., AWS EC2), providers charge users per hour or per minute for a virtual server. These instances are similar to virtual or physical servers that an enterprise would normally provision in their own data center and uses a portion of the underlying physical servers, storage, networking in the data center. For storage (i.e., AWS S3), public cloud vendors charge per gigabyte (GB). This service is often used to serve up static content, such as images, used by applications.
- **Platform as a Service (PaaS) –** PaaS abstracts a layer of complexity, allowing the developer to upload their application code, and the PaaS layer does the rest – its provisions, manages and scales the underlying infrastructure software required for the application to run. This could include the database, middleware, load balancers, and more. Most PaaS forecasts include the underlying infrastructure software that the PaaS software layer provisions. However, these forecasts exclude the IaaS used.

  The structure and pricing of each offering is different. For example, salesforce.com's Force.com PaaS service bundles the PaaS, IaaS, and underlying database in their service. Meanwhile, AWS's Elastic Beanstalk PaaS service helps users scale and deploy applications through software instead of people. For example, with Elastic Beanstalk, software developers can upload their code and instead of engineers and system administrators doing the rest, AWS's software determines how much underlying compute, storage and database capacity is required, how and when to scale capacity based on higher or lower application usage, and helps configure and monitor the system. AWS Elastic Beanstalk is available at no additional cost beyond the AWS compute, storage, load balancing and databases used.

## Infrastructure as a Service (IaaS) foundational components: Storage and Compute

When people in the industry discuss IaaS, they are mostly referring to compute and object storage. These are the most popular public cloud offerings, and are the foundational components required to offer a public cloud service. Both services have similar value propositions, allowing customers to rent (per hour or per month) the services they need, instead of going through the following process:

- Taking days or months to attain internal approvals
- Purchase/build data centers or rent data center space
- Purchase racks of hardware and replace them every 3-5 years

- Purchase the related software, such as virtualization software and the ongoing maintenance or subscription fees
- Hire and train staff to setup and manage the environment to make sure the data is properly managed, backed up and secure (in case of outages, failures or attacks)
- Ensure there is enough (but not too much) of the offering available if the use case ramps faster or slower than expected (i.e., if an app scales up or down millions of users overnight, or demand changes due to an event or holiday)
- Pay for ongoing power and cooling

We explain both services in detail below.

## Object Storage

**Related Services:** Amazon Simple Storage Service (S3), Microsoft Azure Blob Storage, Google Cloud Platform Cloud Storage, Alibaba AliCloud Object Storage Service

Amazon's object storage offering, Simple Storage Service, or S3, was the first public cloud service offered in 2006. This service allows customers to store and retrieve data on the internet. The product is used for a number of use cases, including storing images that will be retrieved and served up on web pages to storing log data from every click on an ecommerce website that can then be analyzed over time. To ensure data doesn't get lost, customer's data is replicated across multiple data centers.

Customers pay vendors three cents per gigabyte (GB) per month for the first terabyte of object storage for Amazon S3 (US East region) and Microsoft Azure Blob Storage (East US). Google Cloud Storage is slightly cheaper at $0.026 per month per GB for standard storage at rest.

In terms of size, Gartner believes that Amazon's Simple Storage Service (S3) is 1.6x as large as all of the other object storage service offerings (by the amount of data stored) in their Magic Quadrant combined (Gartner, July 2016). For context, object storage is one major type of storage used in cloud computing, the others are block storage (designed for databases), and file systems storage (for general purpose applications).

## Compute

**Related Services:** Amazon AWS Elastic Compute Cloud (EC2), Microsoft Azure Virtual Machines, Alphabet's Google Compute Engine (GCE), Alibaba's AliCloud Elastic Compute Service

Customers can use compute services to create virtual servers. Virtual servers, also called virtual machines, emulate physical servers and are able to be used as web servers (i.e., hosting an ecommerce web page) or application servers (i.e., handling the application logic; for example if an item is purchased, the transaction is written to a database). Using virtualization or container technology, public cloud vendor runs multiple virtual servers on each physical server (without this technology only one workload could run per server). Virtual servers are typically packaged with a server operating system and priced as "instances" or "images." It is difficult to compare pricing as each vendor offers slightly different standard instance configurations.

We detail pricing for standard compute instances in the Exhibit below. Each vendor has its own preset instances (also called virtual machines or virtual servers), which have a defined number of virtual CPUs and memory. For example, AWS's smallest instance is named t2.nano, which has one virtual CPU, 0.5 gigabytes of memory and costs $0.0065 per hour.

Notice that the Azure preset instances do not overlap with any of the AWS or GCP instances.

**Exhibit 85: Pricing of compute instances/virtual machines by vendor (USD)**

| Vendor | Instance Name | vCPU/Cores | Memory (GB) | Price/Hour |
|---|---|---|---|---|
| AWS | t2.nano | 1 | 0.5 | $0.0065 |
| AWS | t2.micro | 1 | 1.0 | $0.0130 |
| AWS | t2.small | 1 | 2.0 | $0.0260 |
| AWS | m3.medium | 1 | 3.75 | $0.0670 |
| AWS | t2.medium | 2 | 4.0 | $0.0520 |
| AWS | m3.large | 2 | 7.5 | $0.1330 |
| AWS | t2.large | 2 | 8 | $0.1040 |
| AWS | m4.large | 2 | 8 | $0.1200 |
| AWS | m3.xlarge | 4 | 15 | $0.2660 |
| AWS | m4.xlarge | 4 | 16 | $0.2390 |
| AWS | m3.2xlarge | 8 | 30 | $0.5320 |
| AWS | m4.2xlarge | 8 | 32 | $0.4790 |
| AWS | m4.4xlarge | 16 | 64 | $0.9580 |
| AWS | m4.10xlarge | 40 | 160 | $2.3940 |
| Azure | A0 | 1 | 0.75 | $0.0180 |
| Azure | A1 | 1 | 1.75 | $0.0350 |
| Azure | A2 | 2 | 3.5 | $0.0790 |
| Azure | A3 | 4 | 7 | $0.1760 |
| Azure | A4 | 8 | 14 | $0.3520 |
| GCP | n1-standard-1 | 1 | 3.75 | $0.0500 |
| GCP | n1-standard-2 | 2 | 7.5 | $0.1000 |
| GCP | n1-standard-4 | 4 | 15 | $0.2000 |
| GCP | n1-standard-8 | 8 | 30 | $0.4000 |
| GCP | n1-standard-16 | 16 | 60 | $0.8000 |
| GCP | n1-standard-326 | 32 | 120 | $1.6000 |

*Source: Company websites, Goldman Sachs Investment Research. Pricing is for an instance with the default Linux operating systems. AWS is priced for General Purpose instances in the US East region, Azure for General Purpose Basic Tier in East US and GCP is for Google Compute's Standard Machine Types in the US. Pricing as of October 4, 2016.*

Most vendors charge per hour, except GCP, which charges per minute after a 10 minute minimum. For example, if a customer uses an instance for 12 minutes, on AWS and Azure, the customer would be charged for the full 60 minutes, but GCP would only charge for the 12 minutes of used.

**Public cloud is revolutionizing the way organizations host software applications, shifting IT budget spend from capex to opex**

Prior to the emergence of public cloud, an organization would typically host applications themselves, spending thousands or millions of dollars upfront to procure data center space, purchase hardware (servers, storage and networking equipment), buy infrastructure software (virtualization, operating systems, databases, middleware), contract for heating, cooling and electricity, and hire consultants and staff to architect and manage all of this.

This process would take weeks and often months to setup, whether the application was for a startup that wanted to test their new mobile game, or a Fortune 500 company that needed to track billions of dollars in inventory in their supply chain application.

With public cloud services such as AWS, Microsoft Azure, and Google Cloud Platform, organizations can essentially rent the application infrastructure with a credit card in minutes instead of going through this laborious process.

# Microsoft (MSFT, Buy): Upgrading to Buy from Neutral

### Source of opportunity

We are upgrading Microsoft to Buy from Neutral, with a 12-month price target of $68 (from $60), representing 16% upside versus 11% upside for the rest of our coverage as of the close 11/15 (on which we have an attractive view). We are increasing our revenue estimates by ~$650mn to $102bn in FY18 and ~$1.5bn to $111bn in FY19, and our non-GAAP EPS estimates by $0.21 to $3.30 in FY18 and $0.31 to $3.74 in FY19.

Azure is the #2 market share vendor in the cloud space, and has grown 100% or more yoy eight of the last ten quarters, and in fact growth accelerated in C3Q16. With a large Microsoft customer base and strong C-level relationships, we believe Azure can continue to grow revenue and improve margins over time. Our views are supported by channel partners as well, who have commented recently that they are seeing strong uptake of Azure amongst enterprise customers, particularly as it relates to hybrid cloud.

### Catalyst

Our upgrade is based on 1) accelerating growth in gross profit dollars driven by its cloud transition, 2) an inflection in incremental operating margins as cloud profitability ramps and operating expense growth remains muted, and 3) upside potential to consensus out year EPS forecasts.

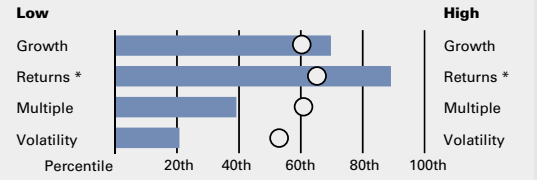
### Valuation

We are increasing our twelve month price target to $68 from $60 (DCF, EV/FCF, P/E).

### Key risks

Adoption of hybrid cloud, Windows and Office performance, IT spending and macro trends. Potential impact of LinkedIn if the transaction closes.

**Investment Profile**




* Returns = Return on Capital

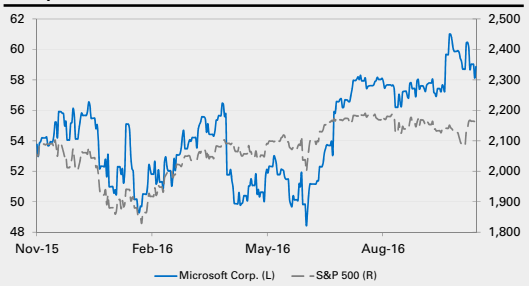
For a complete description of the investment profile measures please refer to the disclosure section of this document.

| Key data | Current |
|---|---|
| Price ($) | 58.87 |
| 12 month price target ($) | 68.00 |
| Market cap ($ mn) | 463,660.1 |

| | 6/16 | 6/17E | 6/18E | 6/19E |
|---|---|---|---|---|
| **Revenue ($ mn) New** | **91,963.0** | **94,618.5** | **101,663.4** | **110,836.2** |
| Revenue ($ mn) Old | 91,963.0 | 94,618.5 | 101,014.6 | 109,383.7 |
| **EPS ($) New** | **2.79** | **3.01** | **3.30** | **3.74** |
| EPS ($) Old | 2.79 | 2.95 | 3.09 | 3.43 |
| P/E (X) | 18.1 | 19.6 | 17.9 | 15.7 |
| EV/EBITDA (X) | 9.9 | 10.8 | 9.4 | 8.1 |
| ROE (%) | 29.4 | 33.7 | 36.4 | 37.2 |

| | 9/16 | 12/16E | 3/17E | 6/17E |
|---|---|---|---|---|
| EPS ($) | 0.76 | 0.77 | 0.71 | 0.77 |

**Price performance chart**




| Share price performance (%) | 3 month | 6 month | 12 month |
|---|---|---|---|
| Absolute | 1.3 | 15.3 | 11.4 |
| Rel. to S&P 500 | 1.7 | 8.2 | 3.4 |

*Source: Company data, Goldman Sachs Research estimates, FactSet. Price as of 11/15/2016 close.*

# Disclosure Appendix

## Reg AC

We, Heather Bellini, CFA, Heath P. Terry, CFA, Piyush Mubayi, Nicole Hayashi, Shateel Alam, Jack Kilgallen, CFA, Mark Grant and Elsie Cheng, hereby certify that all of the views expressed in this report accurately reflect our personal views about the subject company or companies and its or their securities. We also certify that no part of our compensation was, is or will be, directly or indirectly, related to the specific recommendations or views expressed in this report.

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The precise calculation of each metric may vary depending on the fiscal year, industry and region but the standard approach is as follows:

**Growth** is a composite of next year's estimate over current year's estimate, e.g. EPS, EBITDA, Revenue. **Return** is a year one prospective aggregate of various return on capital measures, e.g. CROCI, ROACE, and ROE. **Multiple** is a composite of one-year forward valuation ratios, e.g. P/E, dividend yield, EV/FCF, EV/EBITDA, EV/DACF, Price/Book. **Volatility** is measured as trailing twelve-month volatility adjusted for dividends.

## Quantum

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China Internet: 58.com Inc., Alibaba Group, Baidu.com Inc., Ctrip.com International, Gridsum, JD.com Inc., NetEase Inc., New Oriental Education & Technology, SINA Corp., TAL Education Group, Tencent Holdings, Vipshop Holdings, Weibo Corp..

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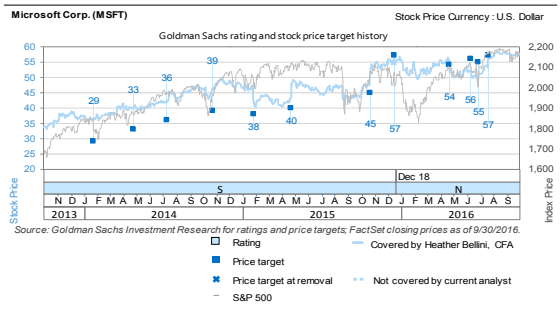


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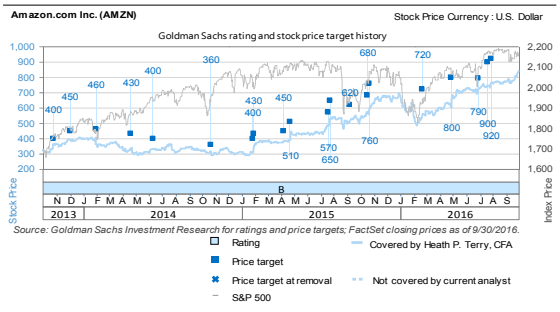


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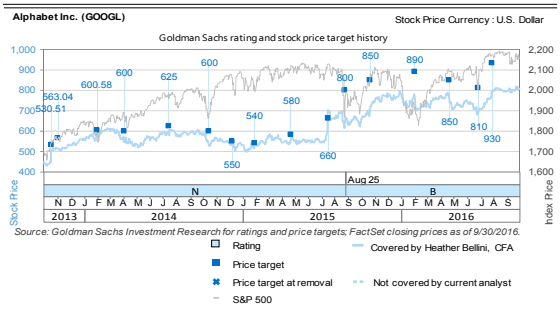


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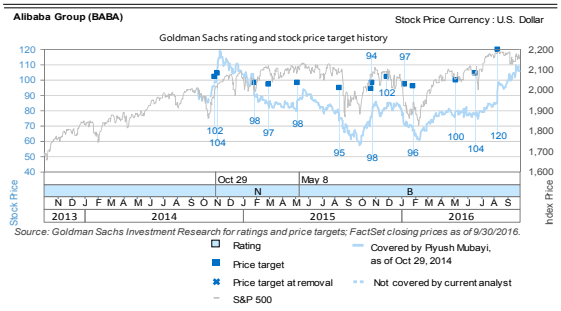


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