ARK INVEST

BIG IDEAS 2018

DISRUPTIVE INNOVATION

ARK INVEST

www.ark-invest.com

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ARK INVEST | BIG IDEAS 2018

About ARK Invest

Rooted in almost 40 years of experience, ARK Invest aims to identify large-scale investment opportunities resulting from technological change. ARK Invest focuses solely on offering investment solutions that capture disruptive innovation in the public markets.

WE BELIEVE INNOVATION IS KEY TO GROWTH.

About Big Ideas

"Big Ideas" is ARK's annual publication showcasing a selection of innovations that we believe will accelerate the pace of change. The research presented in the following slides aims to illustrate how these ideas are transforming the way the world works and delivering outsized growth opportunities across different industries.

Each section highlights a technologically enabled innovation and provides a short research analysis, before briefly sizing the investment opportunity.

Mobility-as-a-Service (MaaS)

Robotics

Deep Learning

CRISPR Genome-Editing

Cryptoassets

Frictionless Value Transfers

3D Printing

ARK's Research Team

ARK's analysts are organized by cross-sector disruptive innovation themes. Each analyst is focused on different innovation elements.

JOIN THE CONVERSATION AND GET IN TOUCH WITH ARK'S ANALYSTS.

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MOBILITY-AS-A-SERVICE

Research by Tasha Keeney and Sam Korus

A Review

2004

DARPA* launches Grand Challenge, a Competition to Foster the Development of Self-Driving Ground Vehicles

(*Defense Advanced Research Projects Agency)

2009

Google Self Driving Car Project Begins

2015

Tesla Launches First Version of Autopilot Software

2016

Tesla and Chevy Launch the First "Mass Market" Electric Vehicles

2017

Large Automakers Begin Making Commitments to Phase Out Fossil Fuel Cars

Planned and Announced Global Battery Production Capacity Doubles from Previous Year to 273 GWh

Waymo Begins Testing Autonomous Cars on Public Roads Without Safety Drivers

WAYMO

Source: ARK Investment Management LLC, 2017 | A selection of events, achievements and innovation milestones.

Today, We See Two Transformations In The Mobility Space

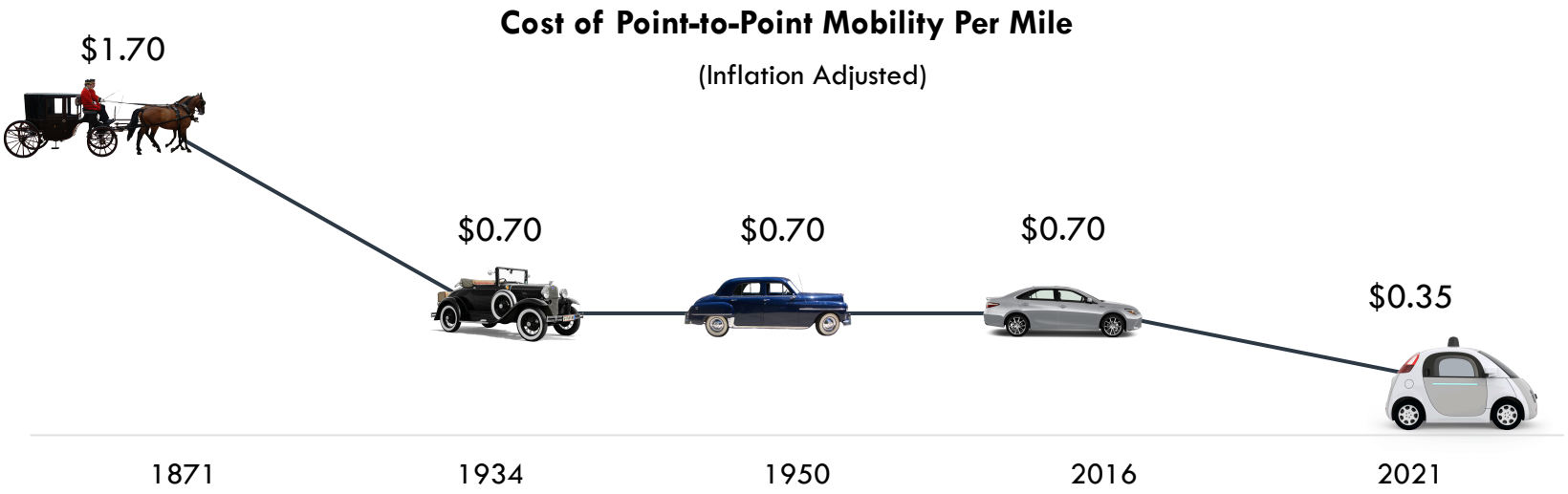
1 ..... **GAS-POWERED** → **ELECTRIC**

2 ..... **HUMAN-DRIVEN** → **AUTONOMOUS**

Autonomous platforms, or Mobility-as-a-Service (MaaS), will come in many different forms, including:

Personal Mobility Should Become More Affordable

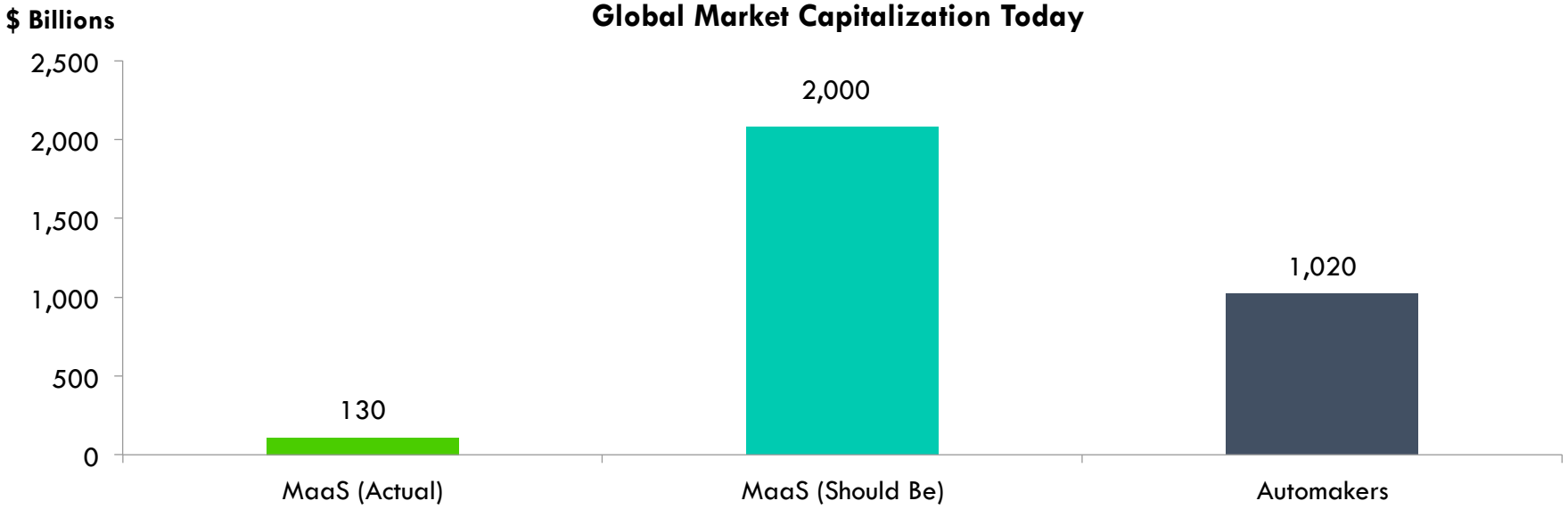
The price of personal mobility has not changed since the Model T.



Sources: ARK Investment Management LLC, 2017 | Morton Salt Company Records, American Automobile Association (AAA)

ARK's Research Shows…

…that MaaS should be valued today at $1-3 trillion dollars.

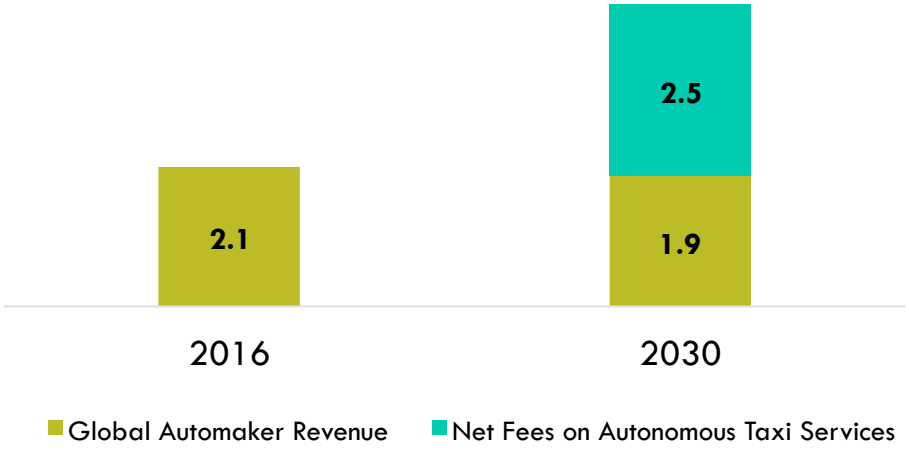


Sources: ARK Investment Management LLC, 2017

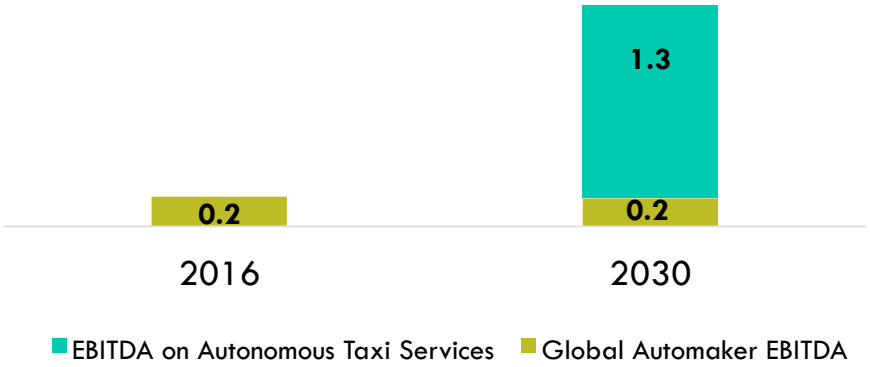
Platform Providers Could Be The Big Winners

ARK believes autonomous platform providers will be roughly 9 times more valuable than the automakers. Likely candidates are Baidu, Alphabet, and Tesla.

Revenues of Automakers and Autonomous Platform Providers ($ Trillions)



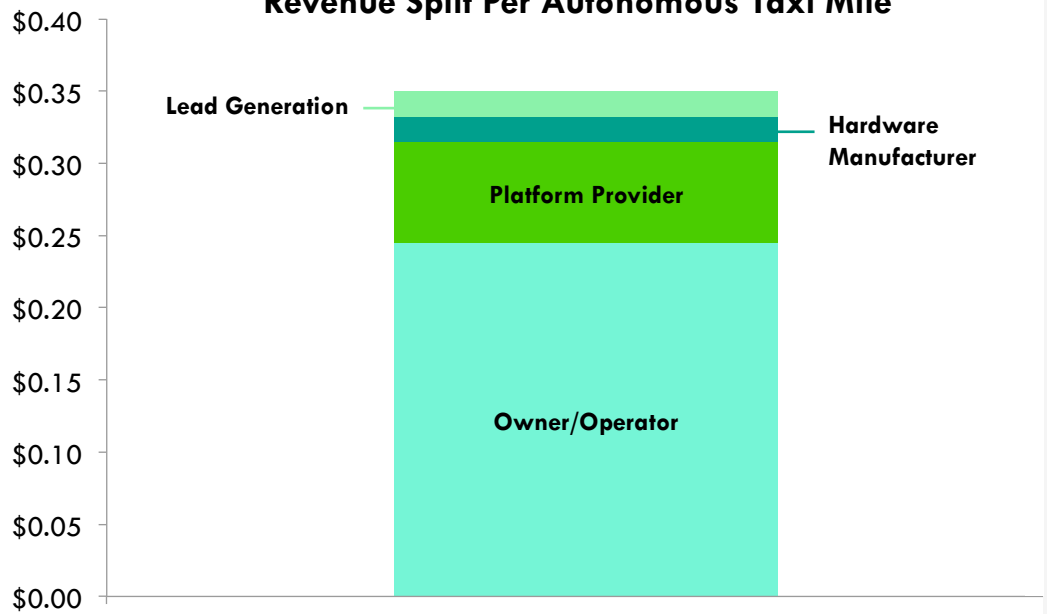
EBITDA for Automakers and Autonomous Platform Providers ($ Trillions)



Sources: ARK Investment Management LLC, 2017

The Revenue From Autonomous Taxi Services Will Be Shared

Autonomous MaaS revenue probably will be split among owners, platform providers, manufacturers, and lead generators.



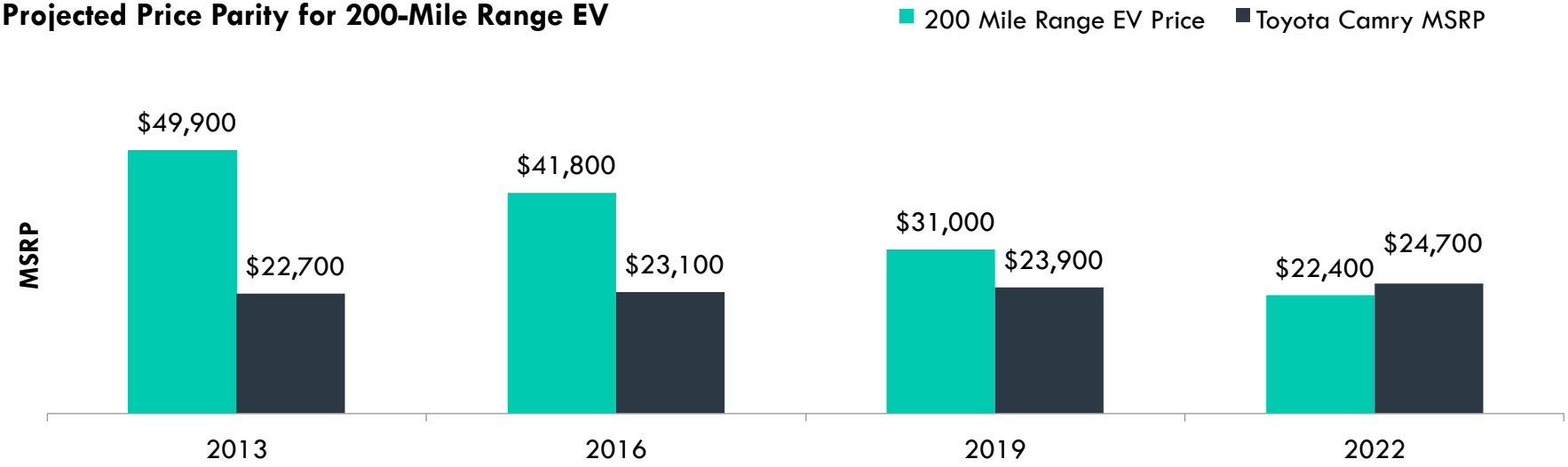
- **Lead Generation:** A share of revenue-per-mile could go towards lead generation and/or traffic acquisition.
- **Hardware Manufacturer:** Today vehicle manufacturers earn roughly 1 penny per mile traveled. In the autonomous MaaS market, hardware manufacturers should benefit either from upfront sales or a recurring revenue stream from autonomous taxis with much higher utilization rates.
- **Platform Provider:** Much like ridesharing firms take a cut of per mile revenues today, we expect MaaS platforms to take a similar, if not higher, share of revenues because they are offering more value than today's ridesharing firms. The share of revenue that MaaS platform firms will command will depend on how much of the technology stack and data pool they control.
- **Owner/Operator:** Owners of the vehicles could be individuals, auto companies, taxi firms, or commercial fleet operators. We expect them to garner most of the revenues and be responsible for most of the maintenance.

Sources: ARK Investment Management LLC, 2017

Electric Vehicles Likely Will Dominate Transportation

Because battery costs have declined faster than most analysts anticipated, ARK foresees a wholesale shift to electric vehicles (EVs). By 2022 EVs should be cheaper than comparable gas-powered cars.

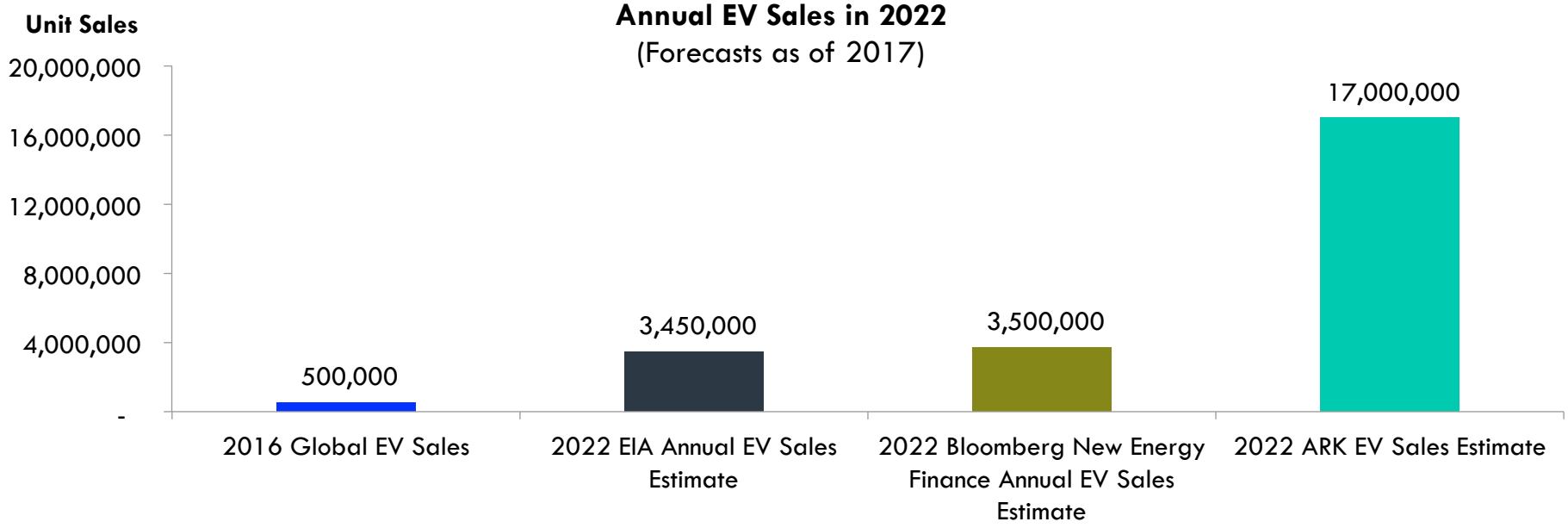
Projected Price Parity for 200-Mile Range EV



Sources: ARK Investment Management LLC, 2017 | ARK's expectation for EV MSRP (Manufacturer's Suggested Retail Price) parity is largely based on decreasing lithium-ion battery costs. Other factors could influence MSRP. The MSRP prices shown do not include any government subsidies.

Based On ARK's Research...

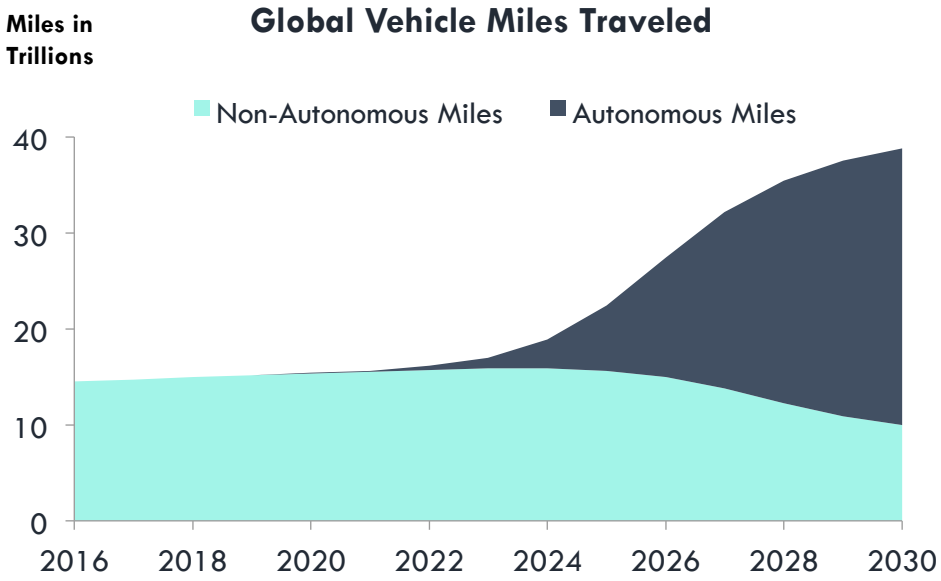
...the demand for EVs will be orders of magnitude higher than current forecasts.

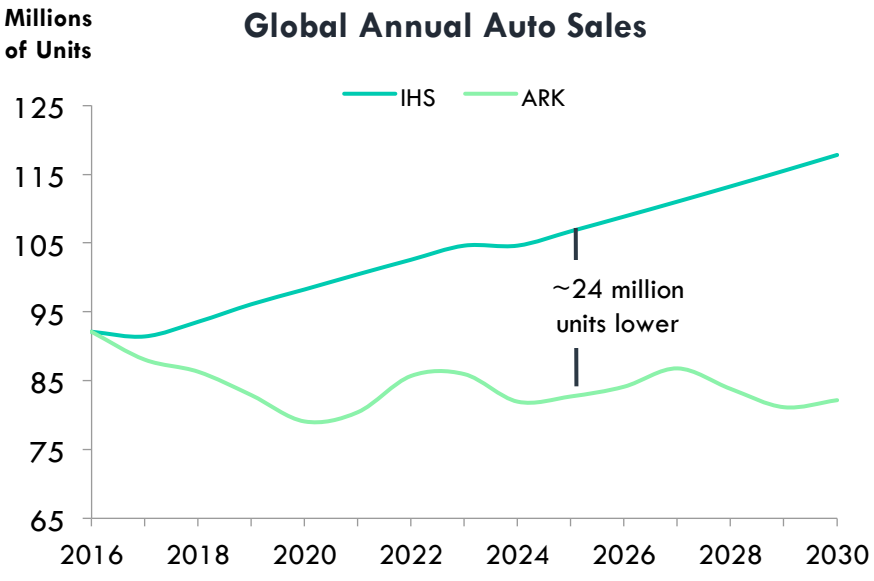


Sources: ARK Investment Management LLC, 2017; Bloomberg New Energy Finance, U.S. Energy Information Administration, EV-volumes.com

MaaS Results In More Miles Traveled And Fewer Cars Sold

While ARK expects global vehicle miles to increase two- to three-fold, auto sales should be flat to down, thanks to the higher utilization of taxi fleets.

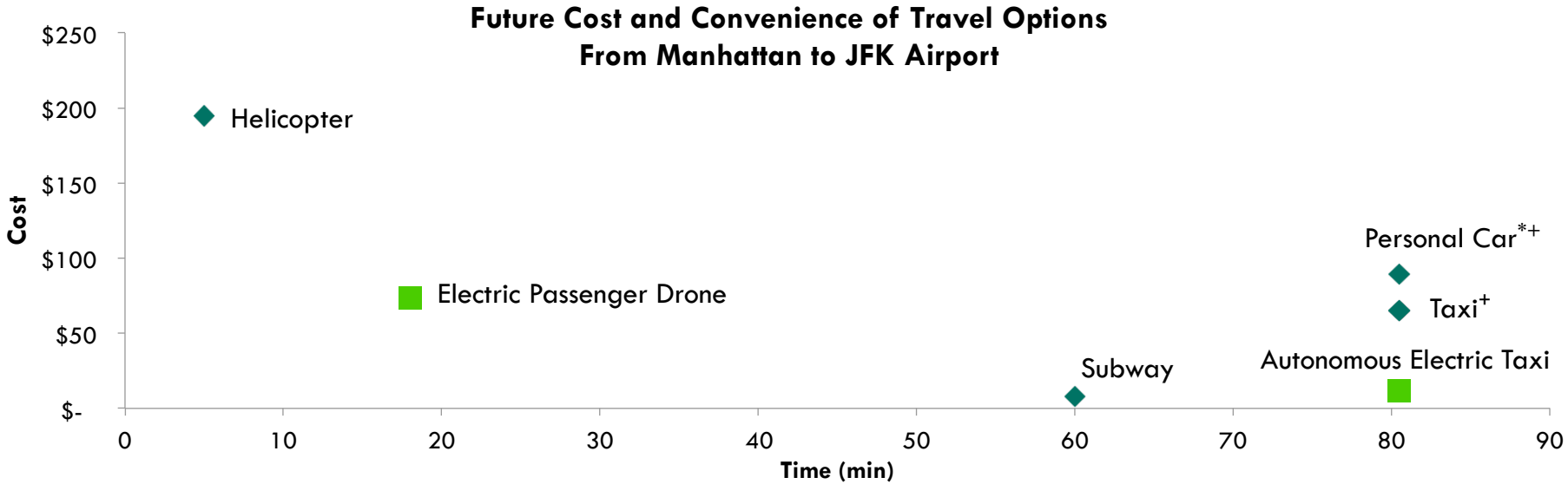




Sources: ARK Investment Management LLC, 2017; IHS Markit, The Federal Highway Administration (FHWA), and the Research and Innovative Technology Administration (RITA)

Transportation By Air

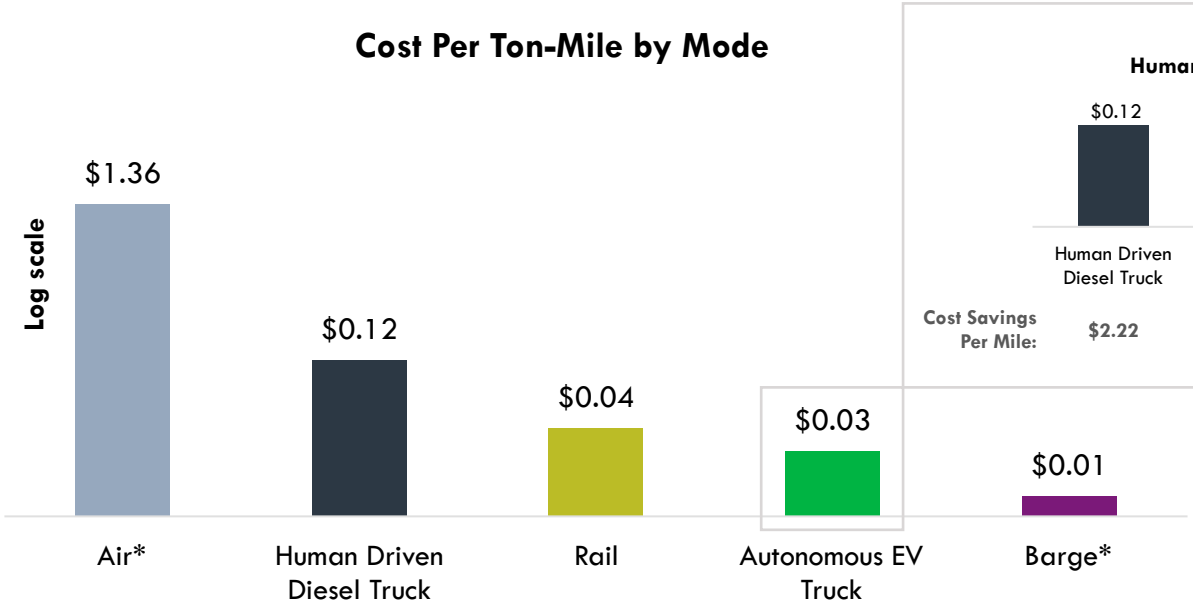
By the early 2020s, electric drones should be able to transport a passenger to the airport for the same price as a taxi, but in a fraction of the time. Alternatively, autonomous electric taxis likely will be able to transport passengers for the price of a subway ride today.

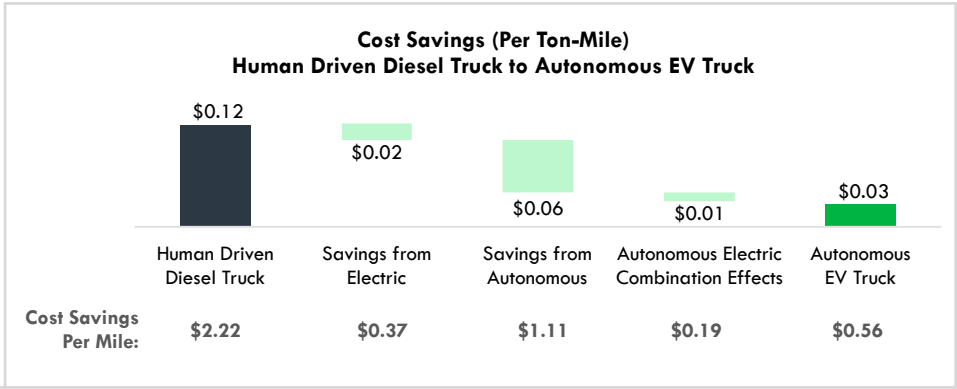


Sources: ARK Investment Management LLC, 2017 | *Includes parking for four days +15% increase in traffic due to autonomous
Data: https://blade.flyblade.com/p/bounce; https://www.panynj.gov/airports/jfk-airtrain.html

Logistics-as-a-Service

Autonomous electric trucks should offer a shipping option less expensive than rail, on a cost per ton-mile basis.

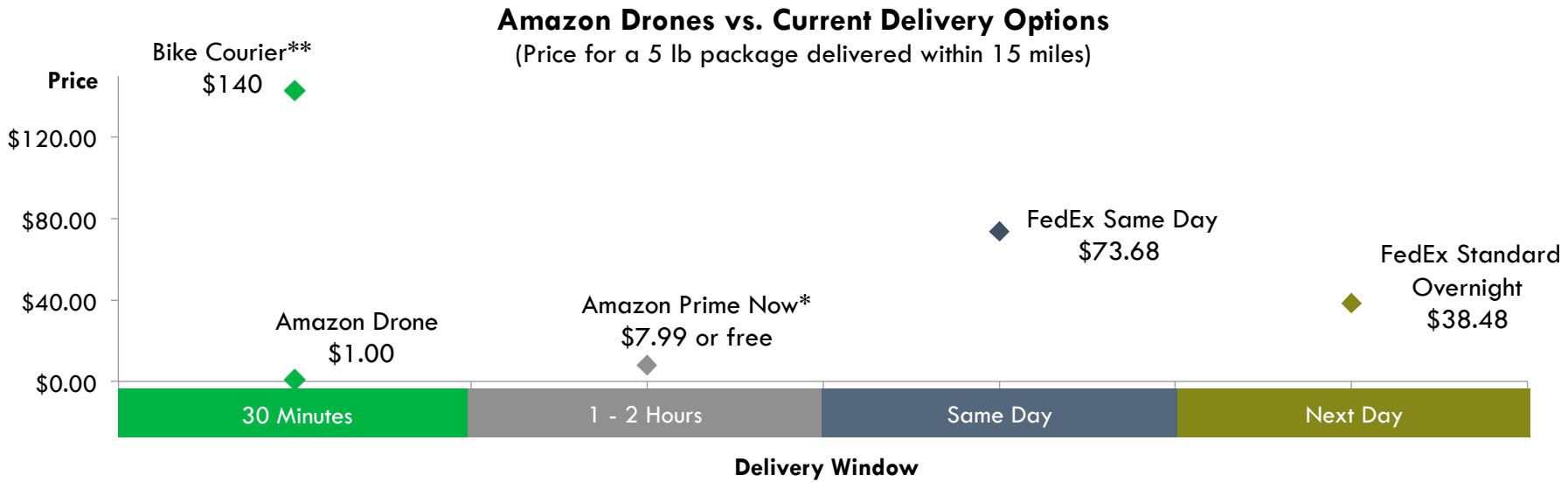




*Note: Cost per ton-mile for air and barge is using 2014 and 2011 data, respectively (latest available)
Sources: ARK Investment Management LLC, 2017; Research and Innovative Technology Administration (RITA), Association of American Railroads (AAR), and the National Transportation Library (NTL)

Delivery By Air

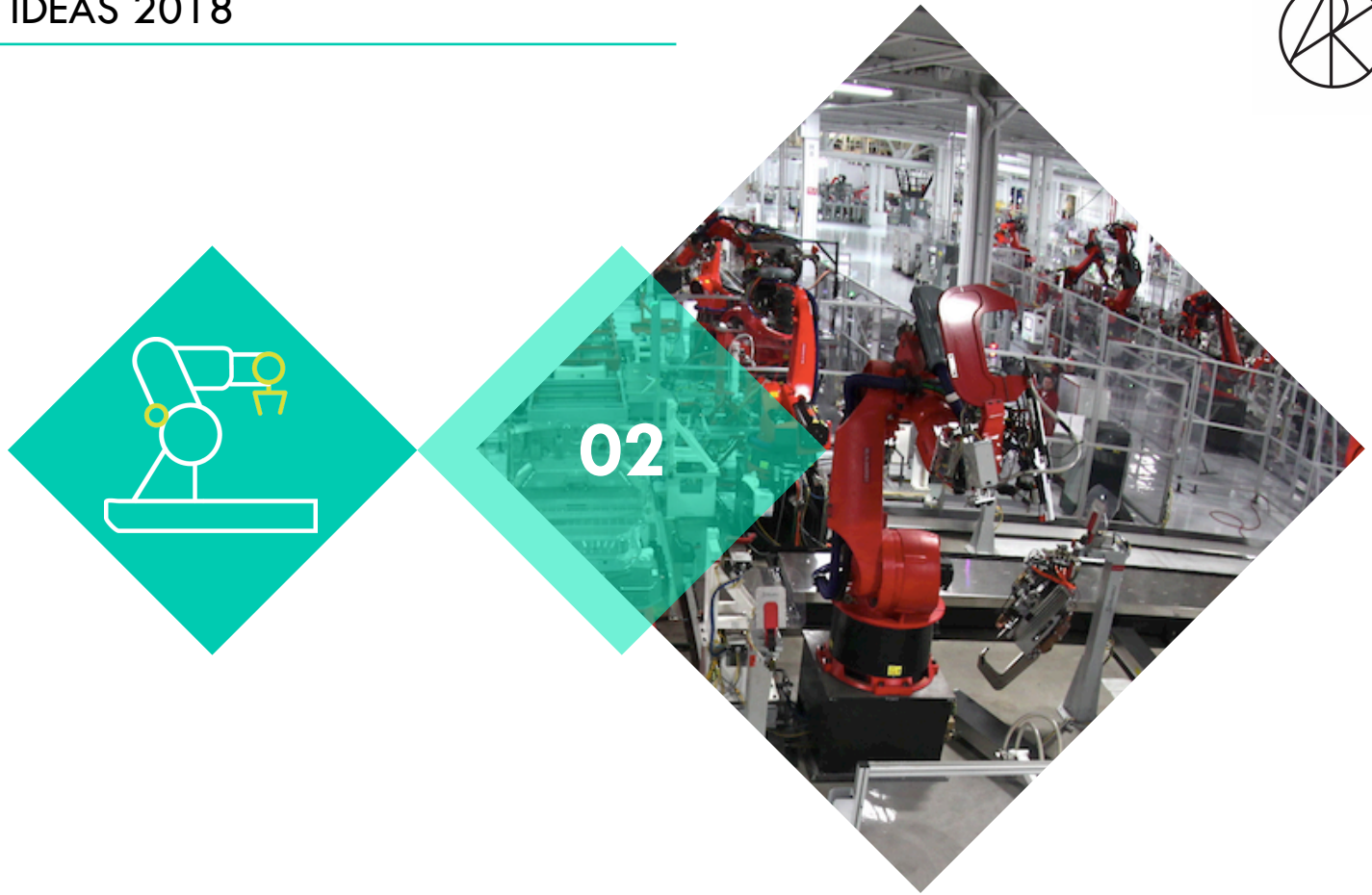
Amazon drones should be able to deliver a 5 lb package in 30 minutes for $1.



* Prices given are for members with a subscription. An Amazon Prime subscription is $99 per year. One hour delivery is $7.99 and two hour delivery is free.
** Most couriers do not travel more than 10 miles. This is an estimate for a 10 mile delivery.

Sources: ARK Investment Management LLC, 2017

ROBOTICS



Research by Sam Korus

A Review

2012

- **Amazon Acquires Kiva Robotics**

2014

- **Amazon Had 1,000 Robots in Its Warehouses at the End of 2013**

2015

- **Teradyne Acquires Universal Robots, a Collaborative Industrial Robot Company**

2016

- **Fanuc and Preferred Networks Train Robots in Parallel Using Deep Reinforcement Learning**

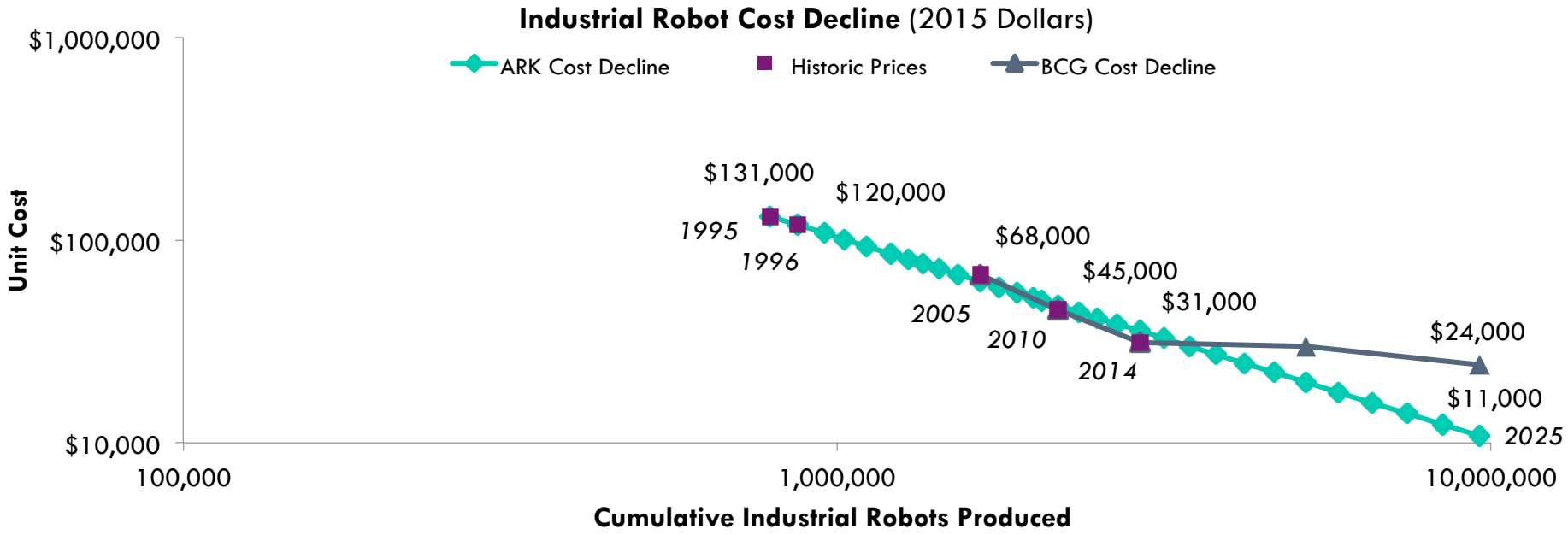
2017

- **Amazon Has Over 100,000 Robots in Its Warehouses**
- **SoftBank Acquires Boston Dynamics**

Source: ARK Investment Management LLC, 2017 | A selection of events, achievements and innovation milestones.

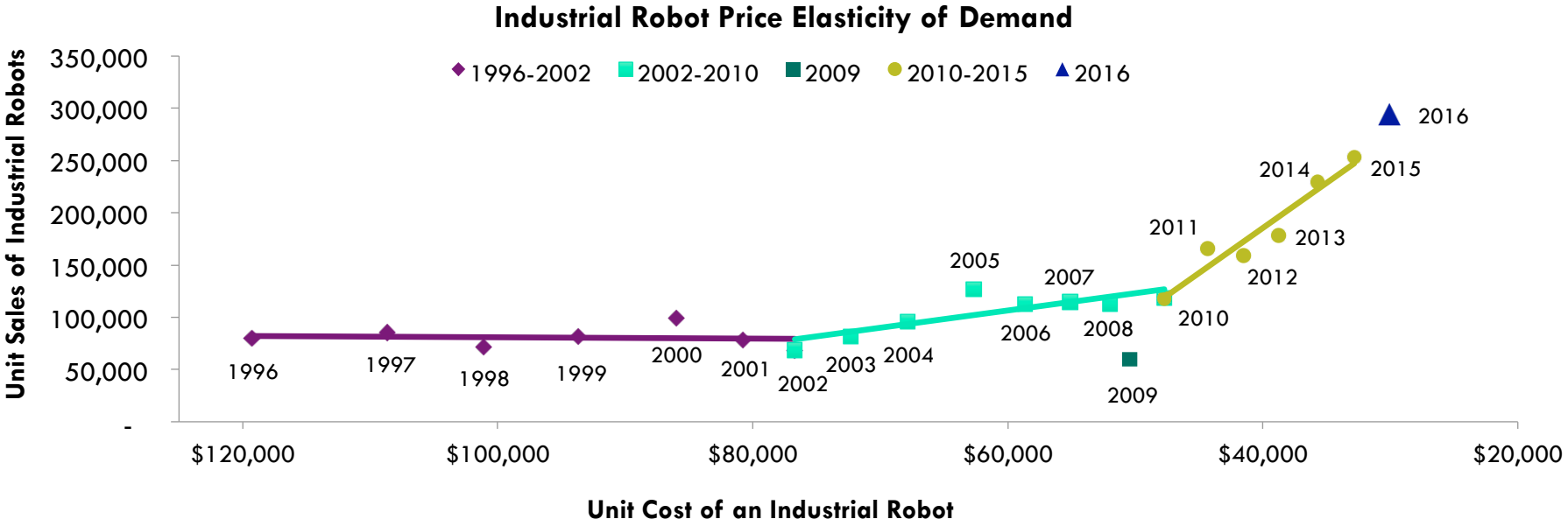
Robot Costs Are Dropping

Industrial robots are continuing to decline in cost, expanding the addressable market.



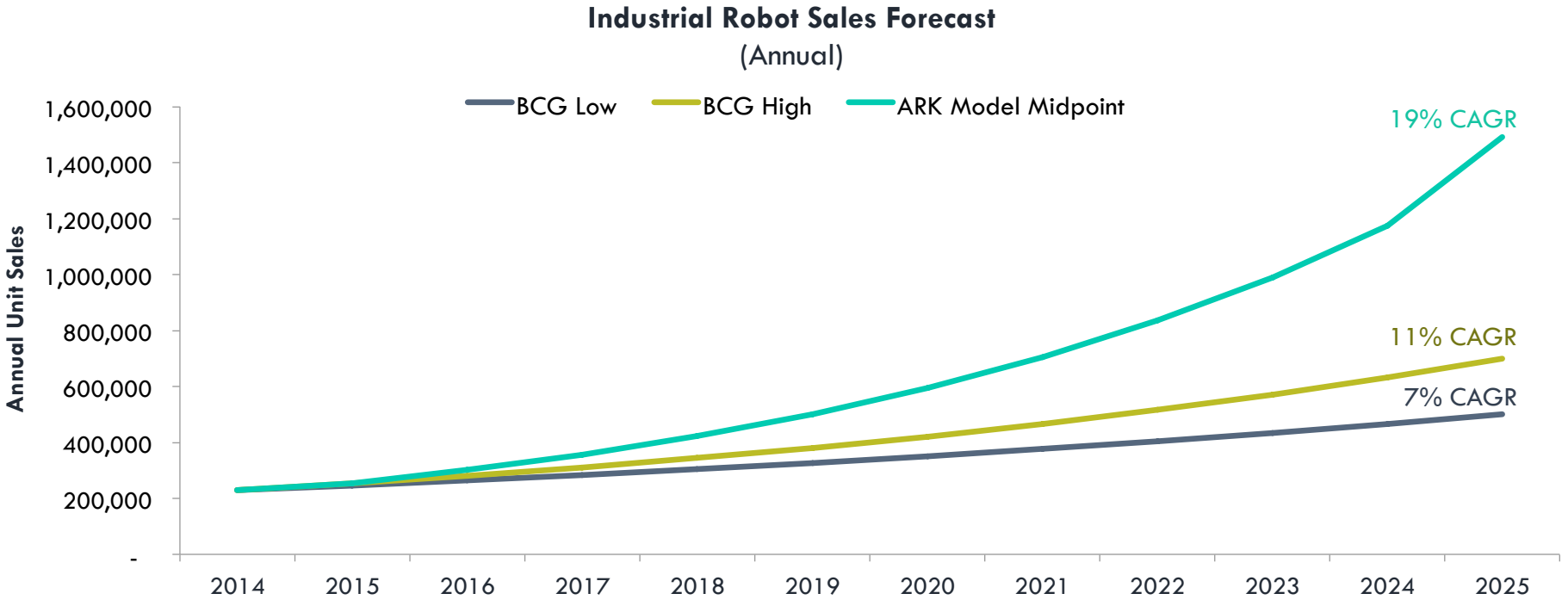
Sources: ARK Investment Management LLC, 2017
Data from: Sources: United Nations Economic Commission for Europe, International Federation of Robotics, Boston Consulting Group

Robot Demand Is Responding To Lower Costs



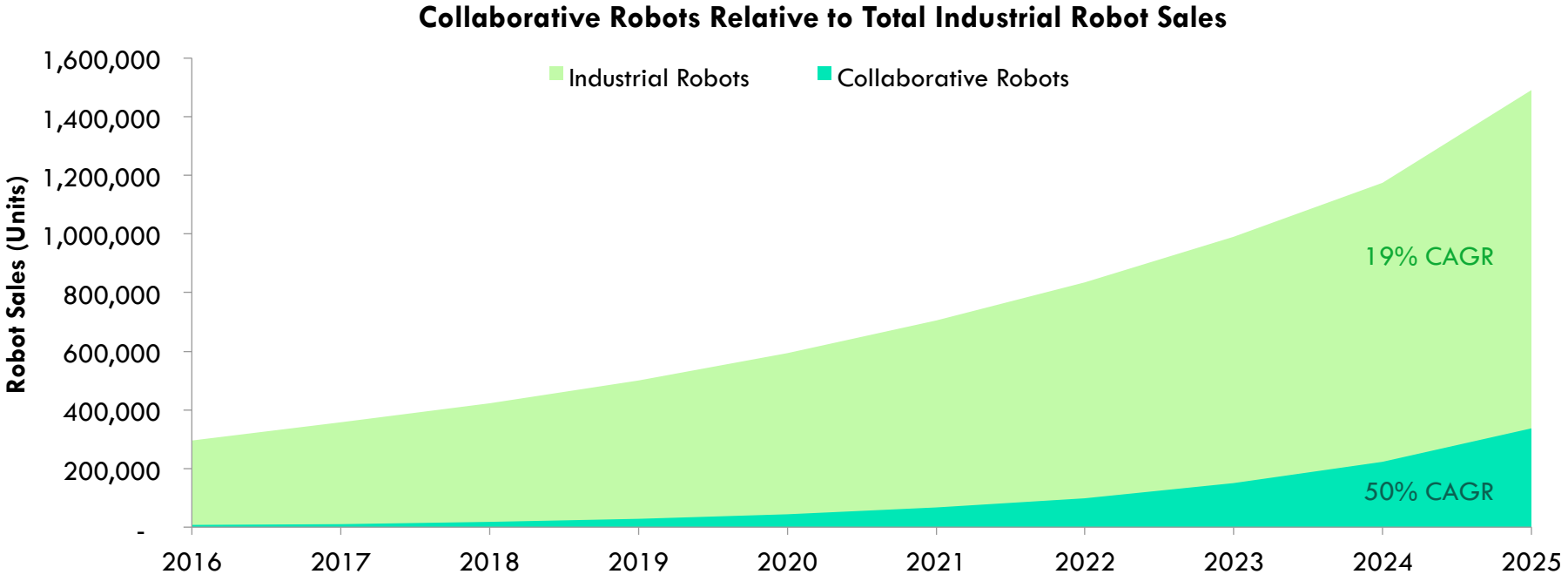
Sources: ARK Investment Management LLC, 2017
Data from: Sources: United Nations Economic Commission for Europe, International Federation of Robotics, Boston Consulting Group

Robot Growth Should Be Sustained By More Use Cases



Sources: ARK Investment Management LLC, 2017; Boston Consulting Group and International Federation of Robotics

Collaborative Robots Should Gain Market Share



Sources: ARK Investment Management LLC, 2017; Teradyne

DEEP LEARNING

Research by James Wang

A Review

1989

- LeCun Uses *Backpropagation* to Train Convolutional Neural Nets that Can Read Handwritten Digits with 99% Accuracy (Later Deployed in ATMs)

2012

- Deep Neural Net Wins 2012 *ImageNet* Challenge, Reducing the Error Rate by 36%

2015

- Microsoft's *ResNet* Deep Neural Net Achieves 96% Accuracy in the *ImageNet* Challenge, Reaching Human Level Performance for the First Time

2016

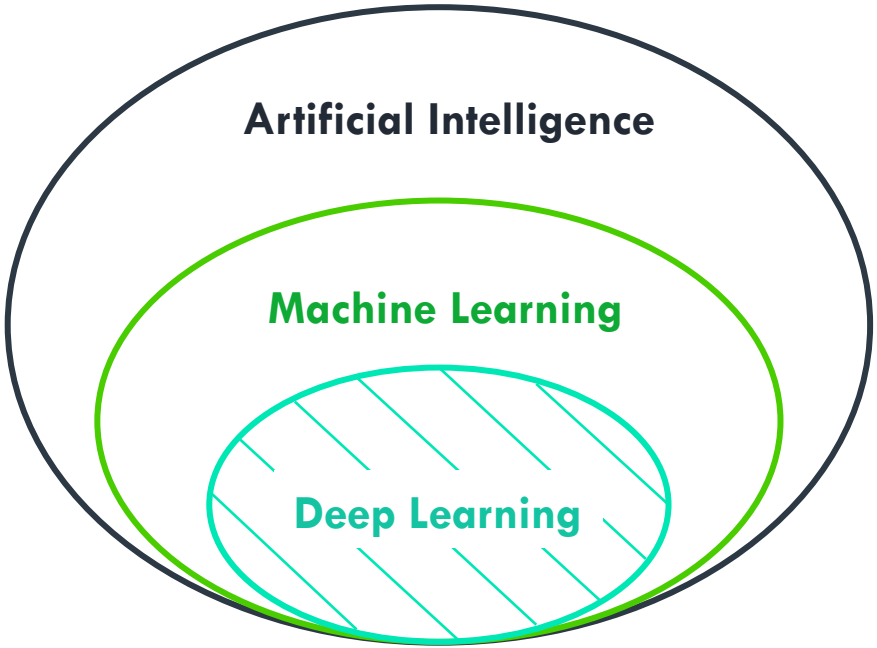
- DeepMind's AlphaGo Defeats Global Champion Lee Sedol in the Game of Go. The AI Program Combined Deep Learning with Monte Carlo Tree Search and Reached a Major AI Milestone Ten Years Ahead of Schedule

2017

- Companies Large and Small are Launching Deep Learning Products and Services. Among them are Apple, Alphabet, Amazon, Baidu, Deere, and Fanuc

Source: ARK Investment Management LLC, 2017 | A selection of events, achievements and innovation milestones.

Deep Learning Is A Subset of Artificial Intelligence (AI)

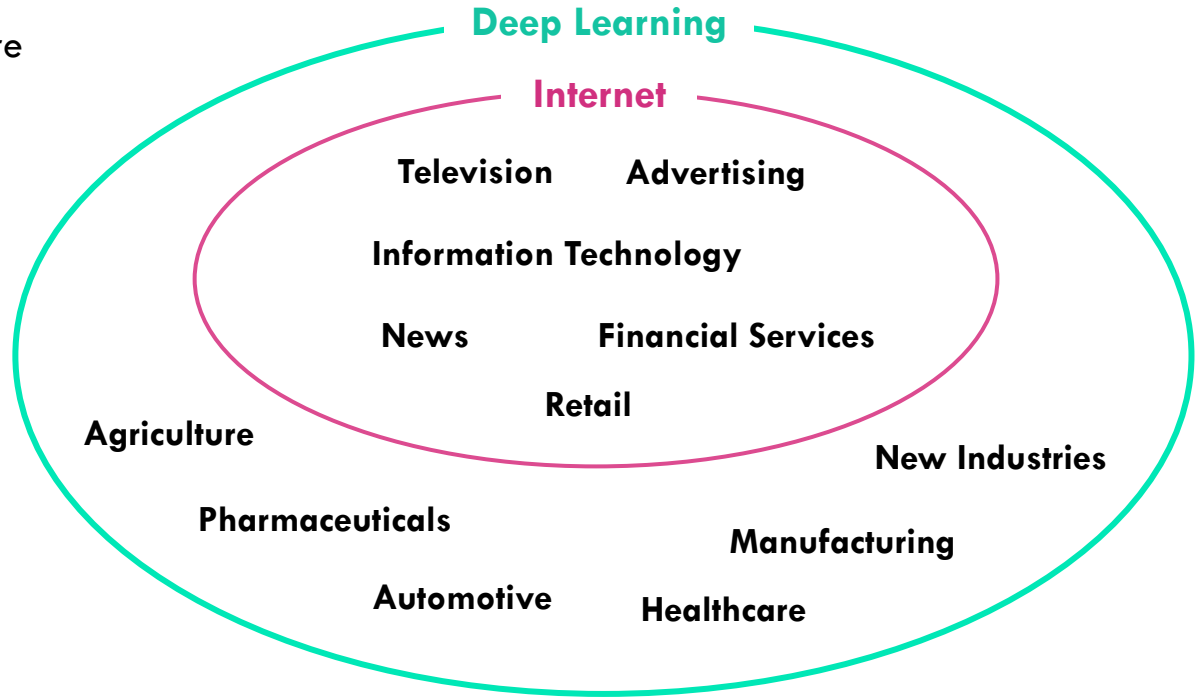


- Classic AI is based on deductive logic. Rules are based on human ingenuity.
- Machine Learning is based on statistical inference. Rules are inferred from data.
- Deep Learning is a type of Machine Learning modeled after the biological brain.

Source: ARK Investment Management LLC, 2017

Deep Learning Is A Continuation Of "Software Eating The World"

Relative to the Internet, Deep Learning could impact more sectors, causing more profound disruptive innovation across different industries.



Source: ARK Investment Management LLC, 2017

Many Deep Learning Products And Services Were Launched In 2017

SMARTPHONES

iPhone X uses AI powered facial recognition.

AGRICULTURE

Deere acquired Blue River for precision agriculture.

ROBOTICS

Miso Robotics launched AI powered burger flipping robot.

AI CLOUD

Amazon
Google
Microsoft
Alibaba
Tencent
Baidu
JD.com
iFlyTek

Every cloud provider launched AI as a service.

SOFTWARE

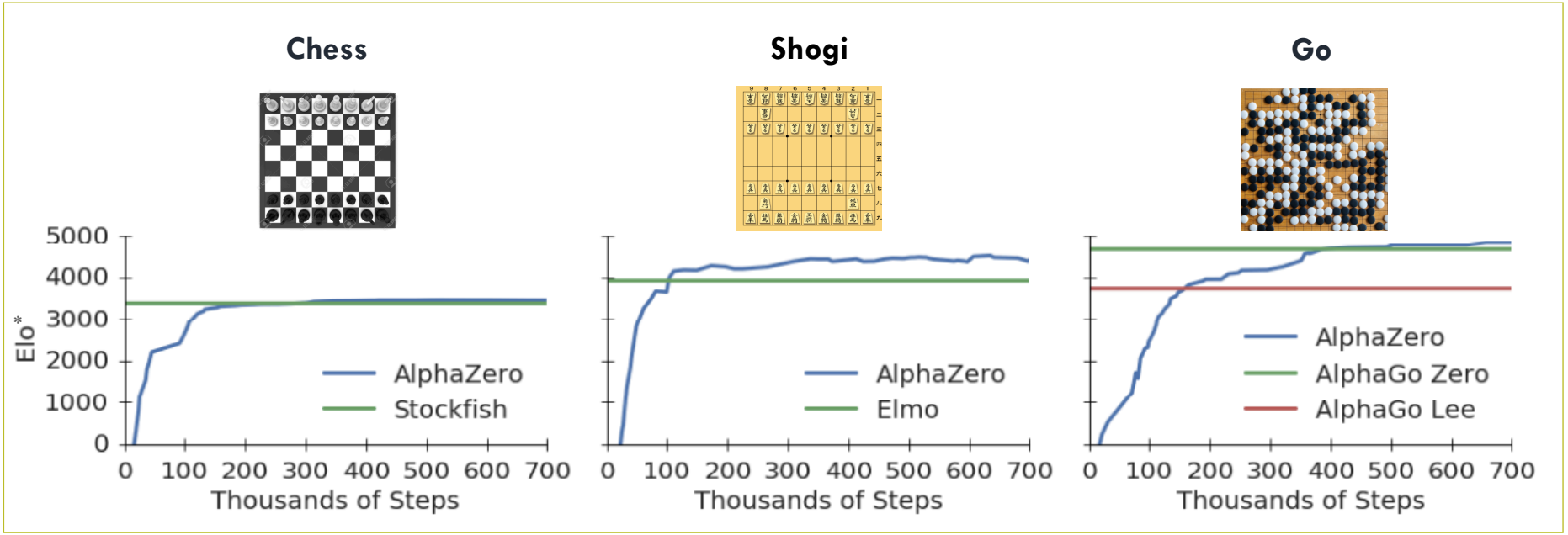
Salesforce
Box
Nuance
Adobe

Software providers use AI for classification and tagging.

Source: ARK Investment Management LLC, 2017

Deep Learning Is Now Smarter And More Adaptive

DeepMind's AlphaZero uses reinforcement learning, with no human training, to achieve world class performance across three games.



Source: DeepMind, https://arxiv.org/abs/1712.01815 | *Elo: A measure of relative skill between players

Deep Learning Achieves Photorealistic Image Generation

Deep learning can recognize and generate images. Early results were blurry and unconvincing, as seen on the left. The latest results approach photorealism, as seen on the right.

Fake Images Generated Using Deep Learning

2016

2017

Source: Alec Radford, NVIDIA

Deep Learning Has Created A New Semiconductor Boom

Deep learning is the fastest growing workload in data centers.

NVIDIA currently has a near monopoly on this market, but a host of companies is vying for this opportunity, which we estimate will generate $9 billion in revenue.

Companies Developing Deep Learning Chips

Company	Ownership	HQ	Story
Nvidia	Public	United States	Current market leader using GPU based deep learning
Google	Public	United States	Custom designed TPU deployed in Google Cloud
Intel	Public	United States	Nervana based chip to be released mid 2018
AMD	Public	United States	GPU based deep learning
Qualcomm	Public	United States	Developing DL silicon for mobile
Cerebras	Private	United States	Ex-AMD team backed by Benchmark Capital
Groq	Private	United States	Ex-Google TPU team backed by Social Capital
KnuEdge	Private	United States	Headed by former NASA CTO
Mythic	Private	United States	In-memory inference for IoT backed by DFJ
Thinci	Private	United States	Computer vision / auto focus
Wave Computing	Private	United States	DL server with custom chip. In customer trials
GraphCore	Private	United Kingdom	UK startup backed by top AI researchers
Bitmain	Private	China	Top maker of Bitcoin mining chips
Cambricon	Private	China	China's state-backed startup with a $1B valuation
DeePhi	Private	China	China based startup with a focus on video analysis
Horizon Robotics	Private	China	Ex-Baidu team. Embedded / computer vision focus
Tenstorrent	Private	Canada	Toronto based chip startup

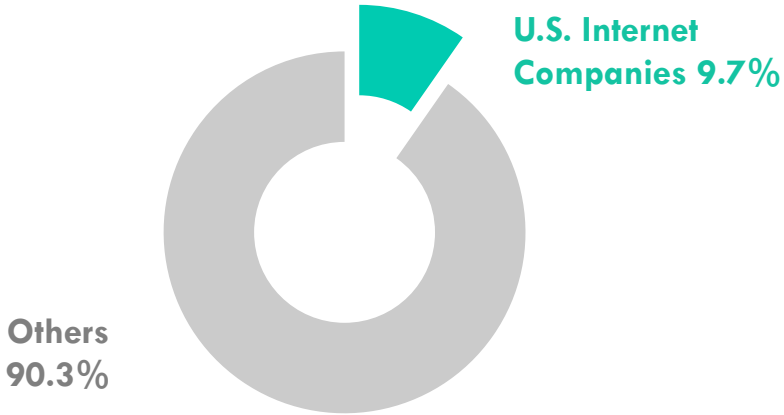
Source: Alec Radford, NVIDIA

Deep Learning Should Be An Internet Scale Opportunity

- In 1996, Internet companies made up 0% of the S&P 500
- In 2017, Internet companies made up 9.7% of the S&P 500

This foundational technology took about 10% share in roughly two decades.

Pure Internet Companies As A Percent of S&P 500



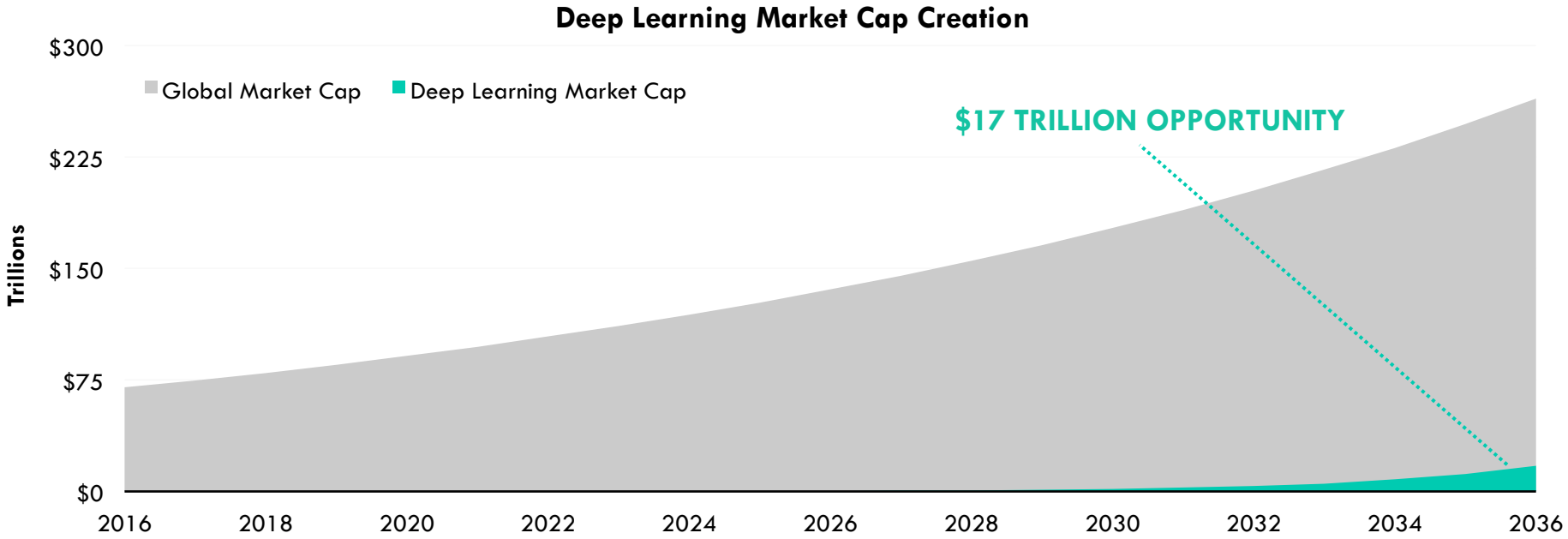
S&P 500 Market Cap Created by The Internet

Company	Market Cap ($B)
Alphabet	$727
Amazon	$563
Facebook	$513
Cisco	$189
PayPal	$88
Priceline	$85
Netflix	$83
Salesforce	$74
Ebay	$39
Expedia	$18
E*Trade	$13
Akamai	$11
Juniper Networks	$11
Verisign	$11
F5 Networks	$8
TripAdvisor	$5
Total	**$2,425**
S&P 500 Market Cap	**$25,107**
Share of Purebred Internet Companies	**9.7%**

Source: ARK investment Management LLC, as of December 2017

Based on ARK's research…

… deep learning could approach a global market cap of $17 trillion in 20 years.

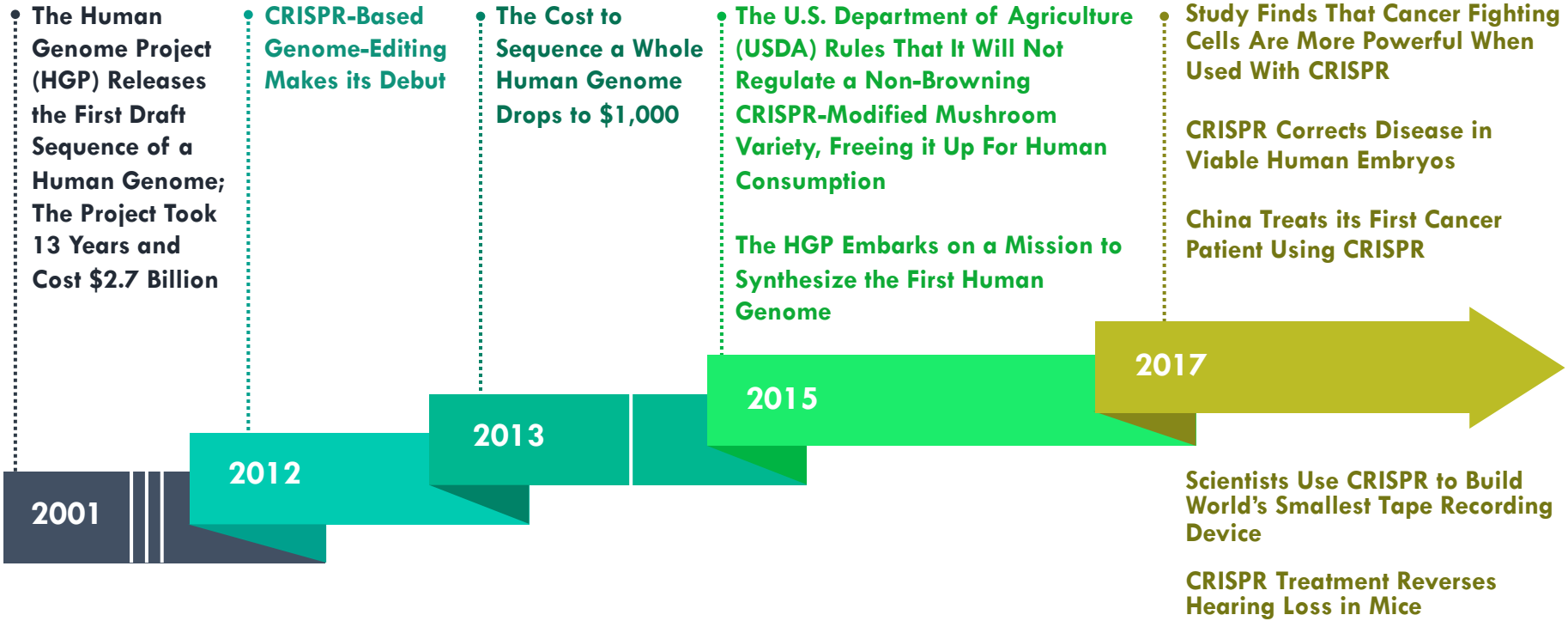


Source: ARK Investment Management LLC, 2017 | Deep learning penetration adjusted for global market cap, assuming 6.9% historical growth rate of global equities, 6.6% deep learning share in 20 years.

CRISPR GENOME-EDITING

Research by Manisha Samy

A Review

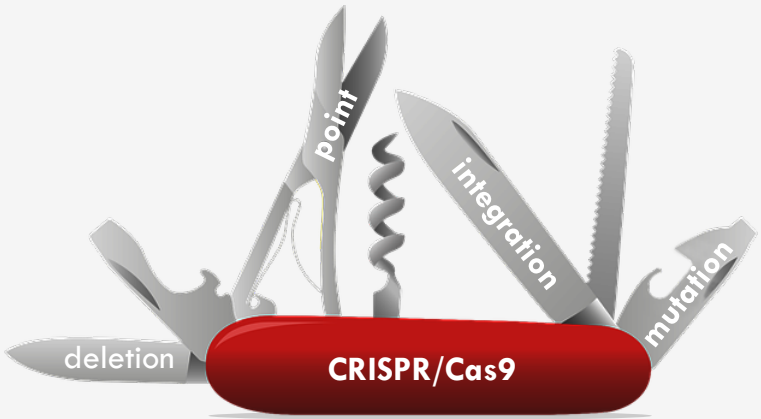


Source: ARK Investment Management LLC, 2017 | A selection of events, achievements and innovation milestones.

Cheap And Rapid "Write" Capabilities Enable Genome Modification

ARK believes that CRISPR is a genome-editing platform that will address the world's most salient health issues. It is like a "Molecular Swiss Army Knife" with a rapidly expanding number of tools that perform different functions:

Clustered Regularly Interspaced Short Palindromic Repeats (CRISPR)

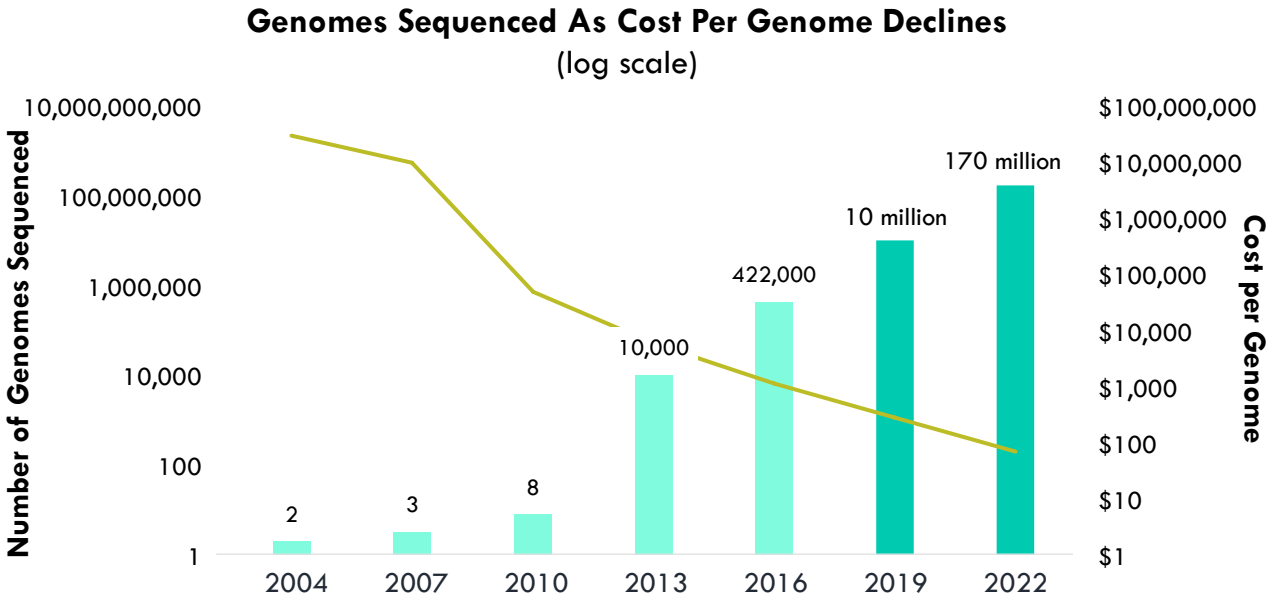


- **Cut** DNA/RNA at a single point or in stretches
- **Insert** DNA/RNA and create novel gene sequences
- **Activate and Silence** genes without making permanent changes
- **Regulate** protein expression levels epigenetically
- **Record and Timestamp** biological events
- **Track** the movement of specific biological molecules
- **Identify** the presence of specific cancer mutations and bacteria
- **Locate** molecules without making changes
- **Target and Destroy** specific viral and bacterial DNA and RNA
- **Interrogate** gene function multiplexed
- **Activate** drug release at a specified trigger

Source: ARK Investment Management LLC, 2017; Image Source: Arup

The Number Of Human Genomes Sequenced Should Soar

By 2022, the cost of sequencing or "reading" the DNA of a full human genome should drop below $100, creating an explosion in the number of whole human genomes sequenced.



KEY EXPECTATIONS

- 2018-2021: NovaSeq instruments and chemistries should drive sequencing costs down by ~40% per year
- 2021: Cost/Genome ~$100
- 2022: ~170 million human genomes should be sequenced

Source: ARK Investment Management LLC, 2017

The Cost Of Editing DNA Mutations Is Dropping Precipitously

The cost of CRISPR, or "editing" DNA, is dropping, as is its time-to-manufacture, accelerating the pace of innovation.

	ZFNs*	TALENs**	CRISPR
Year of First Human Cell Modification	**2003**	**2009**	**2012**
Time to Manufacture (days)	22	10	**5**
Cost (per pair of nuclease)	~$5,500	~$360 per pair	**~$30 per pair**

Newer Genome-Editing Techniques

THE CRISPR ADVANTAGE

- Increases research thanks to lower costs and ease of use
- Reduces manufacturing time thanks to operational efficiencies
- Re-invigorates opportunities in regenerative medicine, such as stem cell research

*ZFNs: Zinc Finger Nucleases **TALENs: Transcription activator-like effector nuclease

Source: ARK Investment Management LLC, 2017

Use Case: Agriculture

CRISPR should increase the yields of livestock, crops, and aquaculture in different ways:

- Breed TB- and other disease-resistant cattle
- Shift breeding practices from random to more scientific techniques
- Raise pigs with lower fat content
- Increase the milk yield of cows

- Yield more productive, pesticide-free, and weather/bug resistant crops
- Enhance taste and nutritional value
- Surface new seed variants for hard-to-modify crops like wheat and rice

- Cut gestation periods in half
- Increase the conversion of feed into weight
- Sterilize farmed fish to protect wildlife
- Breed disease-resistant fish to avoid food poisoning

CRISPR

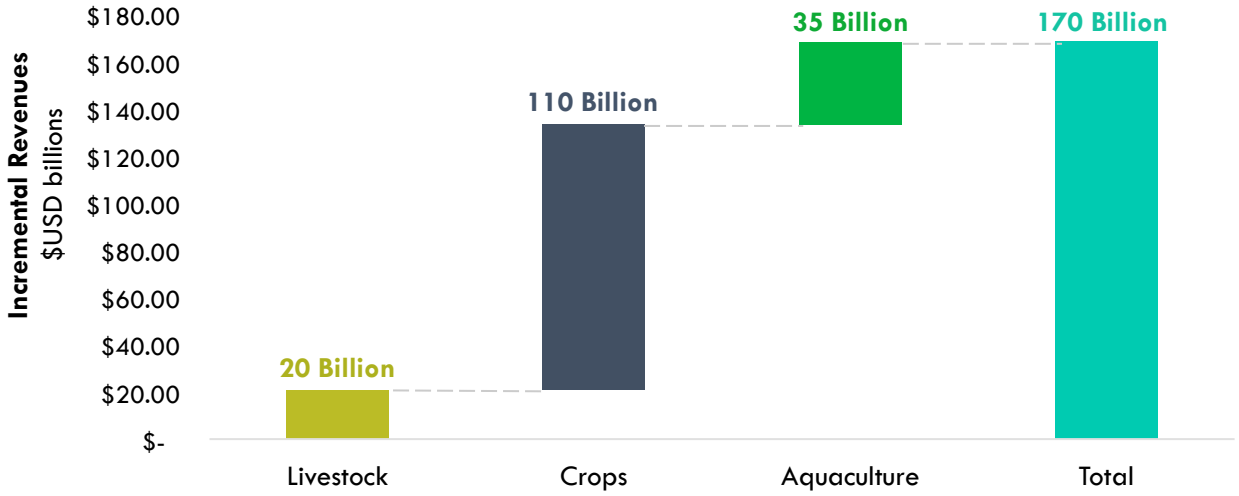
- Minimizes environmental footprint
- Avoids traditional GMO's in which foreign DNA infiltrates genes
- Aids small, family-owned farms with breeding techniques that lower the risk of disease
- Meets global demand for a diversified diet
- Reduces energy consumption associated with inefficient farmed fishing methods

Source: ARK Investment Management LLC, 2017

Use Case: Agriculture

By 2025, CRISPR could expand the agricultural market by an estimated $170 billion, sustaining projected growth in the global population.

Global Agriculture Market Expansion with CRISPR Technology
(2016 to 2025)



CRISPR should have the first commercial impact in Agriculture:

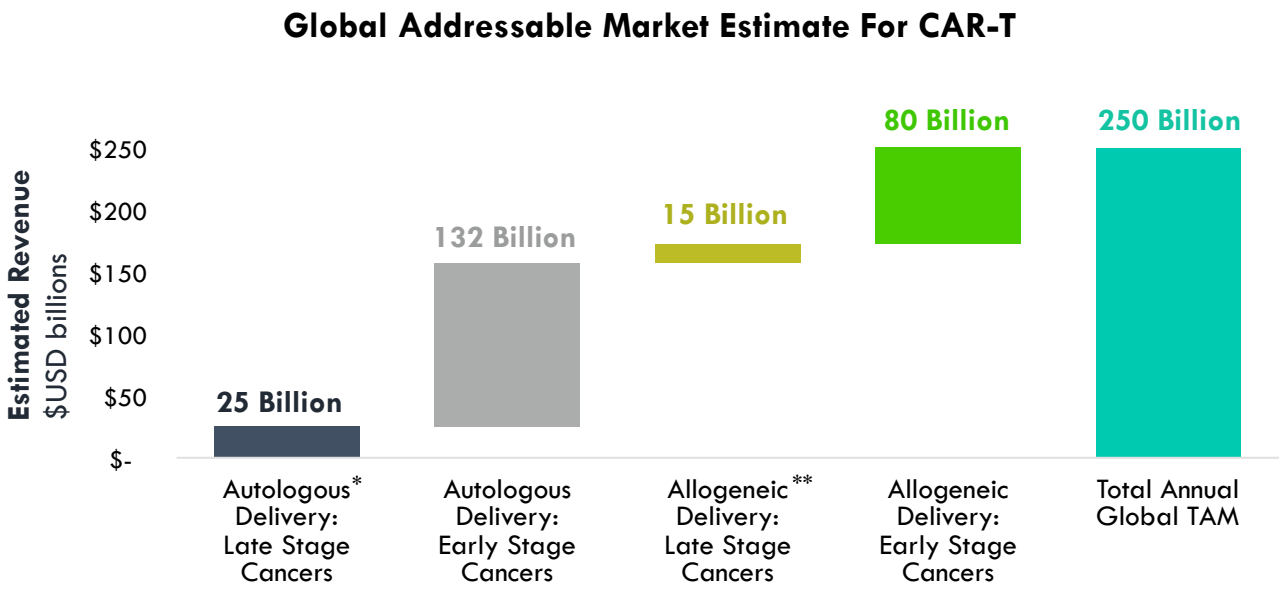
- 2020: CRISPR could enable the first commercial waxy corn variety
- 2025: CRISPR may increase food yield by an estimated 585 trillion calories
- 2025: CRISPR may increase agricultural productivity enough to feed an additional 800 million people

Source: ARK Investment Management LLC, 2017

Use Case: CAR-T

Globally, CAR-T cancer therapy could generate $250 billion per year in revenues, with royalties payable to CRISPR companies.

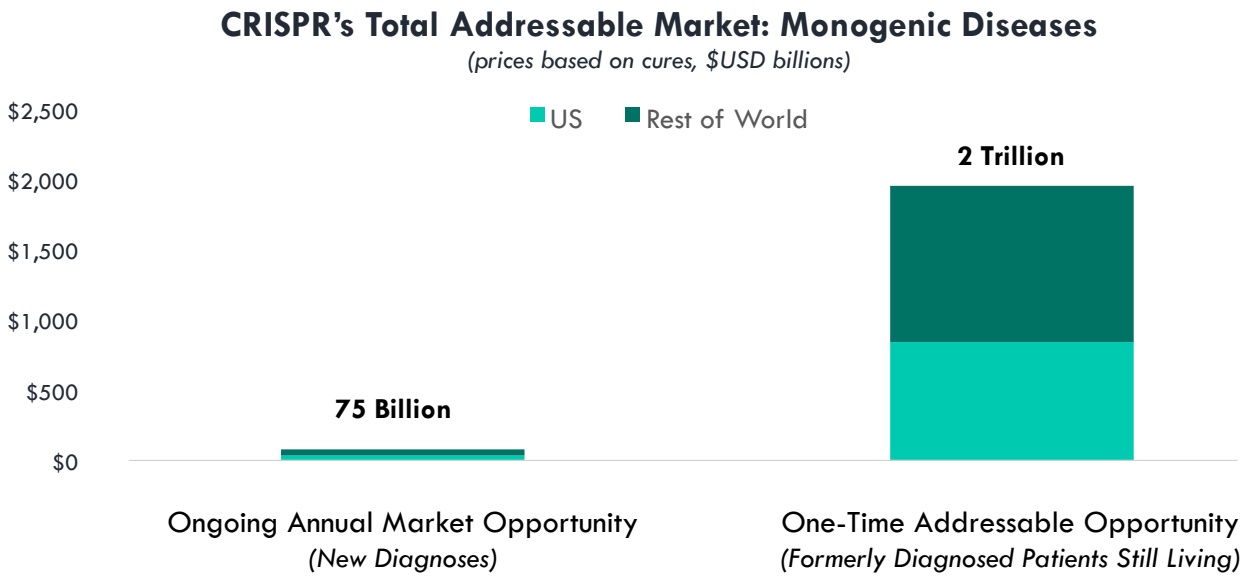
- Chimeric Antigen Receptor T-cell (CAR-T) therapy is a novel immunotherapy that modifies a patient's own T-cells to target and kill malignant cells while keeping healthy cells intact.
- CAR-T therapy is in its infancy: CRISPR could enhance the safety and efficacy of next generation CAR-T therapies.



*Autologous: involves one individual as both donor and recipient. **Allogeneic: involves different individuals of the same species
Source: ARK Investment Management LLC, 2017

Use Case: Monogenic Disease

CRISPR should dominate the $75 billion annual addressable monogenic disease market.
Only 5% of diseases caused by a single gene have any available treatment today.

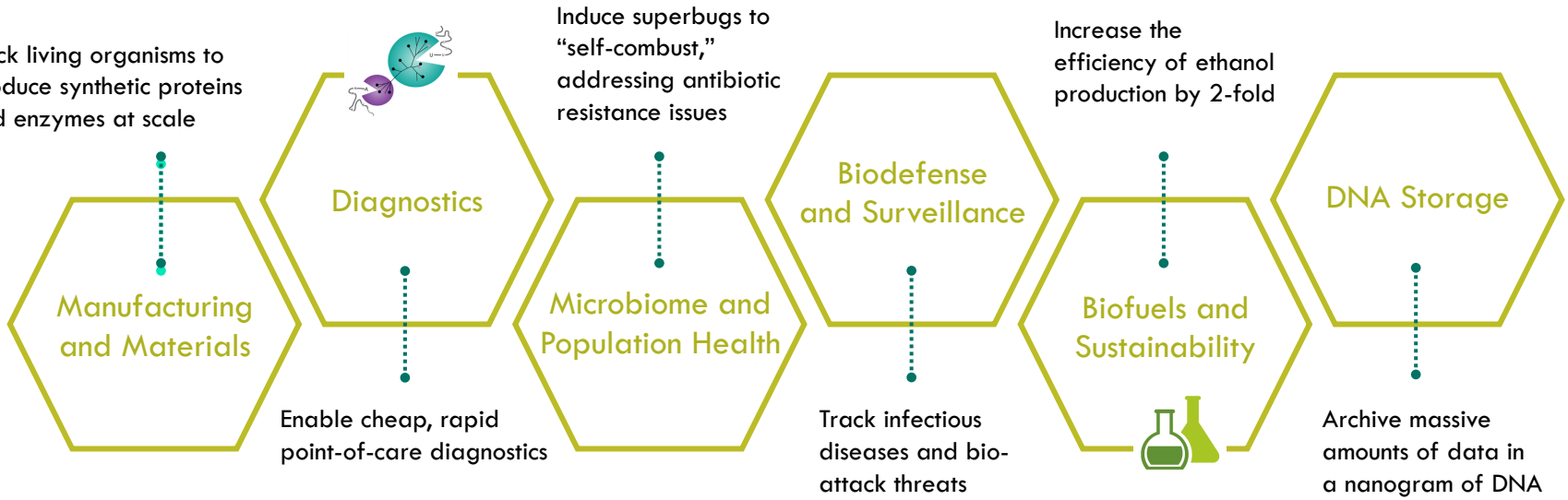


- CRISPR can address 10,000 monogenic diseases, of which only 5% have any treatments today
- 1 in 100 live human births results in a monogenic disease
- CRISPR will enter human trials in 2018

Source: ARK Investment Management LLC, 2017; Genetic Explanation: Sense and Nonsense. Gruber, Jeremy & Krimsky, Sheldon. 2013

Based On ARK's Research...

CRISPR's toolbox should disrupt more than therapeutics and agriculture.

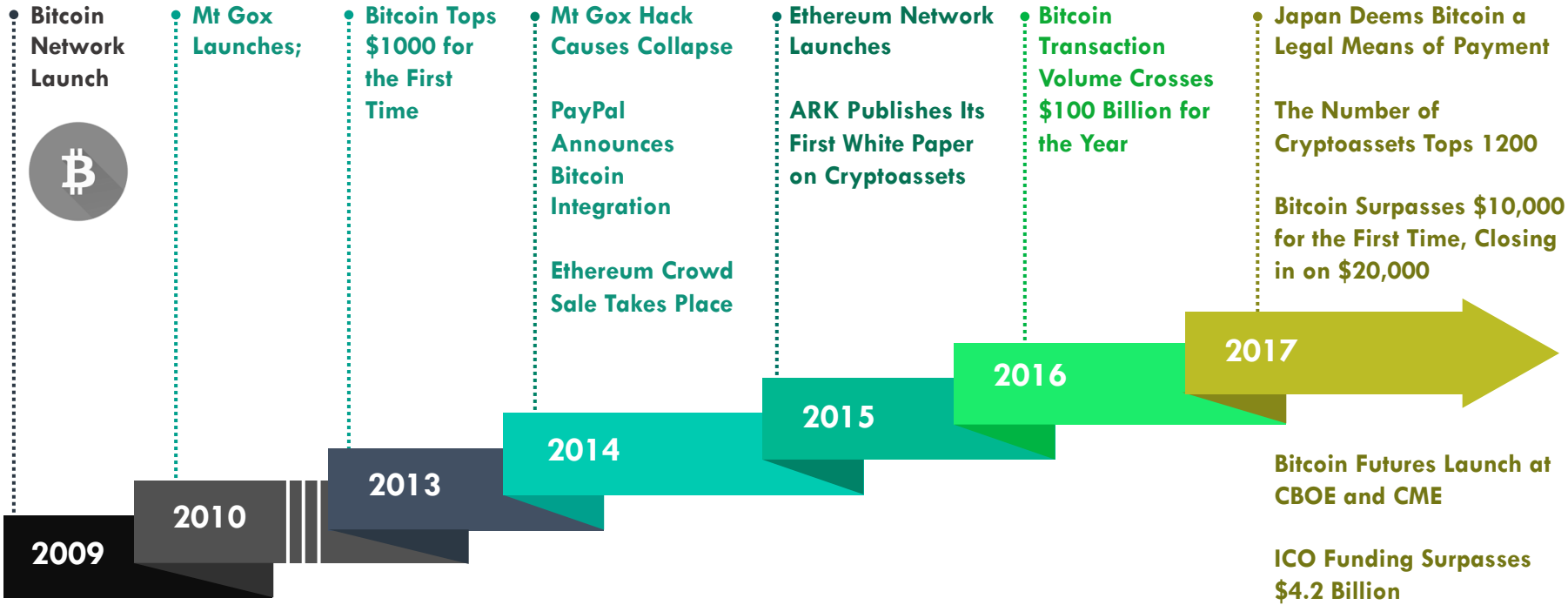


Source: ARK Investment Management LLC, 2017

CRYPTOASSETS

Research by Bhavana Yarasuri and Julia Hemmendinger

A Review



Source: ARK Investment Management LLC, 2017 | A selection of events, achievements and innovation milestones.

Bitcoin Can Play The Roles Of Currency And Store of Value

bitcoin = Money over IP + Digital Gold

Source: ARK Investment Management LLC, 2017

Bitcoin As Money Over IP

In the 1980s, communicating across the world was expensive.

Voice over IP (VoIP)

Instant communication everywhere without relying on expensive telecom providers

The Internet enabled "free voice"

Today, transferring funds across the world is expensive.

Money over IP (MoIP)

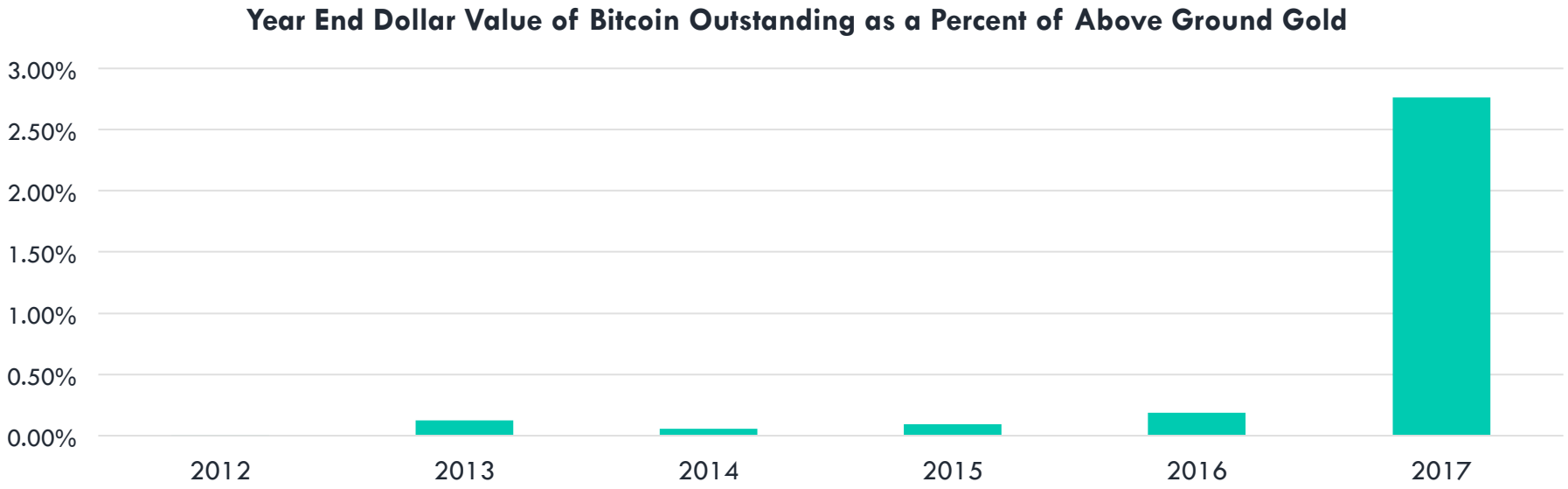
Instant value transfer of any amount to any person anywhere at almost no cost

ARK believes blockchain technology will enable fee-less transfers

Source: ARK Investment Management LLC

Bitcoin As Digital Gold

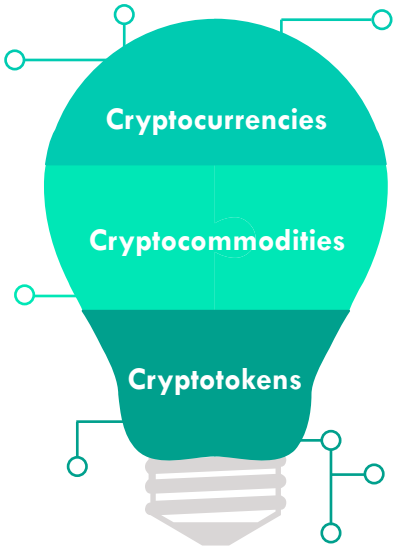
Increasingly, bitcoin is serving as a “store of value”, especially in countries plagued with hyperinflation, like Zimbabwe and Venezuela.



Source: ARK investment Management LLC, as of Dec 2017 | Data: blockchain.info and World Gold Council

Blockchain Technology Has Created A New Asset Class

ARK believes that bitcoin and other cryptoassets are not just "currencies", but part of a new asset class.* Asset classes differ in three ways: politico-economic features, correlation of price movements, and risk-reward profiles.



Verticals within cryptoassets include:

Cryptocurrencies	**Uses**: means of exchange, store of value, unit of account Examples: bitcoin, litecoin, monero, zcash
Cryptocommodities	**Uses**: cloud storage, compute cycles, bandwidth Examples: ether, golem, filecoin
Cryptotokens	**Uses**: consumer facing distributed applications Examples: augur, gnosis, aragon, steemit

*For more information read ARK's whitepaper "Bitcoin: Ringing The Bell For A New Asset Class", http://research.ark-invest.com/bitcoin-asset-class

Cryptoassets Are An Emerging Asset Class

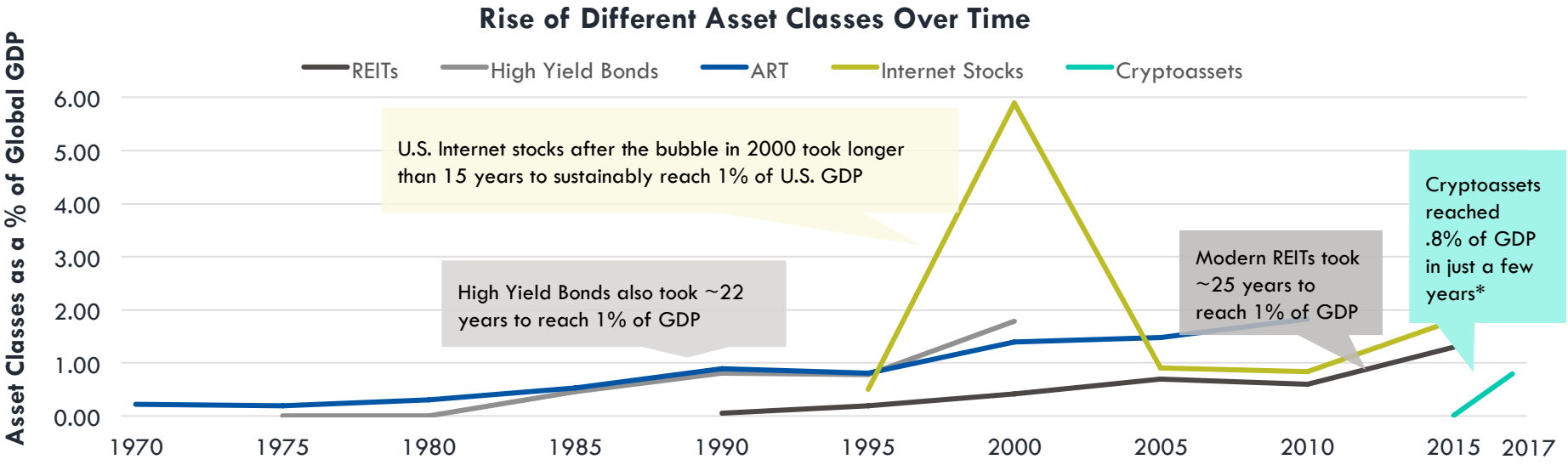
Cryptoassets are still small compared to other asset classes.

Asset Classes	Global Market Capitalization USD Trillions (as of Dec 31, 2017)	Total Cryptoasset Network Value as a % of each asset class
Total Cryptoassets	**$0.6**	**100%**
Gold Outstanding	$8.6	7%
Money Supply (Narrow)	$37	1.7%
Equities Outstanding	$80	0.8%
Money Supply (Broad)	$90	0.7%
Bonds Outstanding	$94	0.7%
Real Estate	$217	0.3%

Sources: ARK Investment Management LLC, 2017 | Data: Coinmarketcap.com, World Gold Council, SIFMA Fact Book & CIA Fact Book

Cryptoassets Have Appreciated Rapidly

After being recognized as a new asset class it typically takes decades before values rise sustainably above 1% of global GDP. Cryptoassets hit 0.8% of global GDP in less than a decade.

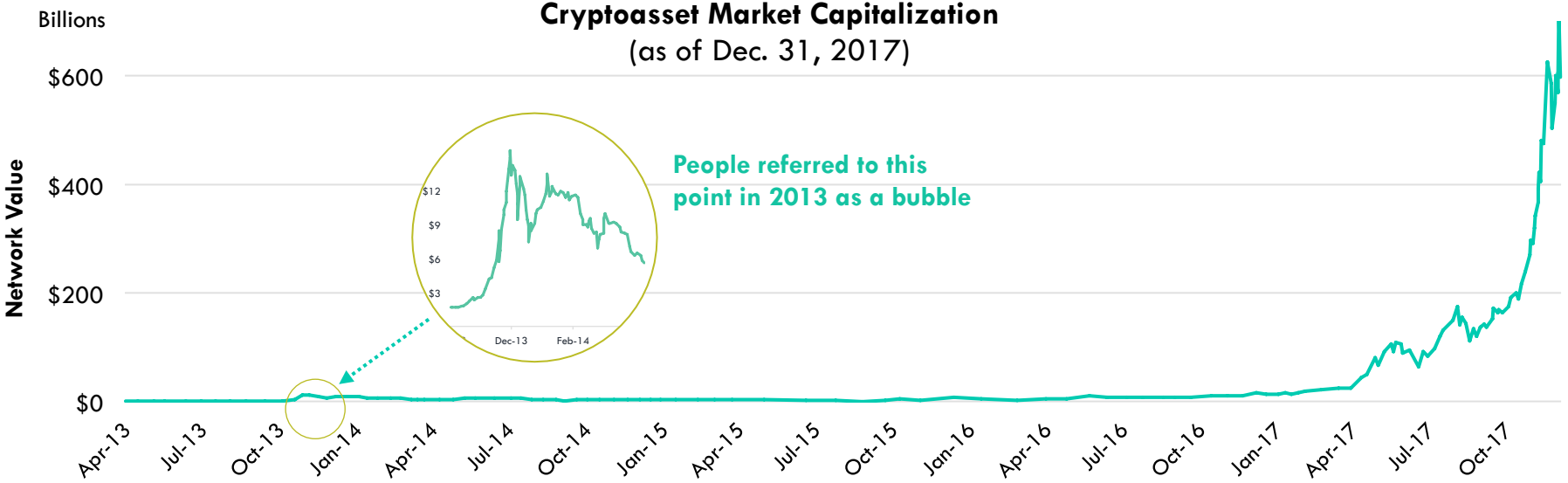


*Cryptoassets formally recognized as a new asset class in 2015 in ARK's whitepaper, "Bitcoin: Ringing The Bell For A New Asset Class"

Sources: ARK Investment Management LLC, 2017 | Data Sources : ART: "Size of Distressed Debt Market and Default Outlook for 2005 - 2006", NYU Stern, "Art as an Asset and the underperformance of the Masters" by Mei and Moses REITs: https://www.reit.com/data-research/reit-market-data/us-reit-industry-equity-market-cap Internet Stocks: "The valuation and market rationality of internet stock prices", 2002, NY Stern

Are Cryptoassets In A Bubble?

Many thought that cryptoassets were in a bubble in 2013 when bitcoin peaked around $1,000. Financial "booms and busts" are normal in technological revolutions. ARK believes the value proposition of blockchain technology is profound.



Source: ARK Investment Management LLC, 2017 | Data: https://coinmarketcap.com/charts/, Dec. 31, 2017

What We Expect In The Future For Cryptoassets

As the cryptoasset market evolves, each category will have a unique utility and value proposition.

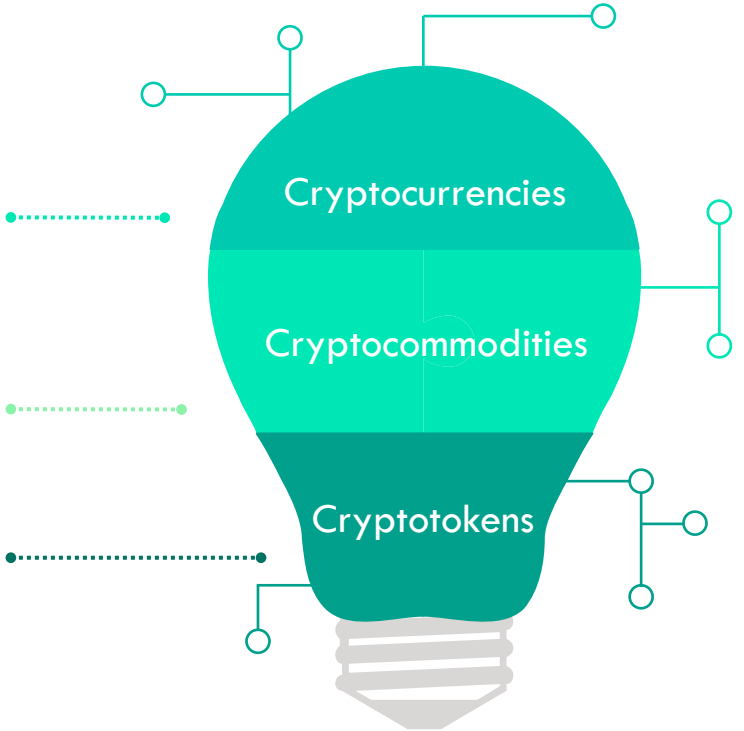
01 A Store of value, particularly in emerging markets.

02 A means of payment, particularly in emerging markets.

03 A reserve currency for all other crypto-assets.

04 Computing power, storage, bandwidth, and other digital commodities will become securitized products that trade on financial exchanges.

05 Just as bonds are claims on fixed assets and equities are claims on excess cash flows, tokens will be claims on the utilization of assets and could become a part of corporate capital structures.



Sources: ARK Investment Management LLC, 2017

ARK INVEST | BIG IDEAS 2018

FRICTIONLESS VALUE TRANSFERS

06

Research by Bhavana Yarasuri and Julia Hemmendinger

A Review

2004

Alipay Launches

2009

Bitcoin Network Launches

2014

Apple Pay Launches

2016

WeChat Pay Reaches 1 Billion Active Users

Mobile Payments Hit $8.6 Trillion in 2016

2017

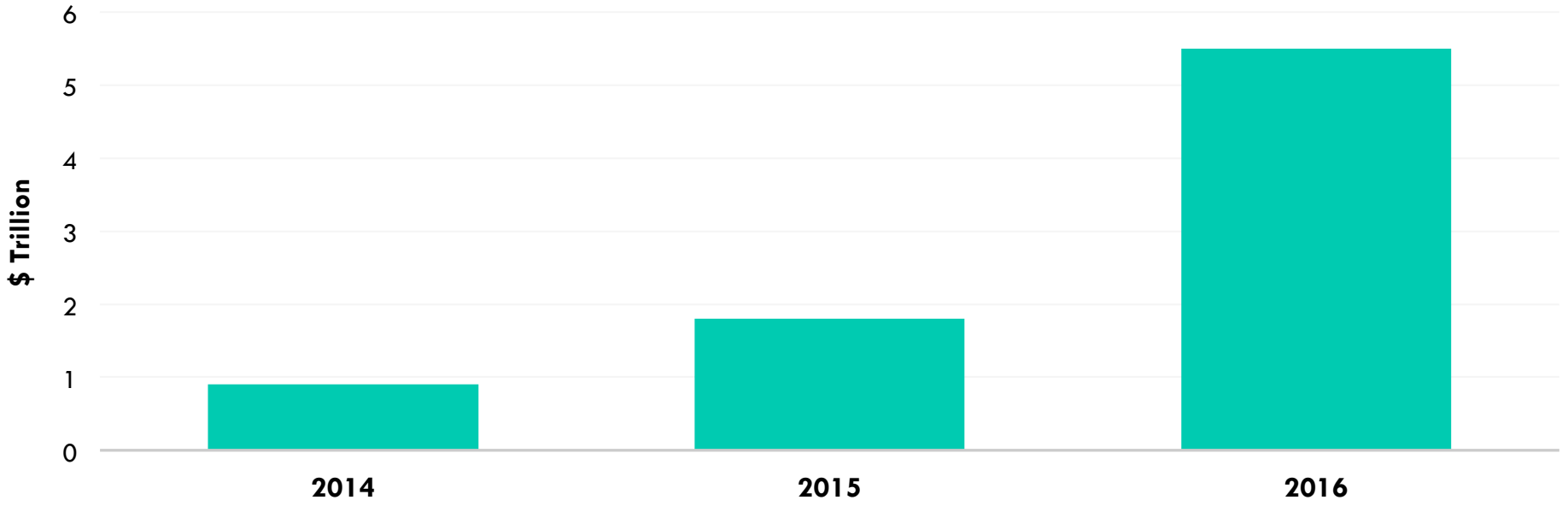
Square Cash App Launches Bitcoin Purchasing Function

Over the 3 Months Ended December 6th, Bitcoin's Blockchain Facilitated More Than $1.5 Billion Worth of Value Transfer on Average Per Day

Source: ARK Investment Management LLC, 2017 | A selection of events, achievements and innovation milestones.

China Points To The Potential Of Mobile Payments

In China, mobile value transfers jumped 5-fold in two years, reaching $5.5 trillion in 2016.

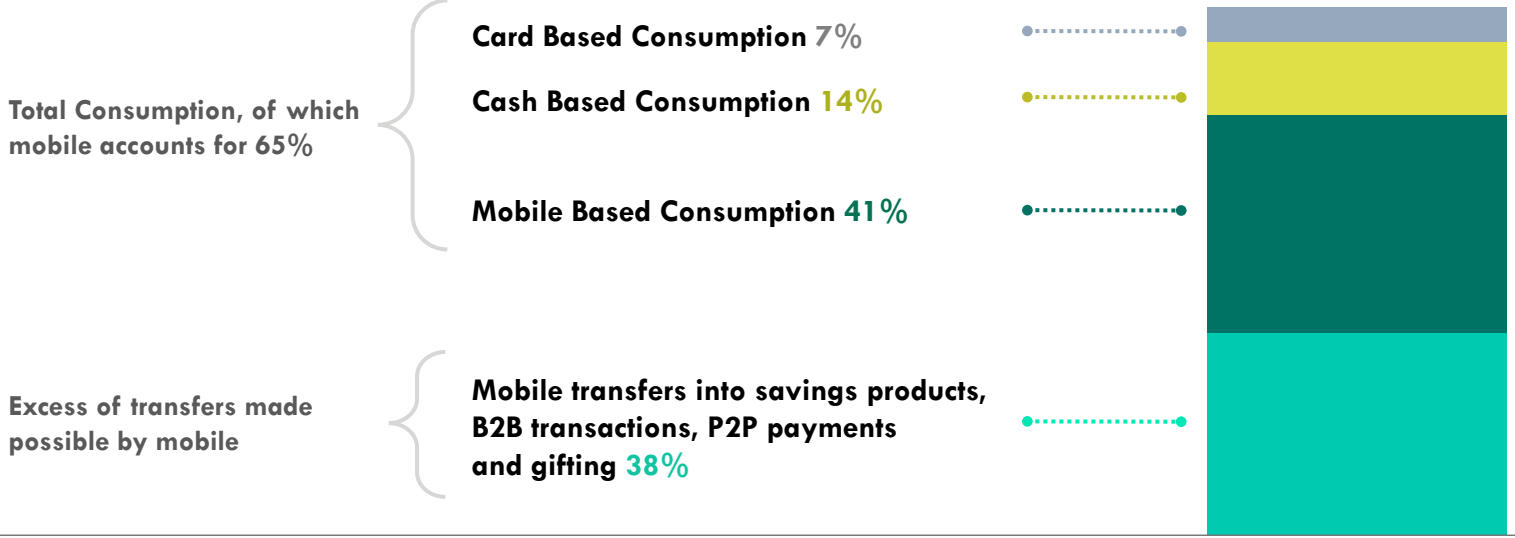


Sources: ARK Investment Management LLC, 2017; Data: http://www.analysyschina.com/

China Points To The Potential Of Mobile Payments

Mobile enables 65% of the consumption in China as well as other financial transfers like gifts and B2B transactions.

Mobile as a % of Total Value Transfers in 2016



Sources: ARK Investment Management LLC, 2017 | Data: http://www.analysyschina.com/

China Points To The Potential Of Mobile Payments

ON-DEMAND BIKE SHARING

- 25 Billion Transactions in 2017
- Average Value of $0.15

TIPPING FOR CONTENT

- 1.2 Trillion Transactions in 2016
- Average value of $0.01

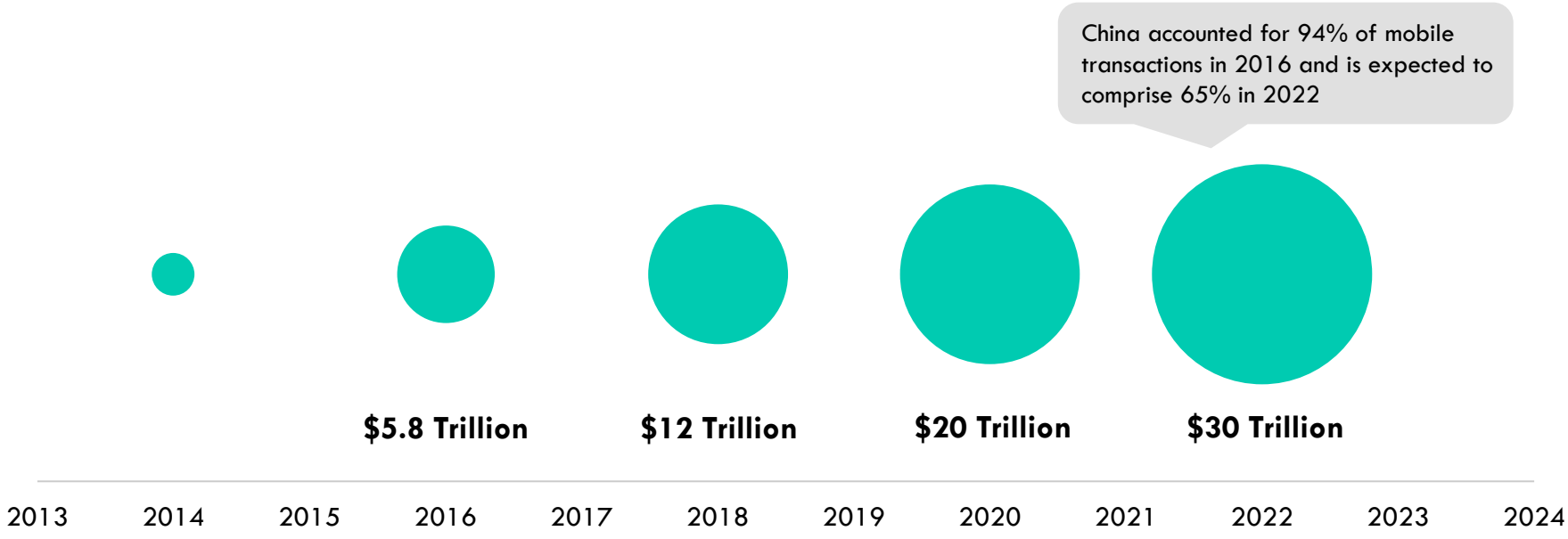
RED ENVELOPES & GIFT GIVING

- 290 Billion Transactions in 2017
- Average Value of $1.50

Sources: https://www.economist.com/news/business/21731675-one-answer-would-be-ofo-and-mobike-merge-chinas-bicycle-sharing-giants-are-still-trying.
https://www.reuters.com/article/us-lunar-newyear-wechat-redpackets/wechat-users-send-46-billion-digital-red-packets-over-lunar-new-year-xinhua-idUSKBN15J0BG

China Points To The Potential Of Mobile Payments

Globally, mobile value transfers are expected to grow 5-fold and to reach **$30 trillion** by 2022.



Sources: ARK Investment Management LLC, 2017

The Evolution Of Frictionless Value Transfers Has Accelerated

The number of transactions should increase significantly as technology enables programmatic value transfers.

Cash

Bank Notes

Demand Drafts

Credit & Debit Cards
VISA, MASTERCARD

Wire Transfers
WESTERN UNION

ATMs

Mobile Payments
WECHAT PAY, ALIPAY

Social Payments
VENMO, SQUARE CASH

Digital Wallets
APPLE PAY, PAYPAL

Embedded Payments
AMAZON ONE CLICK

Machine to Machine Programmatic Value Transfers
BITCOIN, LITECOIN

Digital Commodities

Real Time Insurance Contracts

3D PRINTING

Research by Tasha Keeney

A Review

1980
- **Invention of First 3D Printing Methods**

2003
- **First Patent for 3D Printed Human Cells**

2014
- **Consumer 3D Printing Hype**

2016
- **3D Printing Companies Restructure, Placing Less Emphasis on the Consumer Market**
- **GE Acquires Metal 3D Printing Companies, Arcam and Concept Laser**
- **HP Begins Selling Multijet Fusion Printer**

2017
- **Adidas and Carbon 3D Partner on 3D Printing Shoe Midsoles**
- **FAA Drafts Guidance on Additive Manufacturing in Aerospace**
- **FDA Provides Guidance on Additive Manufacturing for Medical Devices**

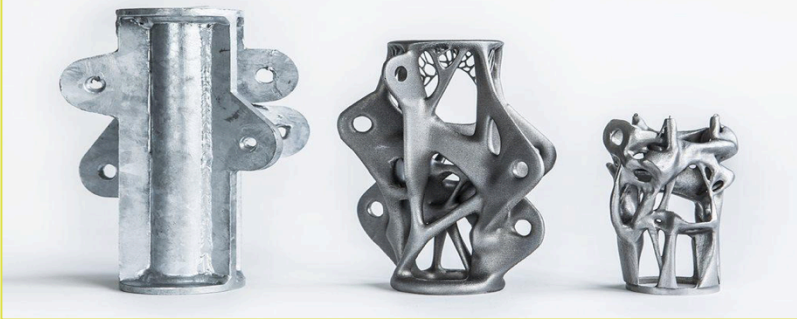
Source: ARK Investment Management LLC, 2017 | A selection of events, achievements and innovation milestones.

3D Printing Should Revolutionize Traditional Manufacturing

By building objects layer-by-layer, instead of removing material from a larger block or using a mold, 3D printing offers a range of benefits:

- **Shortens design-to-production time**
- **Shifts power to the designers**
- **Creates products with less waste**
- **Enables radically new architectures**
- **Reduces the cost of manufacturing significantly**

Traditional Manufacturing → 3D Printing and Machine Learning



For example, these structural nodes all support the same weight, but the part on the right weighs 75% less and is 50% smaller than the original part on the left.

Source: ARK Investment Management LLC; Image Source: https://www.arup.com/projects/additive-manufacturing

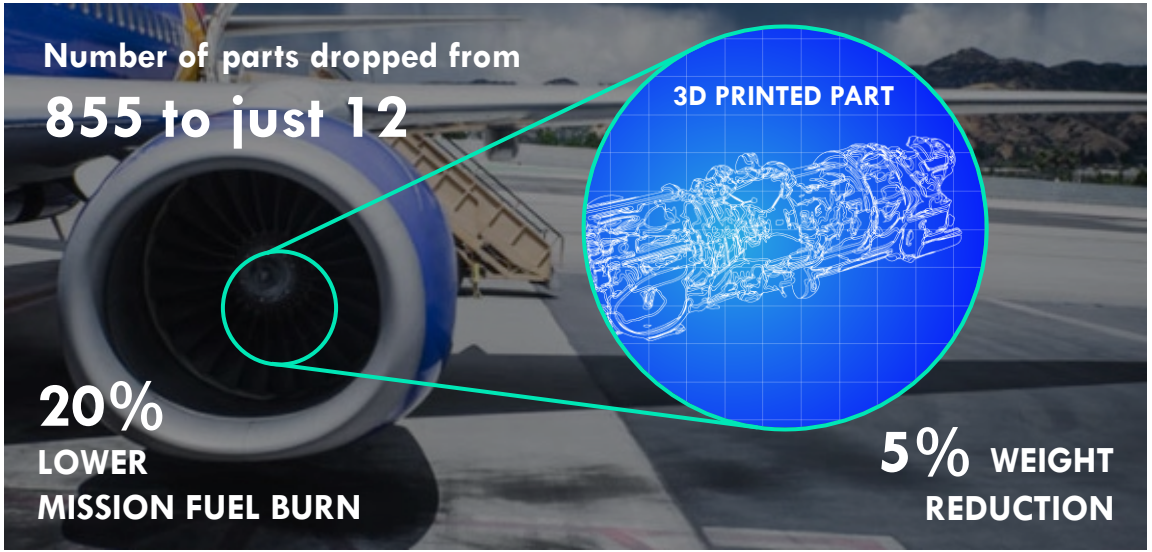
Use Case: Aerospace & Aviation

General Electric expects its additive manufacturing efforts to generate $1 billion in revenues and save $3-5 billion in costs by 2020.

Thanks to 3D printing, GE is reducing costs and producing better performing parts for jet engines.

PROOF OF CONCEPT:
ADVANCED TURBOPROP ENGINE (ATP)

- *Number of parts dropped from 855 to just 12*
- *Fuel burn lowered by 20%*
- *Weight reduced 5%*
- *Test schedule dropped from 12 to 6 months*
- *Structural casting eliminated*

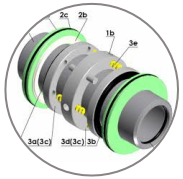


Sources: GE Additive Oppenheimer Annual Industrial conference 2017, https://www.ge.com/investor-relations/sites/default/files/GE%20Additive_Oppenheimer%20Annual%20Industrial%20Growth%20Conference.pdf
https://www.geglobalresearch.com/blog/3d-printing-creates-new-parts-aircraft-engines

3D Printing Is In Its Infancy

ARK's research shows that 3D printing for end use parts is the next frontier.

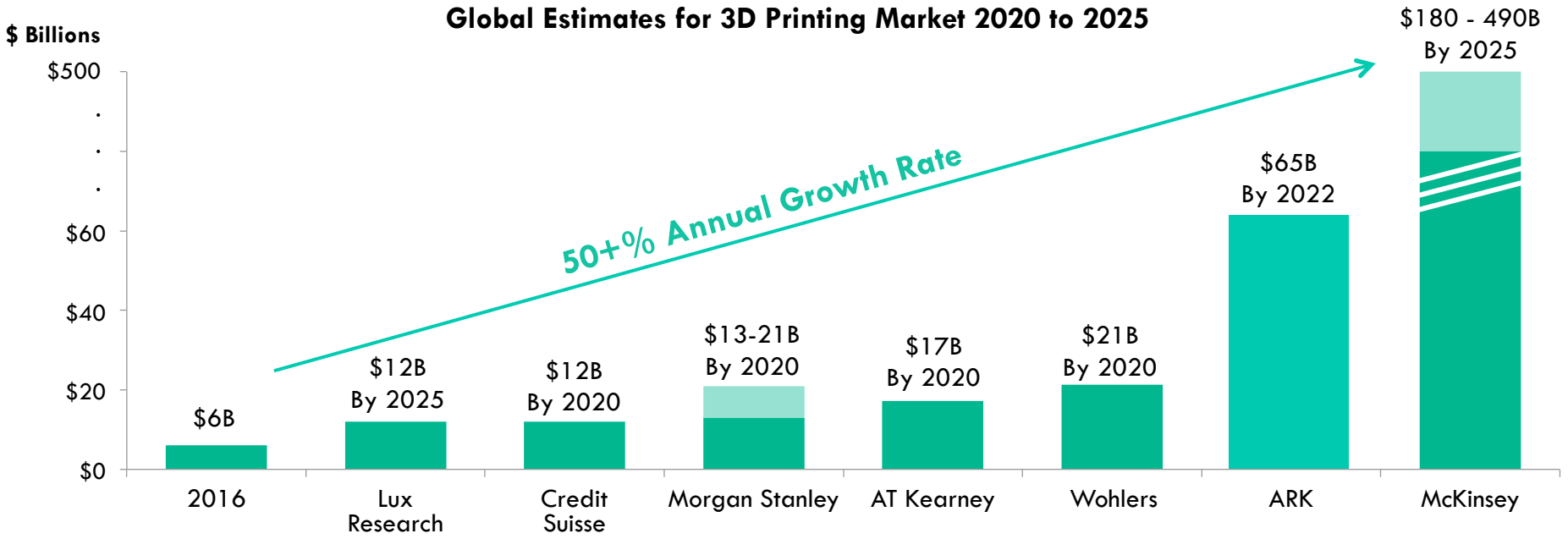
Design for Manufacture

	Prototypes	Molds & Tools	Consumer Products End Use Parts	Non-Consumer End Use Parts
				
Market size:	**$12.5B**	**$30B**	**$260B**	**$230B**
1st Applications:	1980's	1990's	Early 2000's	
Current Penetration:	30-40%	5%	<1%	

Sources: ARK Investment Management LLC, 2017; McKinsey; Stratasys; http://www.avplastics.co.uk/3d-printing-history,

The 3D Printing Market Could Increase Nearly Ten-Fold By 2022

ARK's research predicts the 3D printing market could grow to $65 billion by 2022.



Sources: ARK Investment Management LLC, 2017

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