EVOLUTION OF IT TOWARDS CLOUD COMPUTING

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MODULE OBJECTIVE

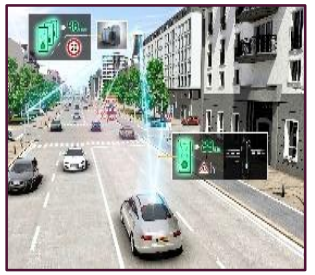
- Understand the evolution of software technology, industry and market over the last 60 years towards industrialization.
- Understand what drove the advent of cloud computing.
- Understand how cloud computing is changing the IT delivery model, software industry structure, and software business models.
- Understand how IT will evolve in the future.

HISTORY OF IT: 1955-2015

FROM MAINFRAME TO MOBILE CLOUD

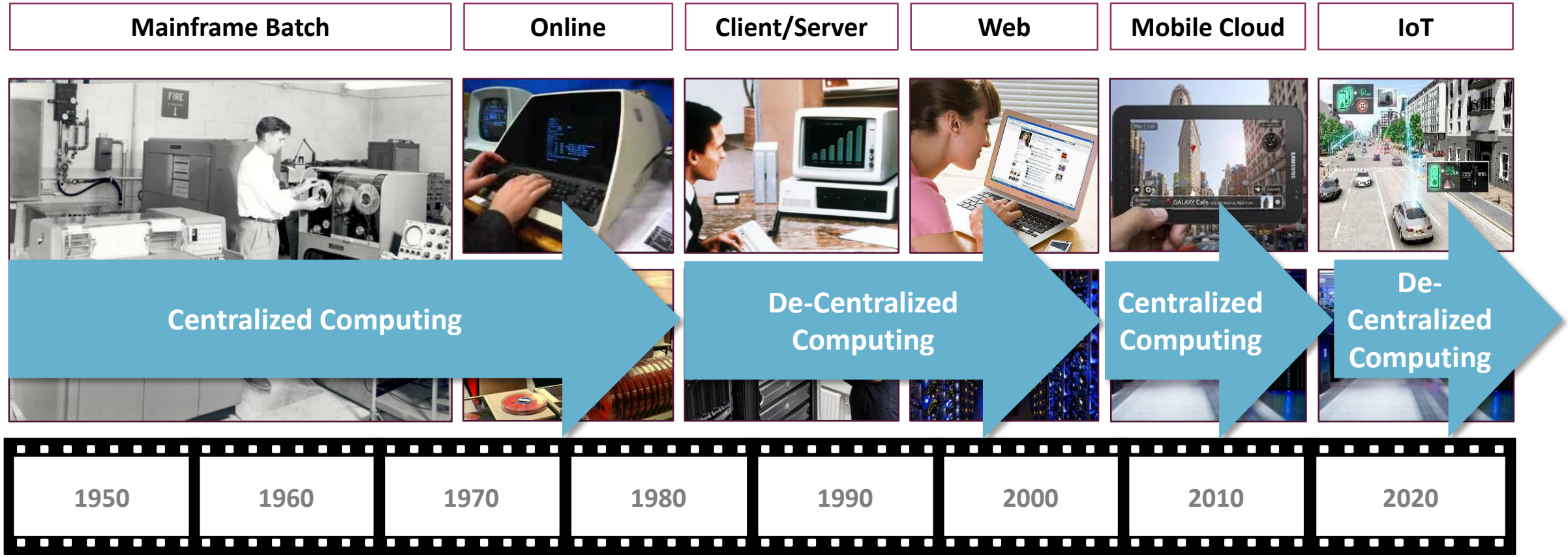
EVOLUTION OF COMPUTING

Mainframe Batch	Online	Client/Server	Web	Mobile Cloud	IoT

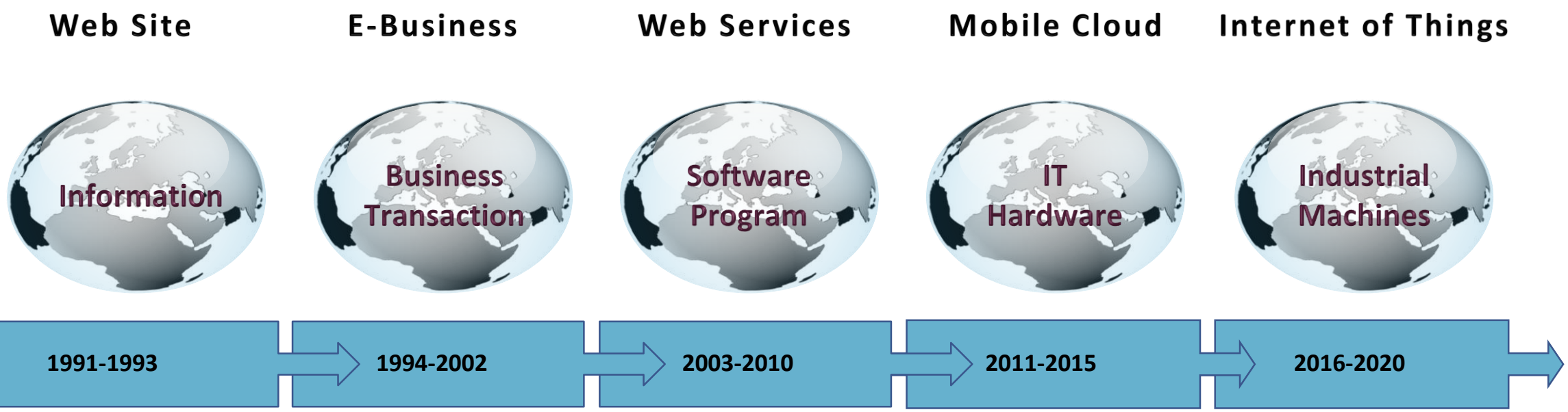


1950 | 1960 | 1970 | 1980 | 1990 | 2000 | 2010 | 2020

EVOLUTION OF COMPUTING



EVOLUTION OF WEB



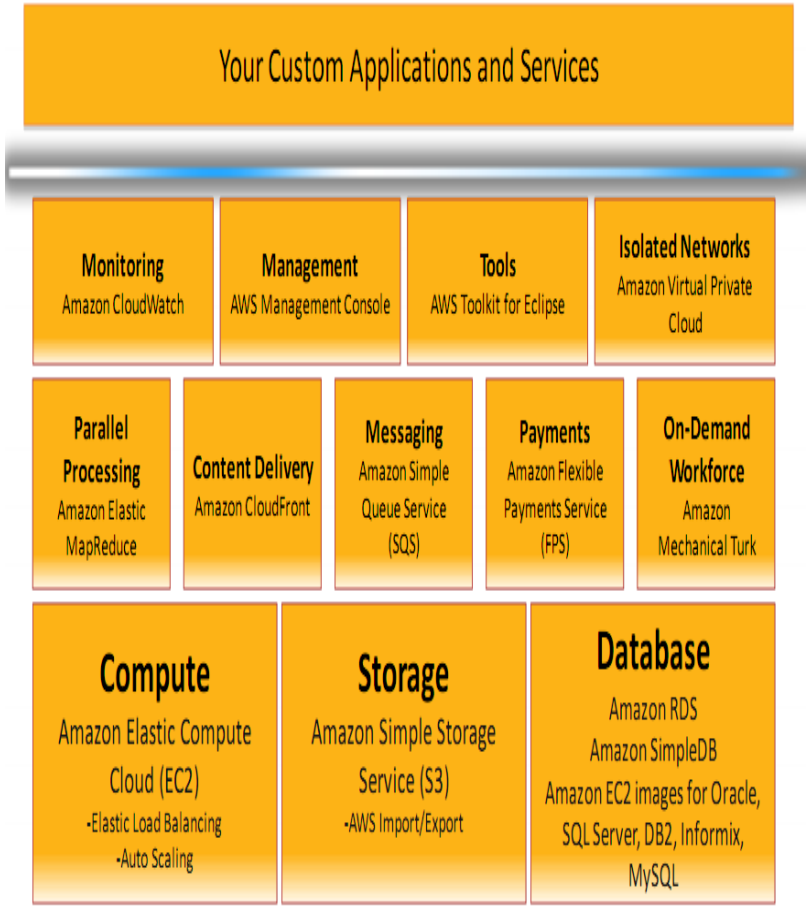
- Amazon opened e-tail shop (1994)
- AOL bought Time Warner (2000)
- Webvan failed losing $1B (2001)

- Amazon launched AWS (2003)
- E-business ended by 2008. (Gartner 2000)
- SOA prevailed by 2008 (Gartner 2003)

- By 2012 80% of Fortune 1000 used cloud services (Gartner 2009)

- AT&T, Cisco, GE and IBM formed Industrial Internet Consortium to integrate physical and digital worlds (2014)

- Amazon founded in 1994 as an online retailer of books invested billions of dollars to build the sophisticated Web infrastructure required to support its massive e-commerce business.
- In 2002 Amazon released product data as Web Services to hundreds of thousands of its third-party affiliates—Web sites that advertised Amazon products using the Amazon's API and received a portion of Amazon's resulting sales.
- In 2003 Amazon decided to expand the Web Services to sell its storage, computing and other technology services to software developers, and ultimately to create an Internet-based operating system for computing.



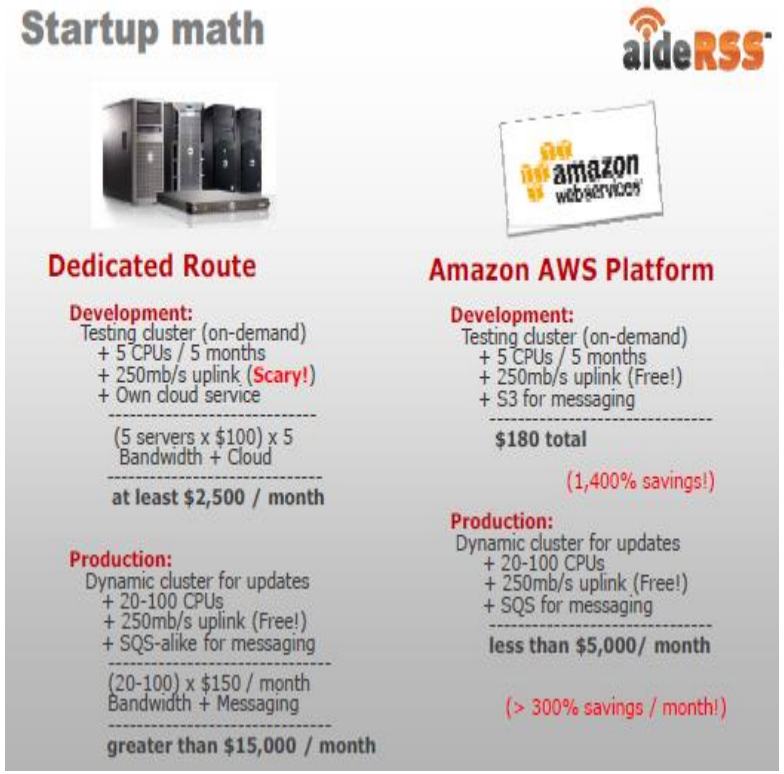
R. S. Huckman, et al., Amazon Web Services, Harvard Business School, Case Study 9-609-048, 2008.

CASE STUDY: ADVENT OF IAAS

Amazon

Value Proposition of IaaS

- Avoid back-end technology infrastructure stack
  - Amazon spent 70+% of its time building and maintaining the back-end technology infrastructure stack that did not differentiate Amazon business from its competitors
  - Same pain points exist in other companies in a range of industries
  - Provide software developers in any company inexpensive, reliable and scalable alternatives to buying or building in-house data centers
- Avoid CapEx
  - No up front capital expenditure for subscribers
  - Based on pay-per-use pricing model
  - Aggressive pricing with a belief that it would take several years before AWS becomes a cash flow generating business
- Fast time to market
  - Self-service for instant capacity
  - Scalable as the business grows



CASE STUDY: ADVENT OF IAAS

Amazon

R. S. Huckman, et al., Amazon Web Services, Harvard Business School, Case Study 9-609-048, 2008.

U.S. CIA

US CIA cloudified its data center using AWS IaaS platform. It's a public cloud on private premises behind very thick firewall in Langley.

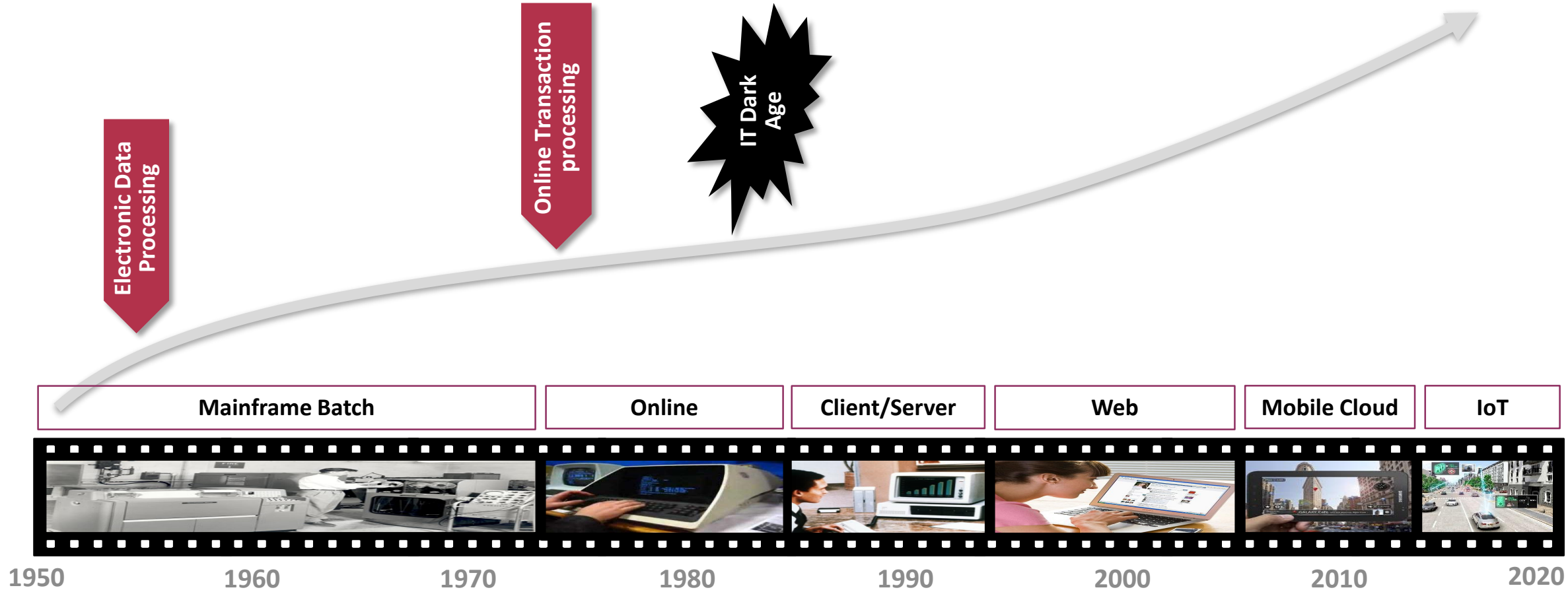
SmugMug

SmugMug is a paid photo-sharing website and image hosting service, launched in 2002 operating in a home office. In 2010, two petabytes of photos from millions of paying customers were stored on AWS S3 service.

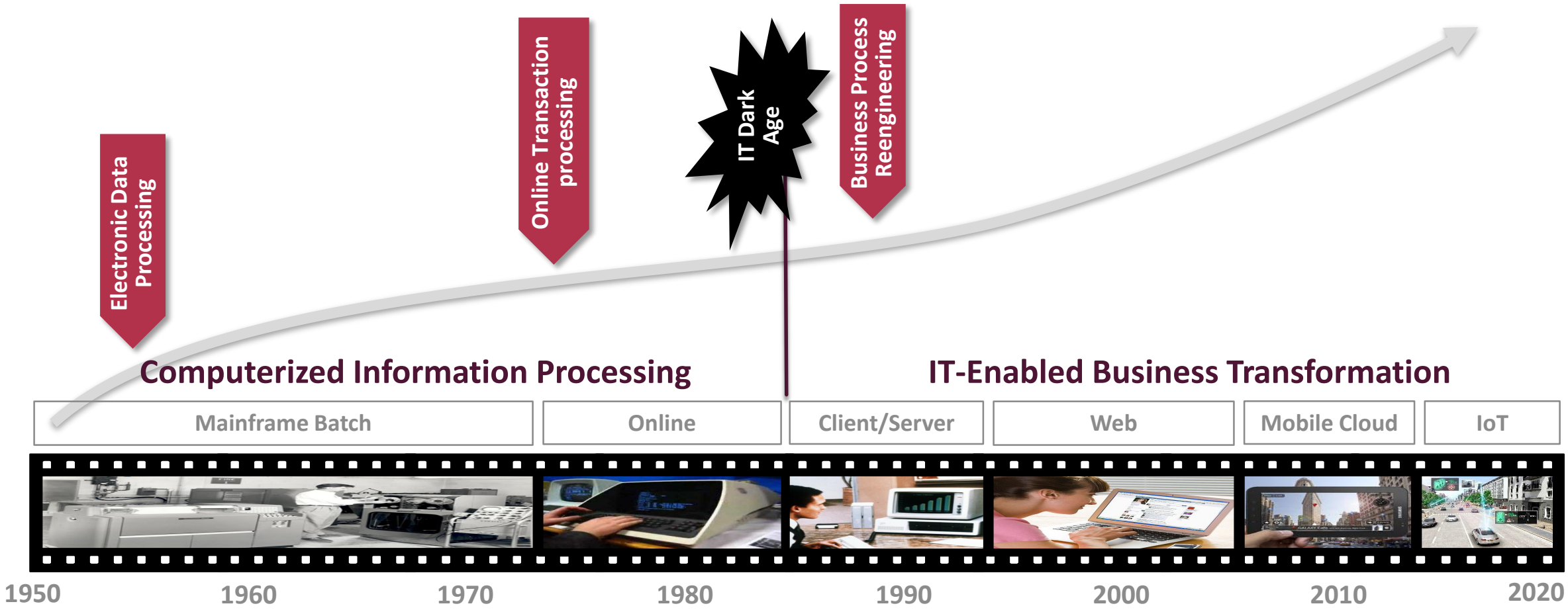
CASE STUDY: ADVENT OF IAAS

Amazon

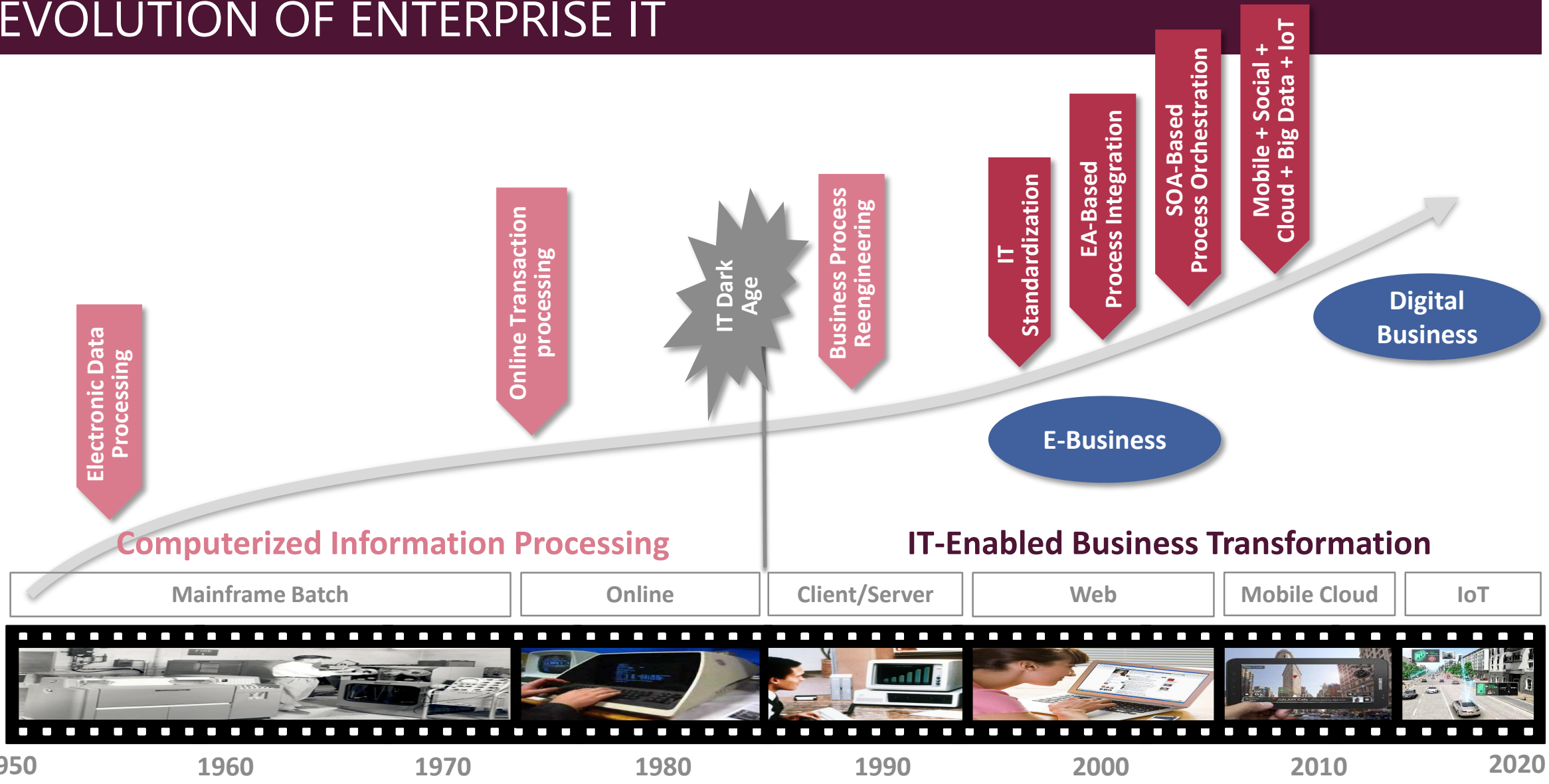
EVOLUTION OF ENTERPRISE IT



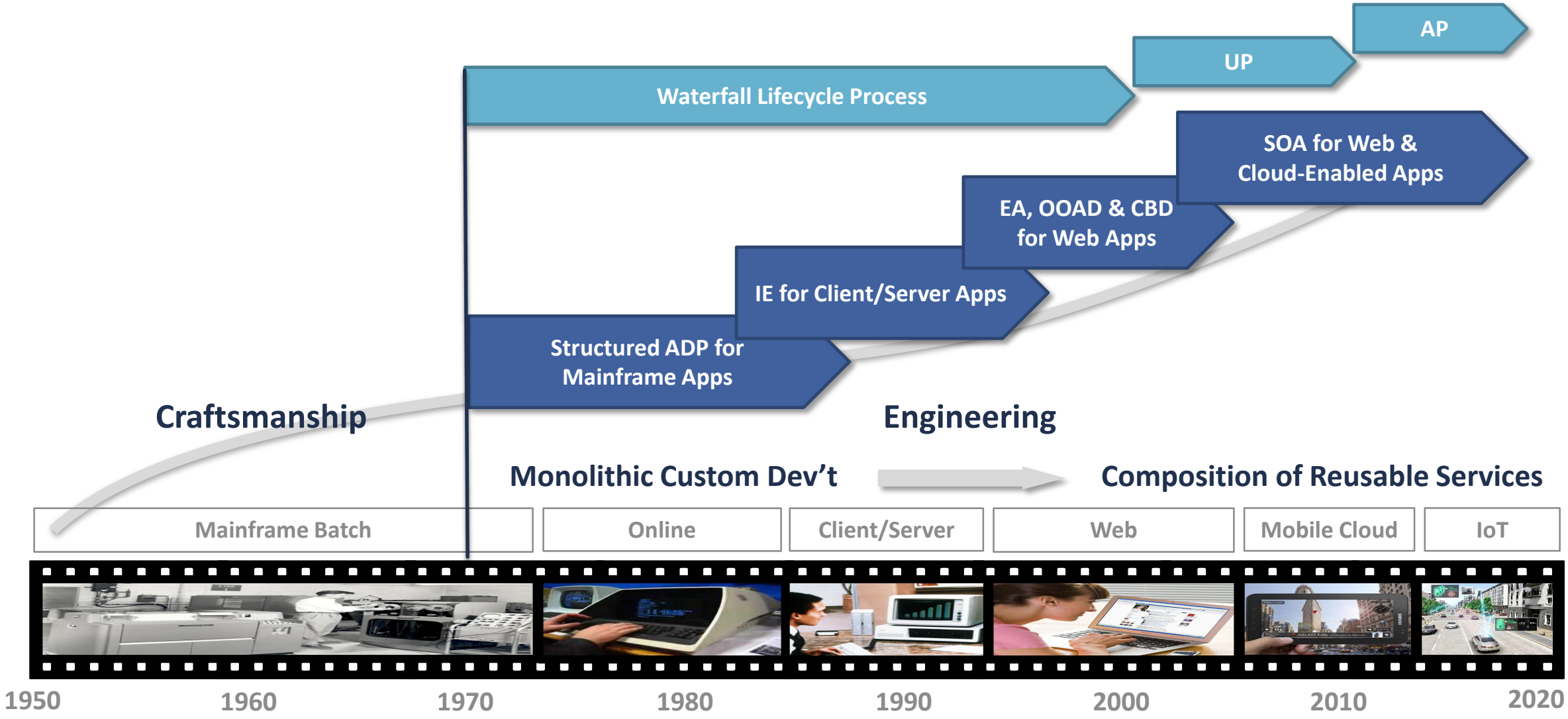
EVOLUTION OF ENTERPRISE IT



EVOLUTION OF ENTERPRISE IT



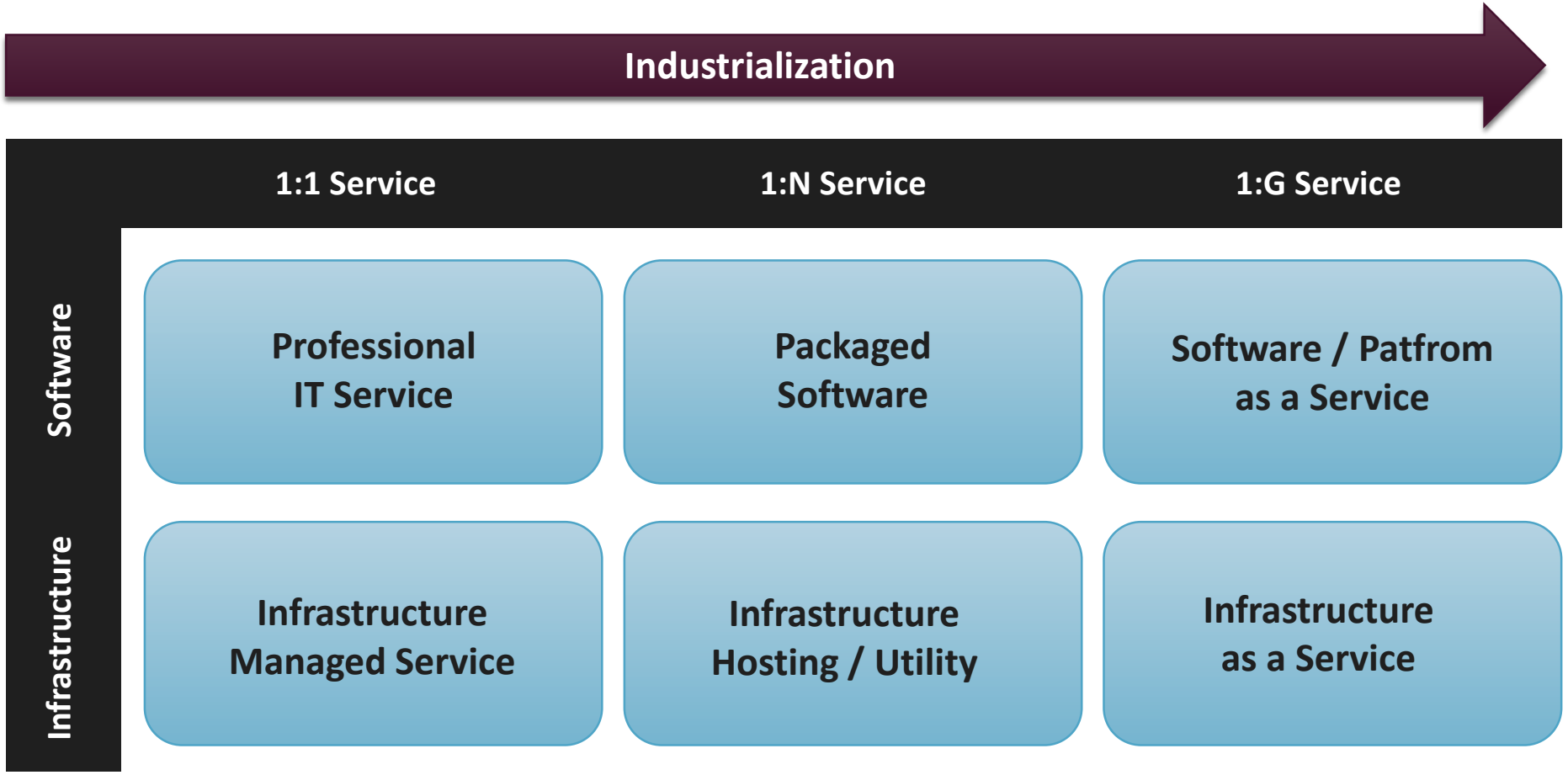
EVOLUTION OF SOFTWARE ENGINEERING



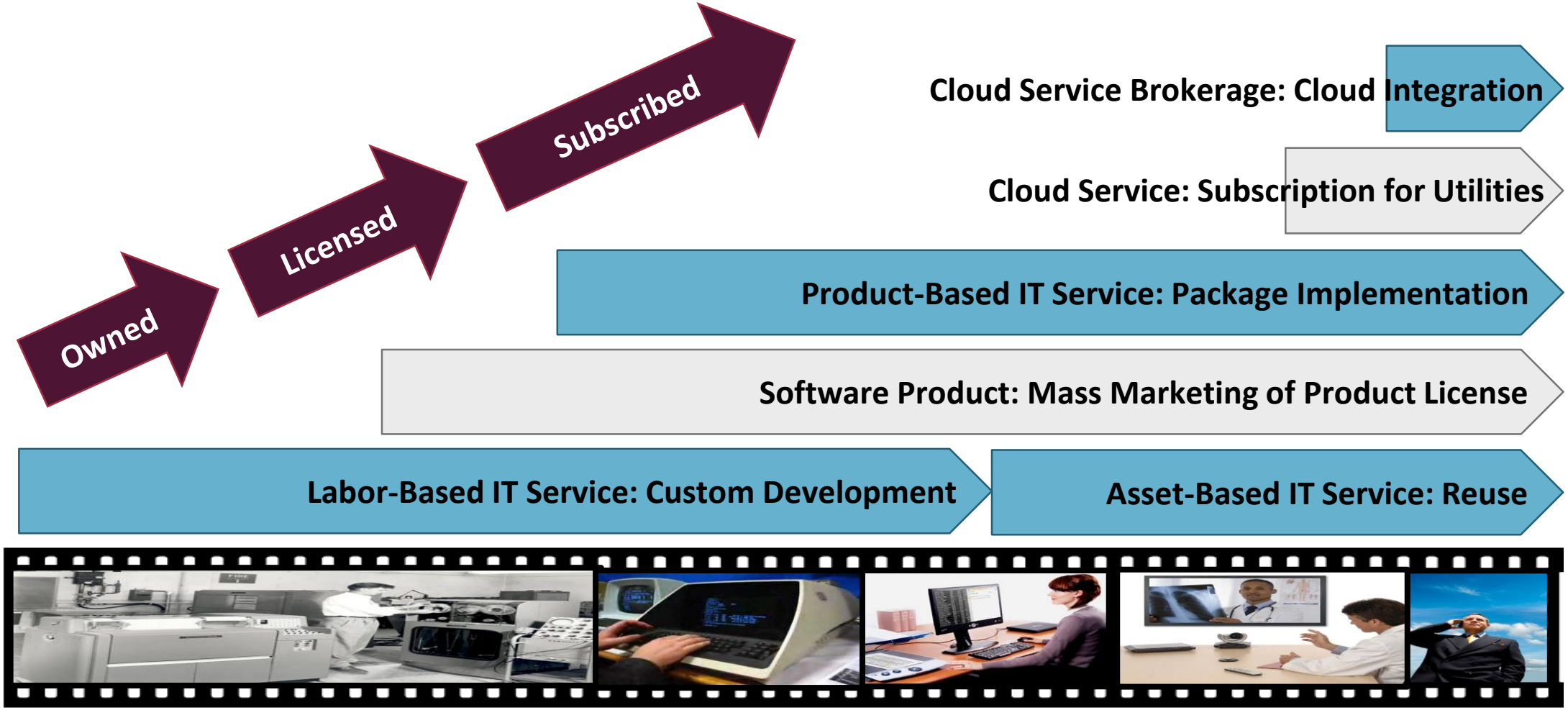
EVOLUTION OF IT DELIVERY MODEL

FROM CUSTOMER DEVELOPMENT TO CLOUD SUBSCRIPTION

EVOLUTION OF IT DELIVERY MODEL



EVOLUTION OF SOFTWARE INDUSTRY



EVOLUTION OF SOFTWARE BUSINESS

Arthur Andersen built a payroll processing system for GE in 1954

SAP founded in 1972

R3 released in 1992

eBusiness Suite released in 2002

Enterprise SOA & NetWeaver released in 2004

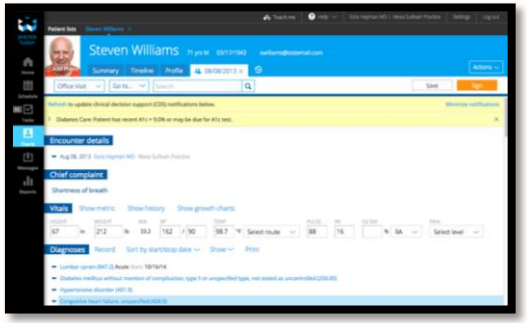
SAP HANA Enterprise Cloud announced in 2013

Accenture migrated iPad Marketplace of eBay to Azure platform in 2010

Accenture launched Cloud Platform in 2014

Mainframe Batch → Mainframe Online → BPR & Client/ Server → E-Business & SOA → Mobile, Cloud & Big Data

1950 1960 1970 1980 1990 2000 2010



Practice Fusion

Practice Fusion, a SaaS startup founded in 2005 to provide a free web-based EMR, serves over 100,000 medical professionals with 81,000,000 patient records in 2014.

Verizon

Verizon, a Telecommunication carrier, provides a mobile healthcare platform which matches patients to the next available clinician in the participating healthcare organization.

CASE STUDY: PROLIFERATION OF SAAS

Healthcare

- Accenture's Cloud Application Factory, offers "rules, tools, and schools" to accelerate a company's adoption of cloud computing. Everything from delivery toolkits to integration frameworks reduces risks and ensures the success of highly complex, global deployments.
- For example, some companies have 10,000 applications that could conceivably run in the cloud. An automated "sustainability assessment" helps determine the business case for cloud computing on an application-by-application basis.
- "We select SaaS solutions and build both public and private Cloud infrastructure and more recently to re-platform and build using PaaS."
- "Our competitive advantage is that we created an industrialized approach to solution design and development using proven assets specifically for salesforce.com that make it faster to deliver salesforce.com solutions," said David Jones, business development director at Accenture.
- The Force.com Factory can generate work plans and estimate timelines for rebuilding applications on salesforce.com's cloud-based multitenant architecture.

accenture

High performance. Delivered.

CASE STUDY: CLOUD SERVICE BROKERAGE

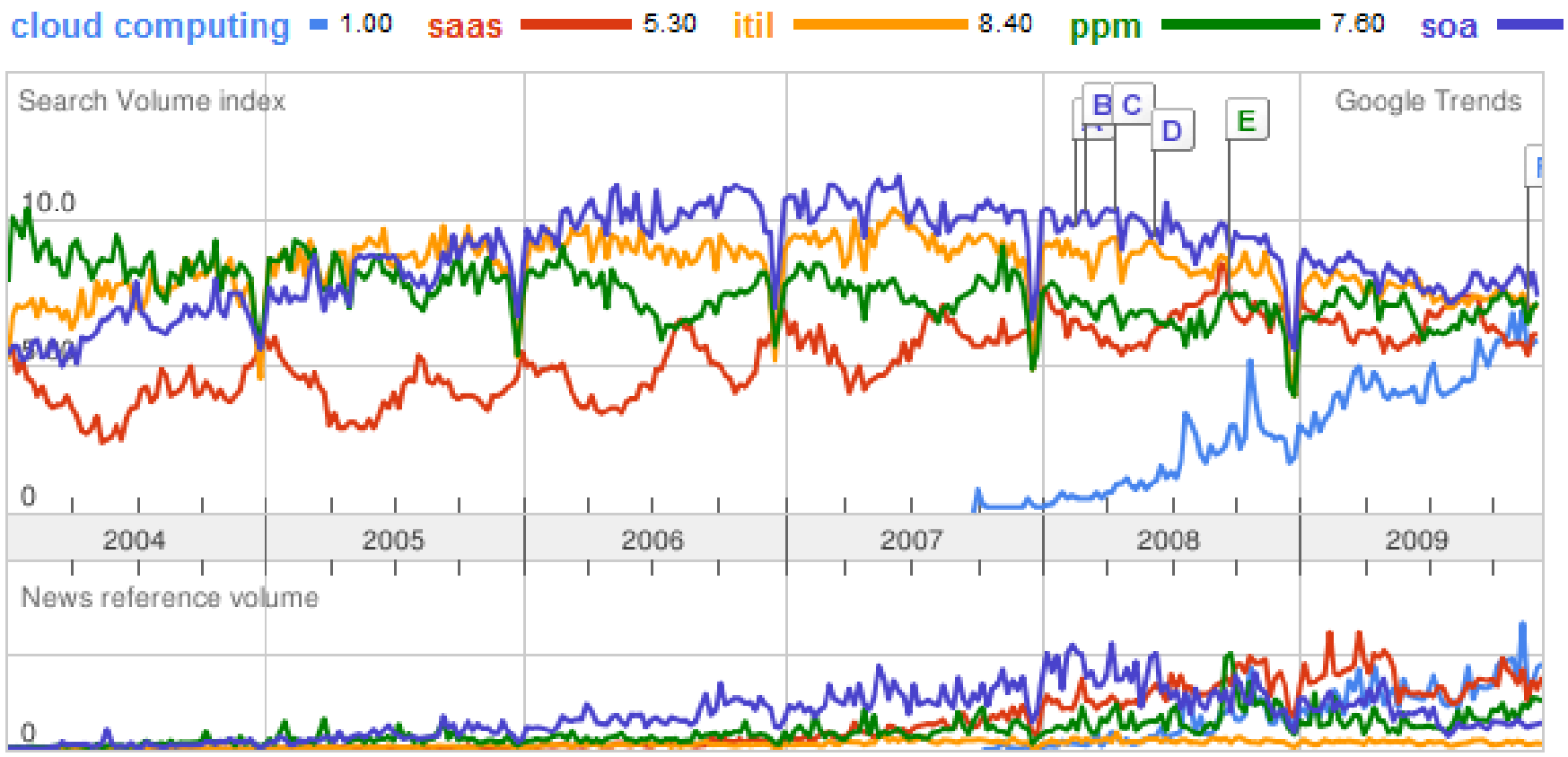
Accenture

GROWTH OF CLOUD COMPUTING: 2007-2015

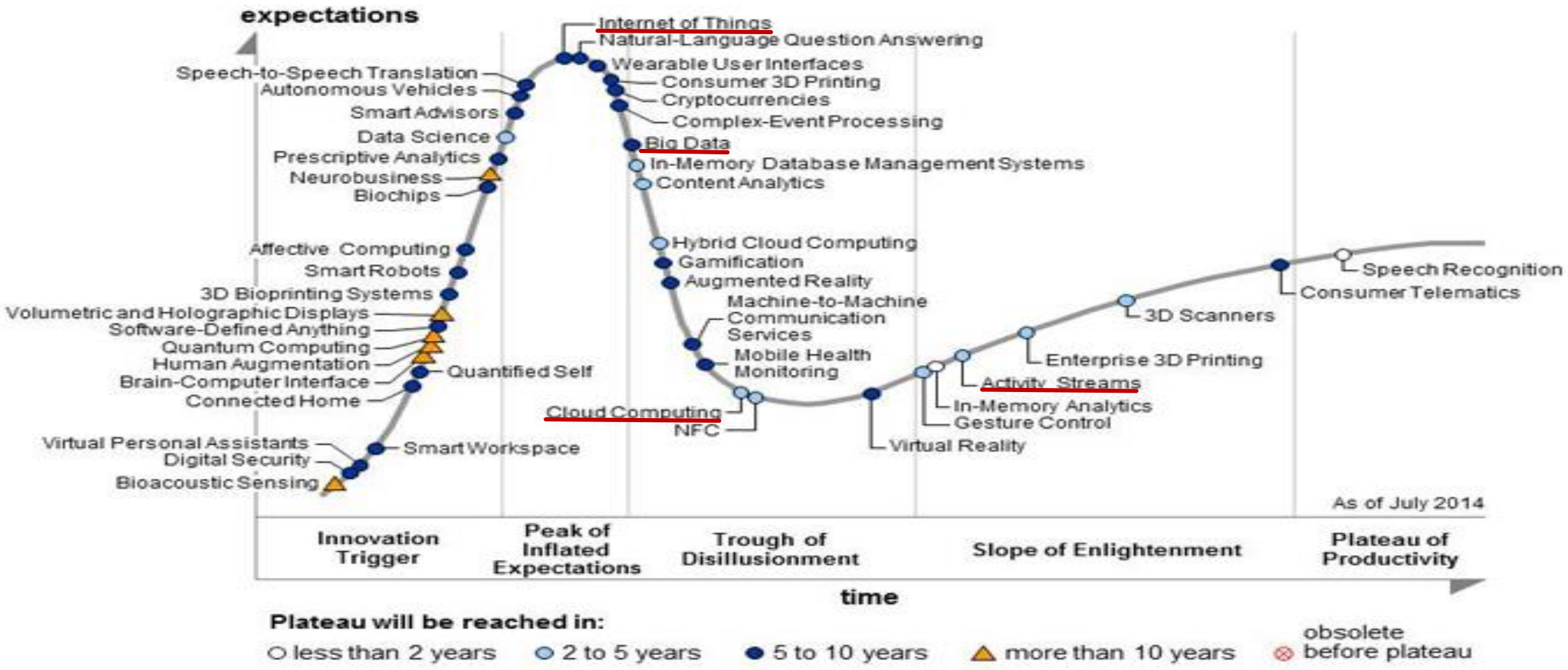
FROM HYPE TO REALITY

GROWTH OF CLOUD COMPUTING

- Cloud computing, started as hype and gradually adopted worldwide, is now here!

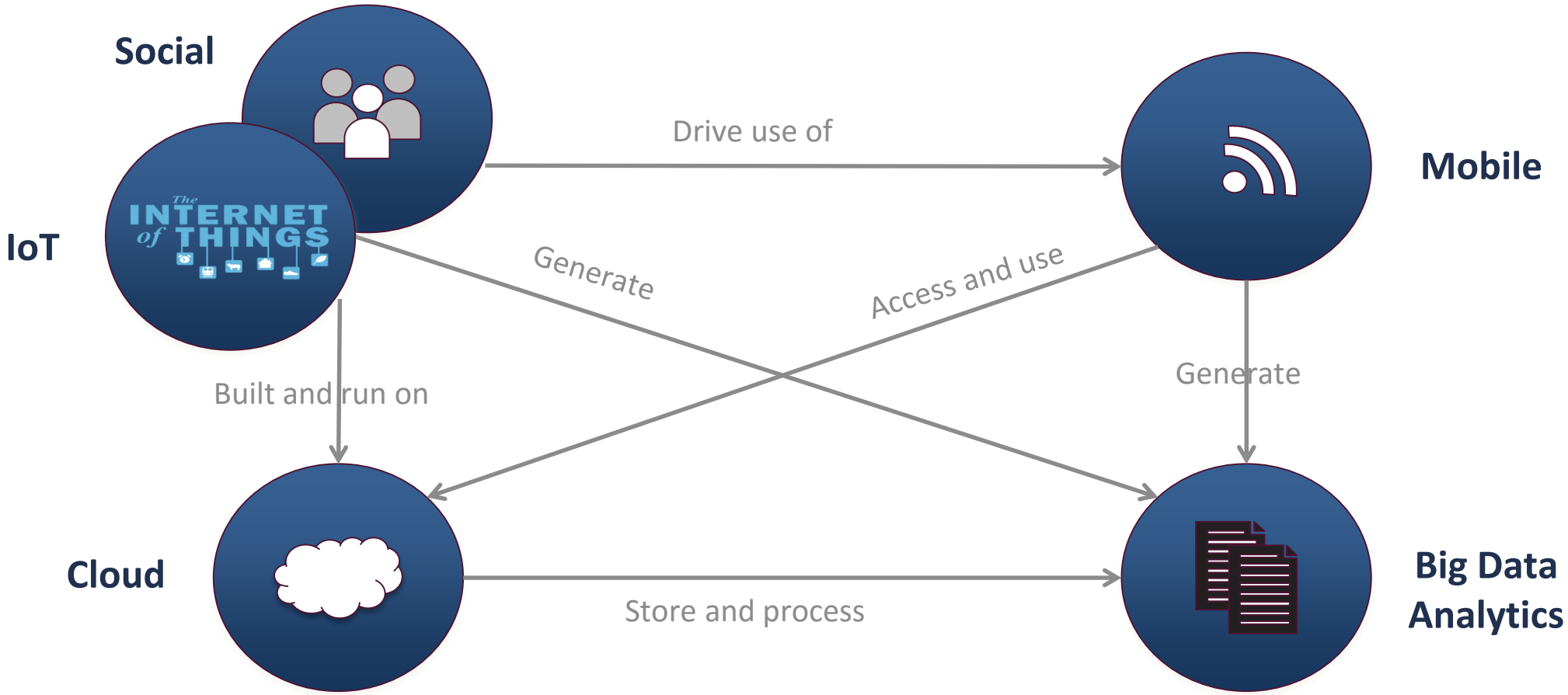


IT HYPE CYCLE



Source: Gartner (August 2014)

IT MEGA-TREND: SMACI



CIO PRIORITIES

- SMACI is driving all industry sectors into digital business (a.k.a. 4th Industrial Revolution)

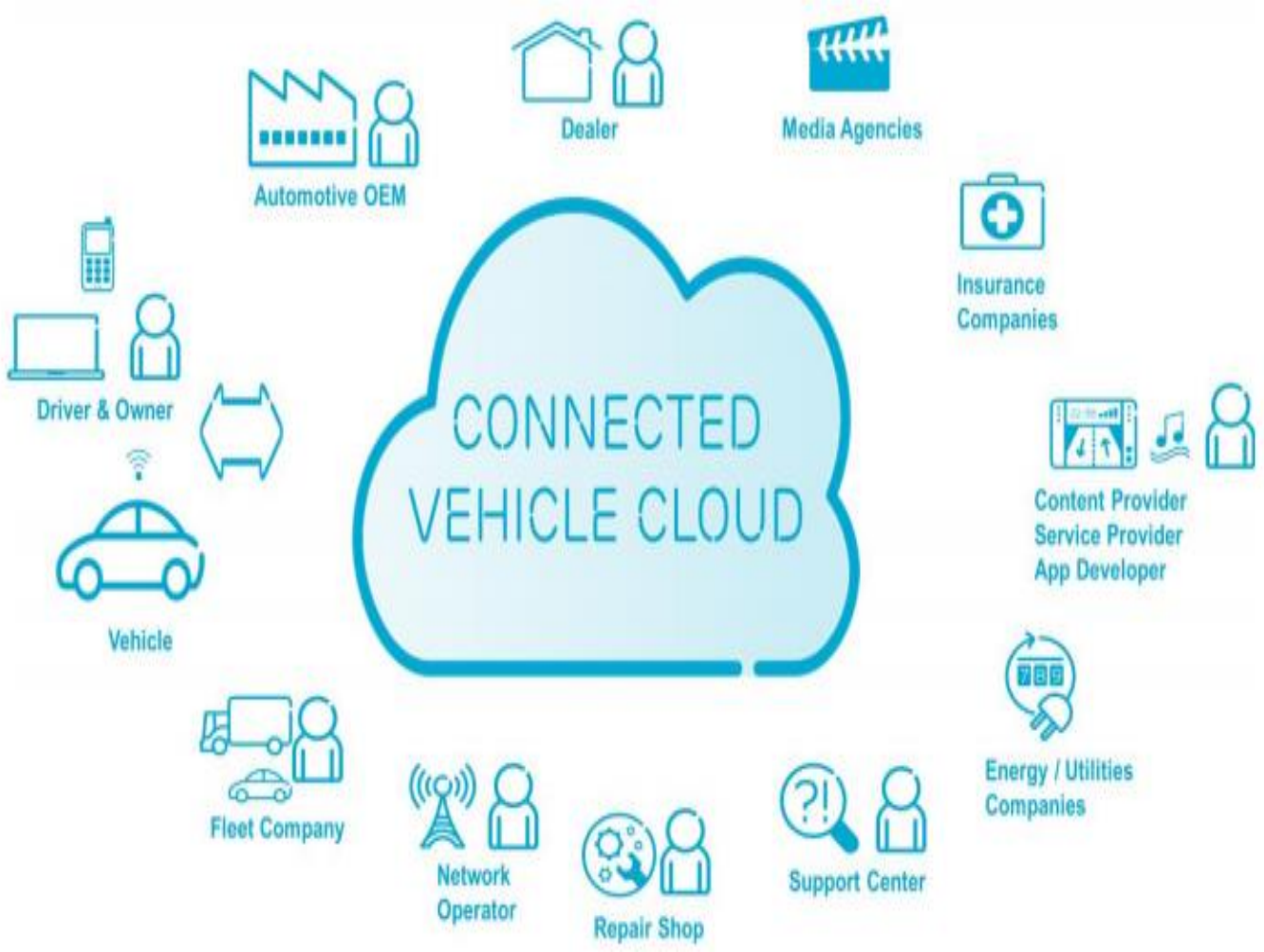
CIO technologies	Ranking of technologies CIOs selected as one of their top 3 priorities in 2012				
Ranking	**2012**	**2011**	**2010**	**2009**	**2008**
Analytics and business intelligence	1	5	5	1	1
Mobile technologies	2	3	6	12	12
Cloud computing (SaaS, IaaS, PaaS)	3	1	2	16	*
Collaboration technologies (workflow)	4	8	11	5	8
Virtualization	5	2	1	3	3
Legacy modernization	6	7	15	4	4
IT management	7	4	10	*	*
Customer relationship management	8	18	*	*	*
ERP applications	9	13	14	2	2
Security	10	12	9	8	5
Social media/Web 2.0	11	10	3	15	15

* Not an option that year

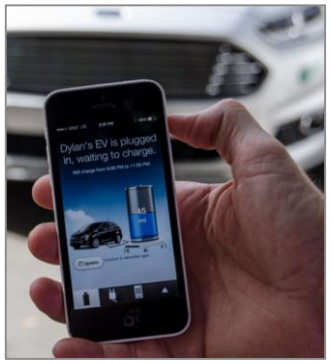
Source: Gartner Inc.

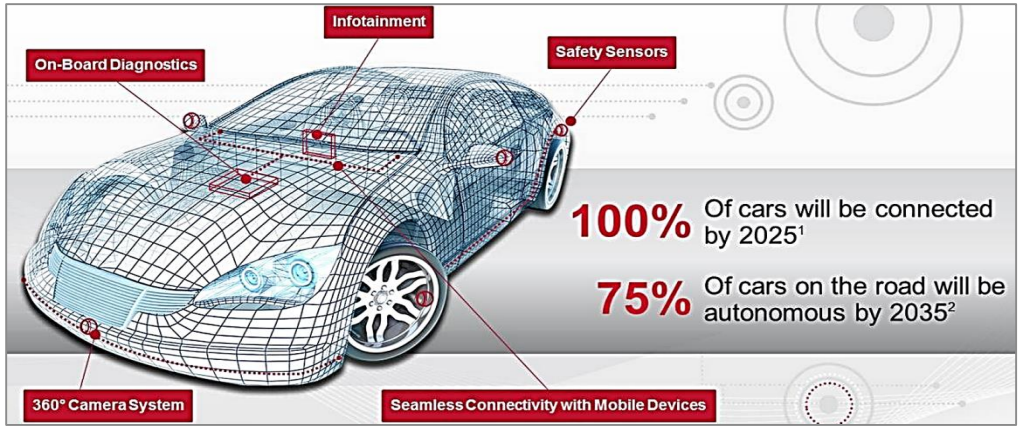
DIGITAL AUTOMOTIVE BUSINESS: CONNECTED CAR

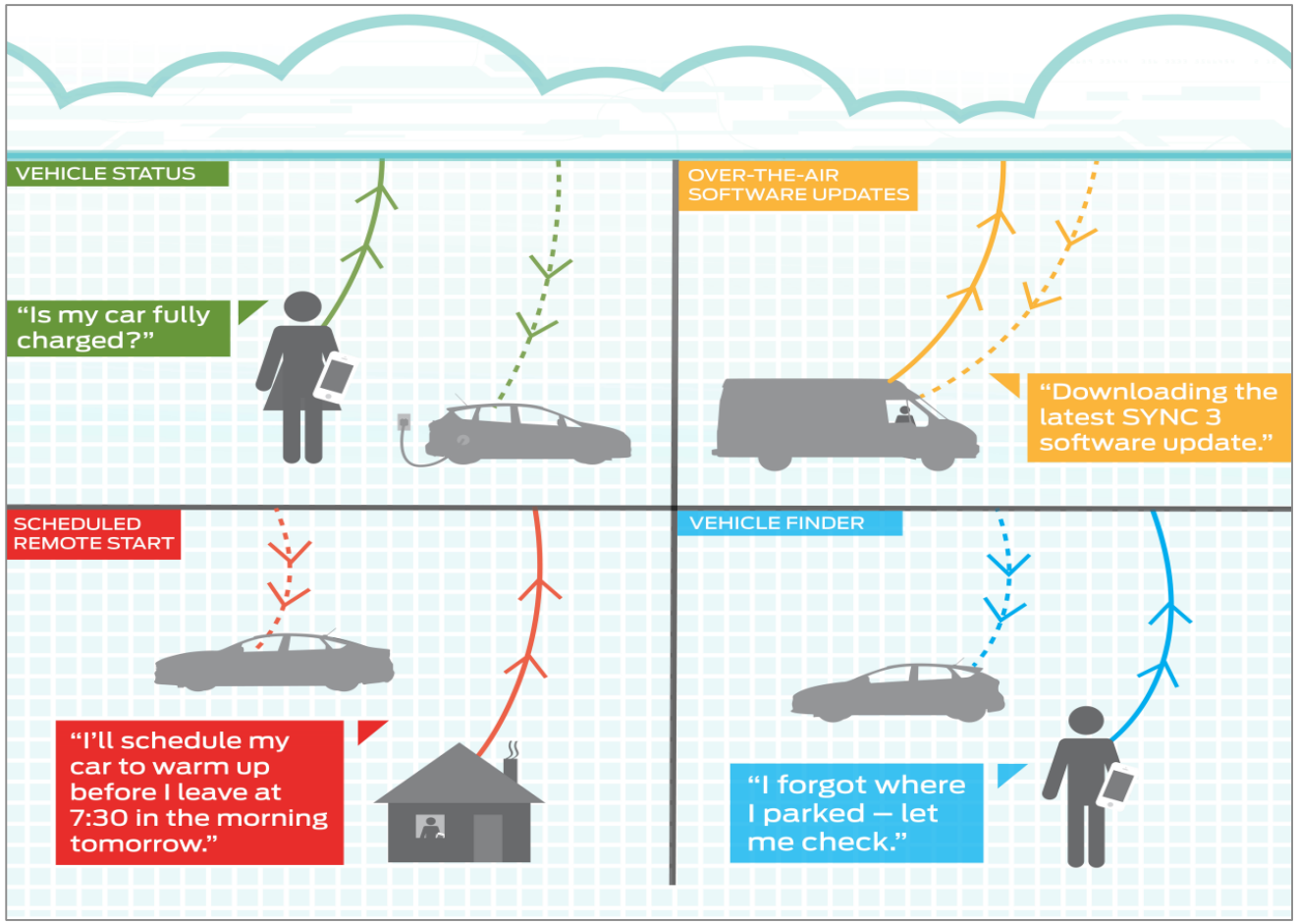
- **Navigation**: • Live traffic information • Points of interest displayed in the car • Finding parked car • Intelligent parking - pinpointing available parking spots • Counterevidence for speeding tickets • Areally/ timely extension of navigation area • Booking of parking spots in advance • Intermodal route planning • Automatic traffic sign recognition • Locally based information about events • Offers of available parking spots • Electronic logbook
- **Safety**: • eCall • Wrong-way driver warning • Prevention of accidents (M2M communication) • Health check of driver
- **Infotainment**: • WLAN in the car • Purchasing and downloading music • Entertainment streaming into the car's displays • Synchronization via the airwaves • SMS messages - reading and sending • Spotify and Internet radio • Location-based ads • Business functions such as calendars, address books • Social networking in the car • Location-sharing and tracking of friends
- **Remote telematics**: • Remote control • Stolen vehicle recovery • Surveillance of the car • Analyzing driving behavior/ optimizing fuel efficiency
- **Diagnose**: • Self-diagnosis including data cloud • Used car check
- **Insurance**: • Usage-based insurance • Combined insurance services (e.g. bCall) • Cross-selling offers
- **Ad hoc carpooling**: • Combined booking of cars and parking spots • Private car sharing without physically exchanging keys
- **Other**: • Reminder of forgotten mobile devices in the car • Mobile payment of car tolls • Concierge services • Automatic information on delays • Location-based memory function • Leasing rate based on driving behavior • Current car residual value sent to the consumer



- Ford expands connected services for customers around the world with the cloud-based Ford Service Delivery Network, powered by Microsoft Azure.







CASE STUDY: CONNECTED CAR

Ford

CLOUD SERVICE MARKET AND INDUSTRY TREND

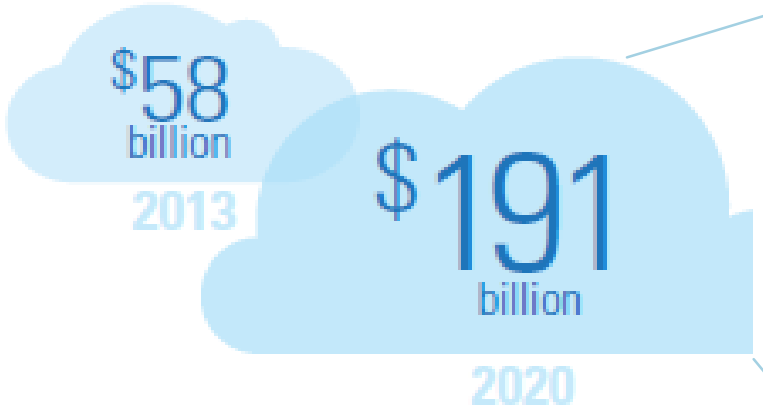
FROM IBM TO AMAZON

GLOBAL SOFTWARE MARKET: 2010-2015

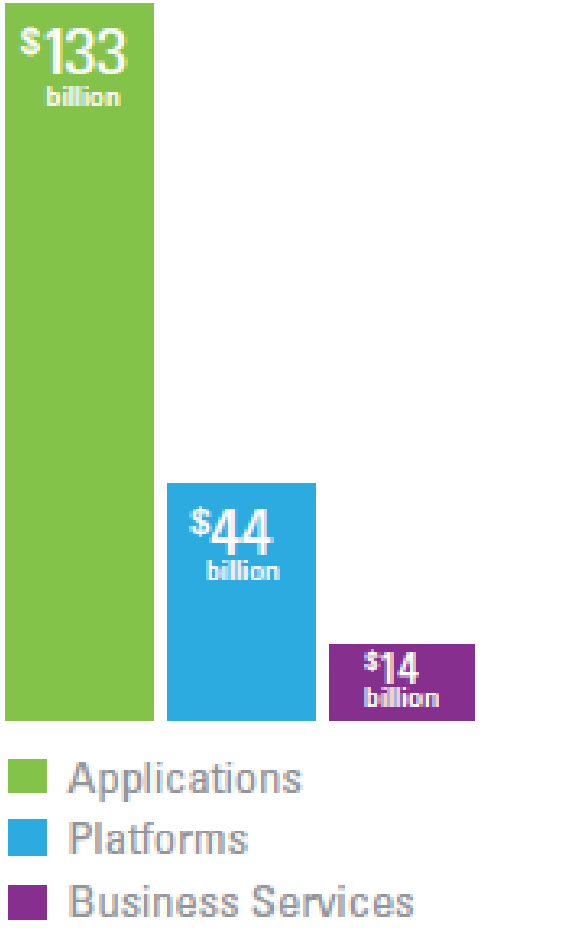
IT		2010 ($B)	2015 ($B)	CAGR (%)
Software		1,111	1,538	7
	Software Product	244	351	8
	IT Services	793	1,004	5
	SaaS/PaaS	71	158	17
	IaaS	3	20	48
	Cloud Service Brokerage	0.05	5	400
IT Hardware		788	1,176	8
	Computing Hardware	375	604	10
	Telecom Equipment	413	572	7
Telecom Services		1,602	1,914	4

Gartner Dataquest, Forecast Alert: IT Spending, Worldwide, 2008-2015, 2Q11 Update, June 2011.

GROWTH OF CLOUD MARKET

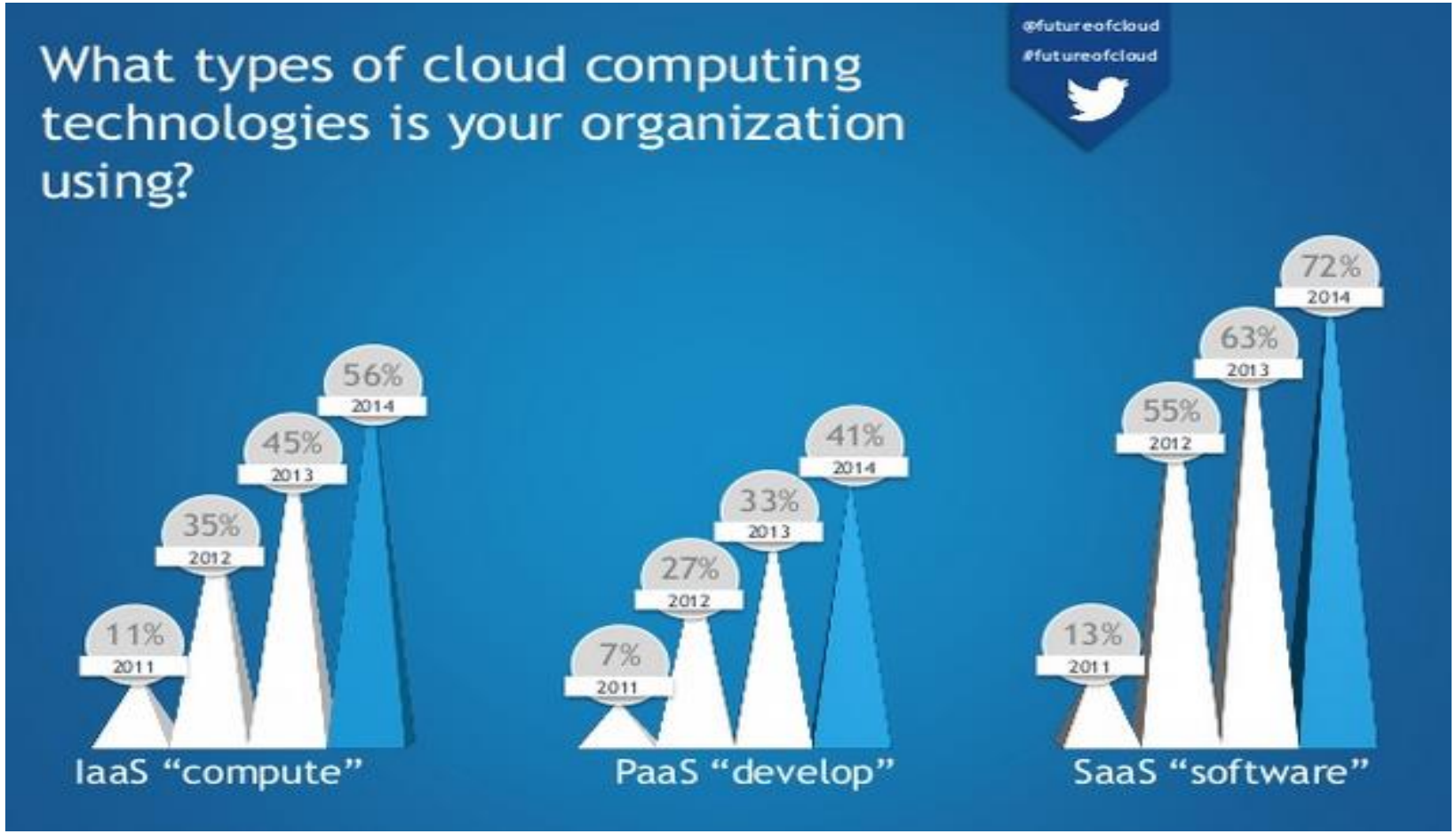


Estimated growth of the public cloud market by 2020



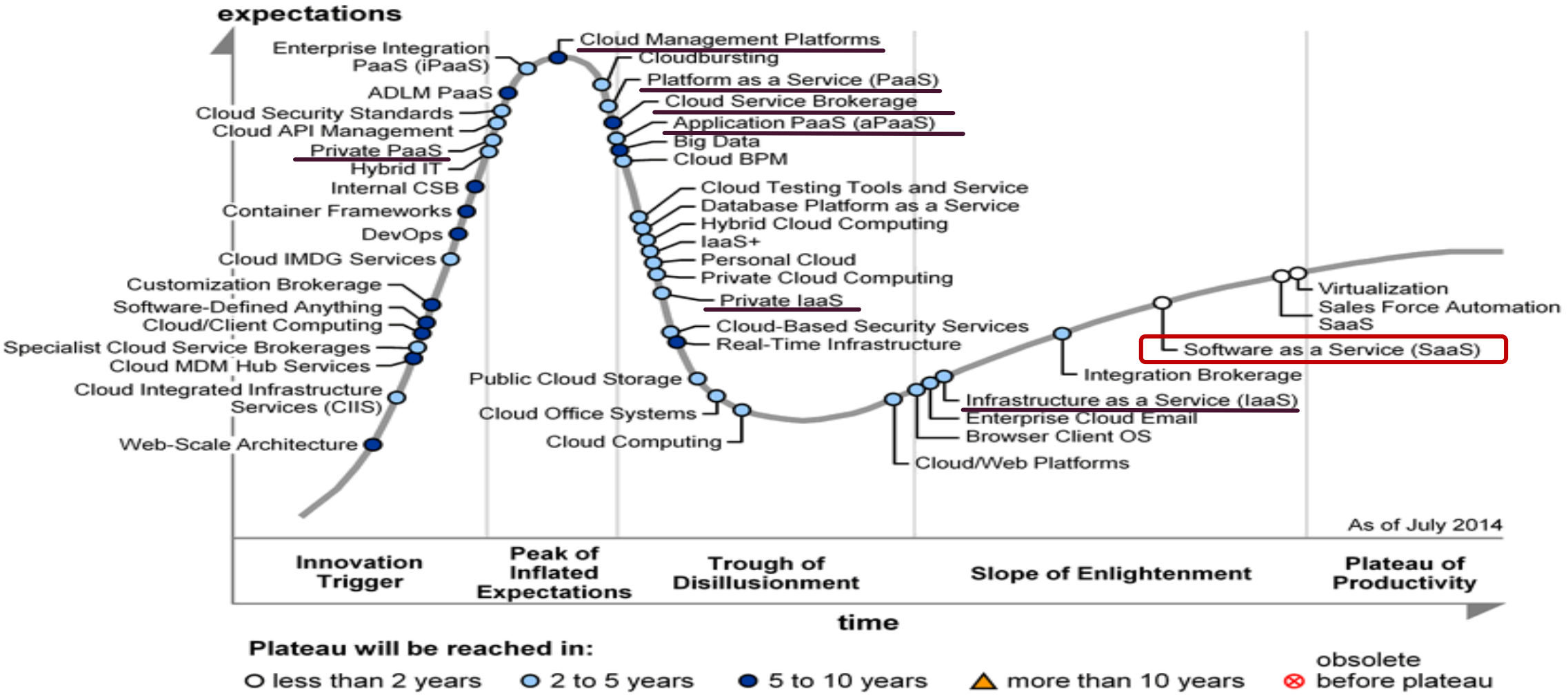
Estimated revenue growth by 2020

CLOUD ADOPTION BY CLOUD SERVICE MODELS



North Bridge, Future of Cloud Computing Survey, 2014.

CLOUD COMPUTING HYPE CYCLE



Gartner, Hype Cycle for Cloud Computing, 2014

PROFIT MODELS OF SOFTWARE BUSINESS

	Accenture 2010	SAP 2010	Microsoft 2010	Salesforce 2010	Google 2010
Revenue (M$)	21,550	12,464	62,484	1,306	29,321
Cost of Services	66%	32%	20%	20%	36%
Gross Margin	34%	68%	80%	80%	64%
Sales & Marketing	12%	21%	21%	46%	10%
R&D	2%	14%	14%	10%	13%
G&A	6%	13%	6%	15%	7%
Operating Profit	14%	21%	39%	9%	35%

- 97% of Google's revenue is ad revenue.
- 91% of Salesforce.com's revenue is subscription revenue.

MARKET VALUES OF SOFTWARE BUSINESS

Microsoft

Salesforce.com

MARKET VALUES OF SOFTWARE BUSINESS

- The ratio of the market value to prior year sales (Price-Sales Ratio, or P/S ratio) reflects the expectation of investors on the firm's potentiality for sustainable, profitable, high growth.
- Facebook, LinkedIn, Salesfoprce.com and Google which showed the highest P/S ratios exhibited high levels of both growth rates and gross margin percentages.

2010/ 11 Jan. 2012	Prior Year Sales ($B)	Op. Profit %	Gross Margin %	Market Value x Sales	Sales Growth %	Sales/Person	Sales, Mktg, GA%	R&D%	Product Sales%
Facebook	$3.7	47%	77%	28x	88%	$1.2 M	20%	10%	15%
Microsoft	$70	39%	78%	3x	12%	$778 K	26%	13%	90%
Google	$29	35%	65%	7x	24%	$1.2 M	16%	13%	4%
Oracle	$36	34%	76%	4x	33%	$333 K	21%	13%	38%
Apple	$108	31%	41%	4x	66%	$1.7 M	7%	2%	94%
Infosys	$6	29%	42%	5x	26%	$46 K	12%	2%	5%
SAP	$16.5	21%	69%	4x	17%	$308 K	26%	14%	26%
IBM	$100	19%	46%	2x	4%	$234 K	19%	6%	41%
Salesforce	$1.7	6%	80%	9x	27%	$321 K	63%	11%	94%
Linkedin	$0.52	4%	84%	13x	215%	$260 K	46%	25%	20%

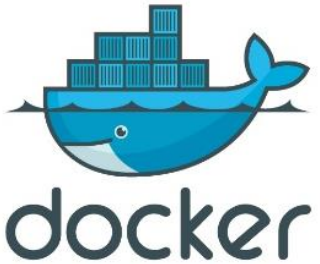
M. A. Cusumano, Reflecting on the Facebook IPO, Communications of the ACM, 55, 10, October 2012.

CLOUD ERA: 2020 PREDICTION

SOFTWARE AND HARDWARE MODULARIZED AND COMMODITIZED

2020 CLOUD COMPUTING PREDICTION

- Separation of software and hardware
  - Multiple layers of virtualization including PaaS, IaaS and hypervisors used between application software and bare machines will enable application software to be developed and executed independently of underlying middleware and hardware.
- Software Modularization
  - Applications will be easily composed by assembling SaaS components using their open APIs.
  - Business process orchestration and metadata-based data federation will be essential for the integration among multiple SaaS and on-premise applications.
- Infrastructure Modularization
  - Data center infrastructure will be easily assembled using cheap commodity hardware, just like a PC can be assembled, owing to the standardization of hardware specifications driven by OpenCompute project.



2020 CLOUD COMPUTING PREDICTION

- SaaS Vendors Merged
  - Incumbent software vendors as well as non-IT companies will keep on buying SaaS vendors to keep up with the paradigm shift towards cloud computing.
  - In 2012, for example, IT industry showed a record-high M&A deal volume and most of the deals were to buy cloud service companies (such as SAP buying Ariba at $4.5B, Oracle buying Taleo and Eloqua at $2B and $1B, respectively)
- IaaS Vendors Consolidated and IaaS Price Falling
  - As IaaS becomes more and more technology-intensive and capital-intensive, vendor consolidation will be accelerated, leaving smaller vendors in a variety of niche areas of special-purpose services.
  - 64-bit, low-power ARM and Atom chips, increasing core count of processors, super-fast interconnects, software-defined networking based on OpenFlow standard, and automated IT service management will dramatically increase the computing speed and lower the cost of computing.
  - This will enable IaaS vendors to cut the price deeper as they face severer competitions.
- Shift to Cloud Generation
  - A new generation of CIOs grown up in a cloudy world will change the IT consumption model.