

Technology Will Keep Changing Everything – and Do it Faster

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Banning Garrett, PhD

Adjunct Faculty, Singularity University

Senior Fellow, Global Federation

of Competitiveness Councils

Chief Strategy Officer, nR LLC

We cannot turn back the technology clock – in fact, it is speeding up

We cannot successfully meet the global grand challenges of the 21st Century if we do not harness science and technology

Technology is developing at an exponential, not linear, rate

Exponential technologies will change the world more in the next twenty years than in the last fifty – think of the impact of the Internet

These changes will be disruptive to governments, businesses and the lives of citizens

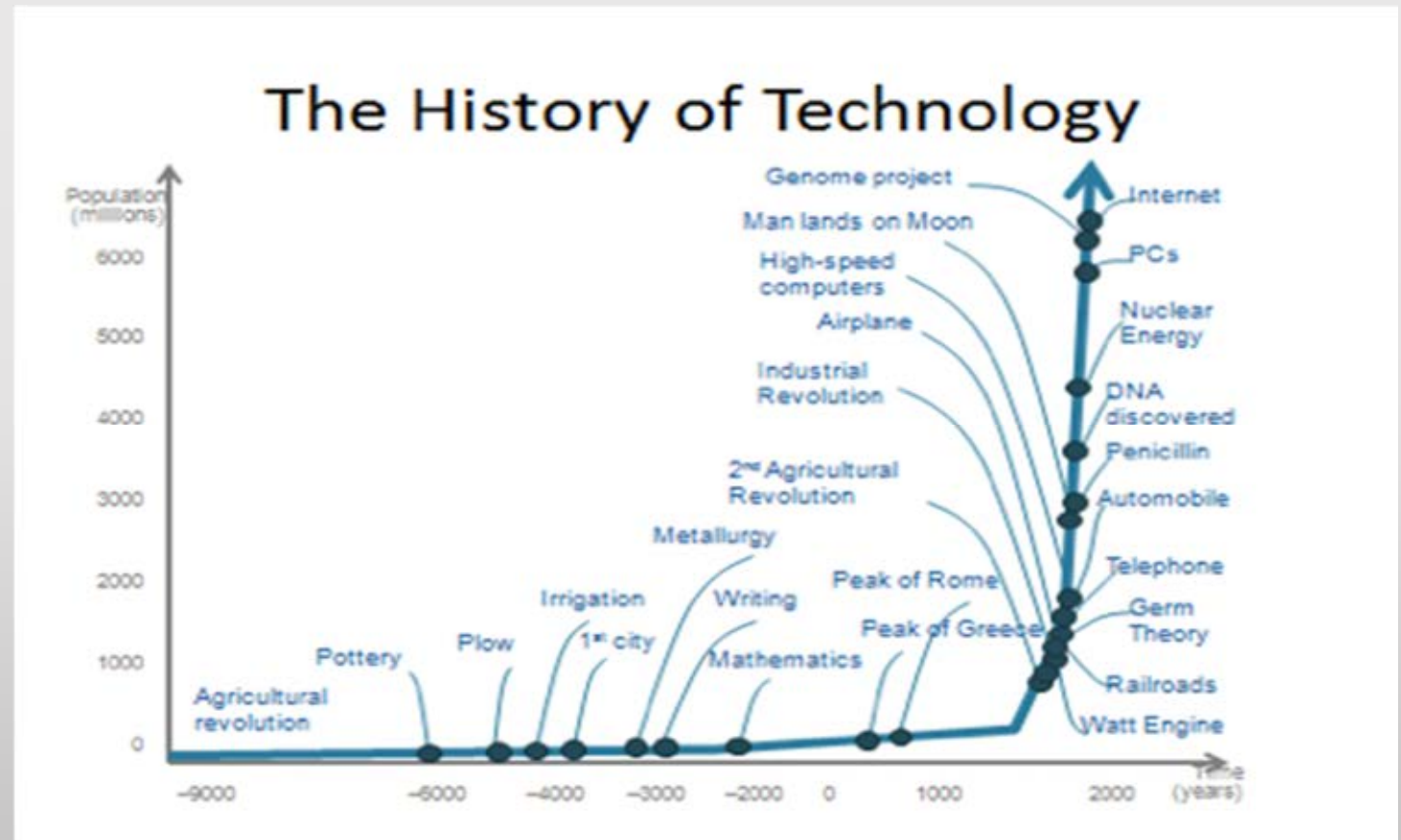
But they also hold great promise for a more prosperous, sustainable, secure and just world

Moore's Law Accelerating Technological Change

Moore's Law Still at Work after 50 Years

1. ICT
2. Artificial Intelligence
3. Robotics
4. 3D Printing
5. Synthetic Biology
6. Nano materials
7. Digital Medicine
8. Sensors & Networks

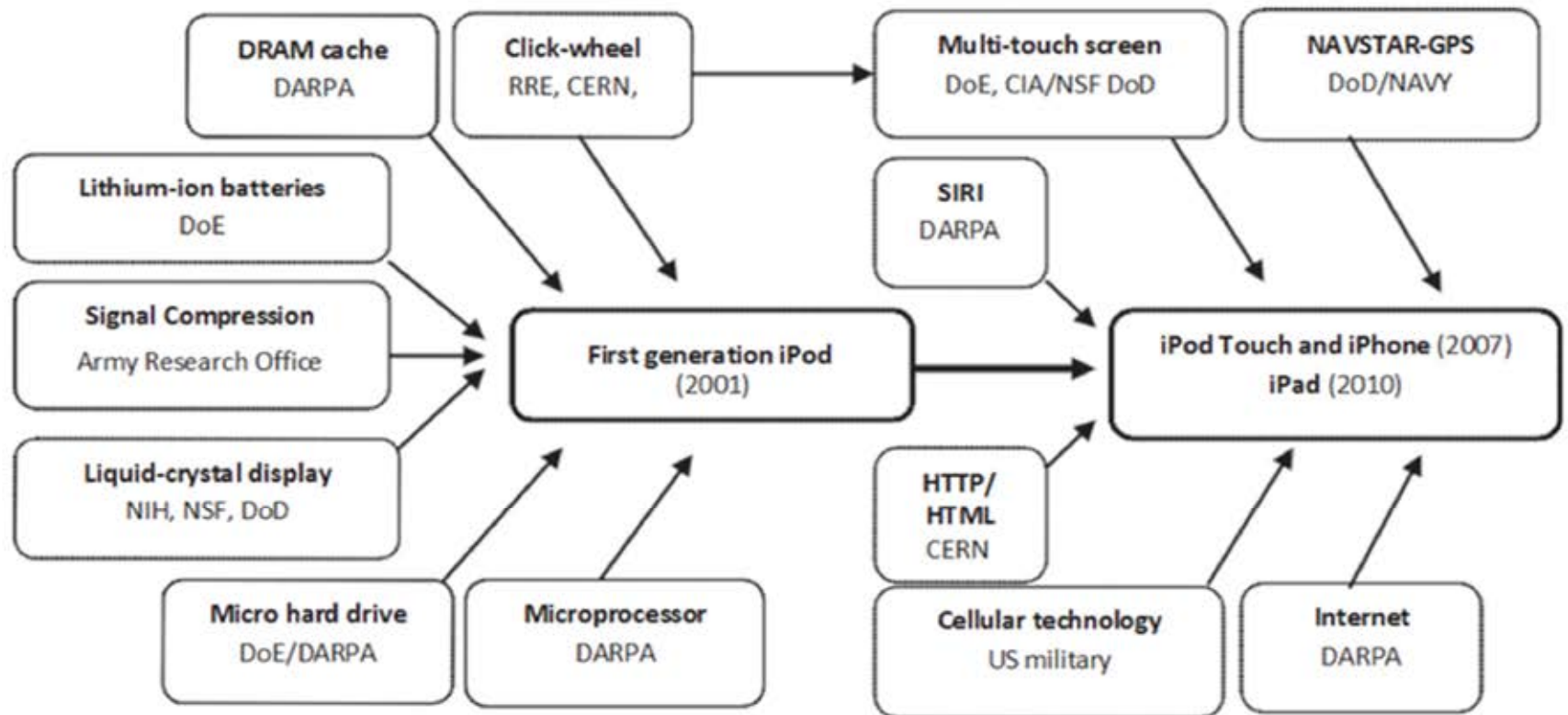
(List from Peter Diamandis)



Everything that can be digitized is subject to Moore's Law

Moore's Law Made Possible by Massive Government-Funded Research

What Makes the iPhone so Smart?



Source: *The Entrepreneurial State: debunking public vs. private sector myths* (Mazzucato, 2013), p109. Fig 13

Moore's Law & Smart Phone Capabilities: From \$900,000 to "Free"

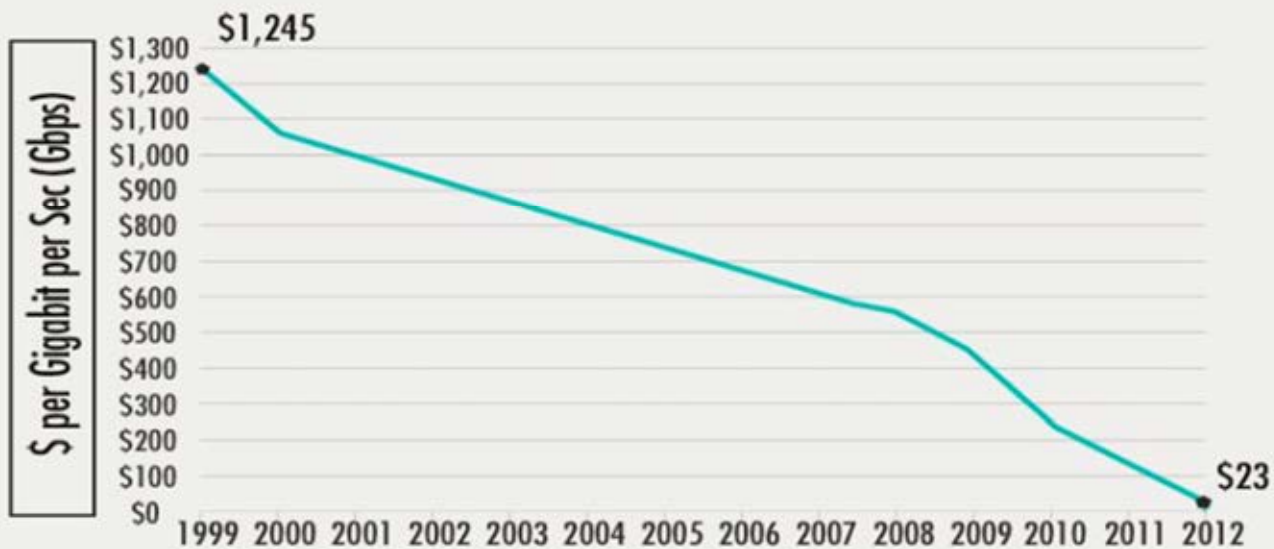
>\$900,000 worth of applications in a smart phone today

Application	\$ (2011)	Original Device Name	Year*	MSRP	2011's \$
1 Video conferencing	<i>free</i>	Compression Labs VC	1982	\$250,000	\$586,904
2 GPS	<i>free</i>	TI NAVSTAR	1982	\$119,900	\$279,366
3 Digital voice recorder	<i>free</i>	SONY PCM	1978	\$2,500	\$8,687
4 Digital watch	<i>free</i>	Seiko 35SQ Astron	1969	\$1,250	\$7,716
5 5 Mpixel camera	<i>free</i>	Canon RC-701	1986	\$3,000	\$6,201
6 Medical library	<i>free</i>	e.g. CONSULTANT	1987	Up to \$2,000	\$3,988
7 Video player	<i>free</i>	Toshiba V-8000	1981	\$1,245	\$3,103
8 Video camera	<i>free</i>	RCA CC010	1981	\$1,050	\$2,617
9 Music player	<i>free</i>	Sony CDP-101 CD player	1982	\$900	\$2,113
10 Encyclopedia	<i>free</i>	Compton's CD Encyclopedia	1989	\$750	\$1,370
11 Videogame console	<i>free</i>	Atari 2600	1977	\$199	\$744
Total	free				\$902,065

*Year of Launch

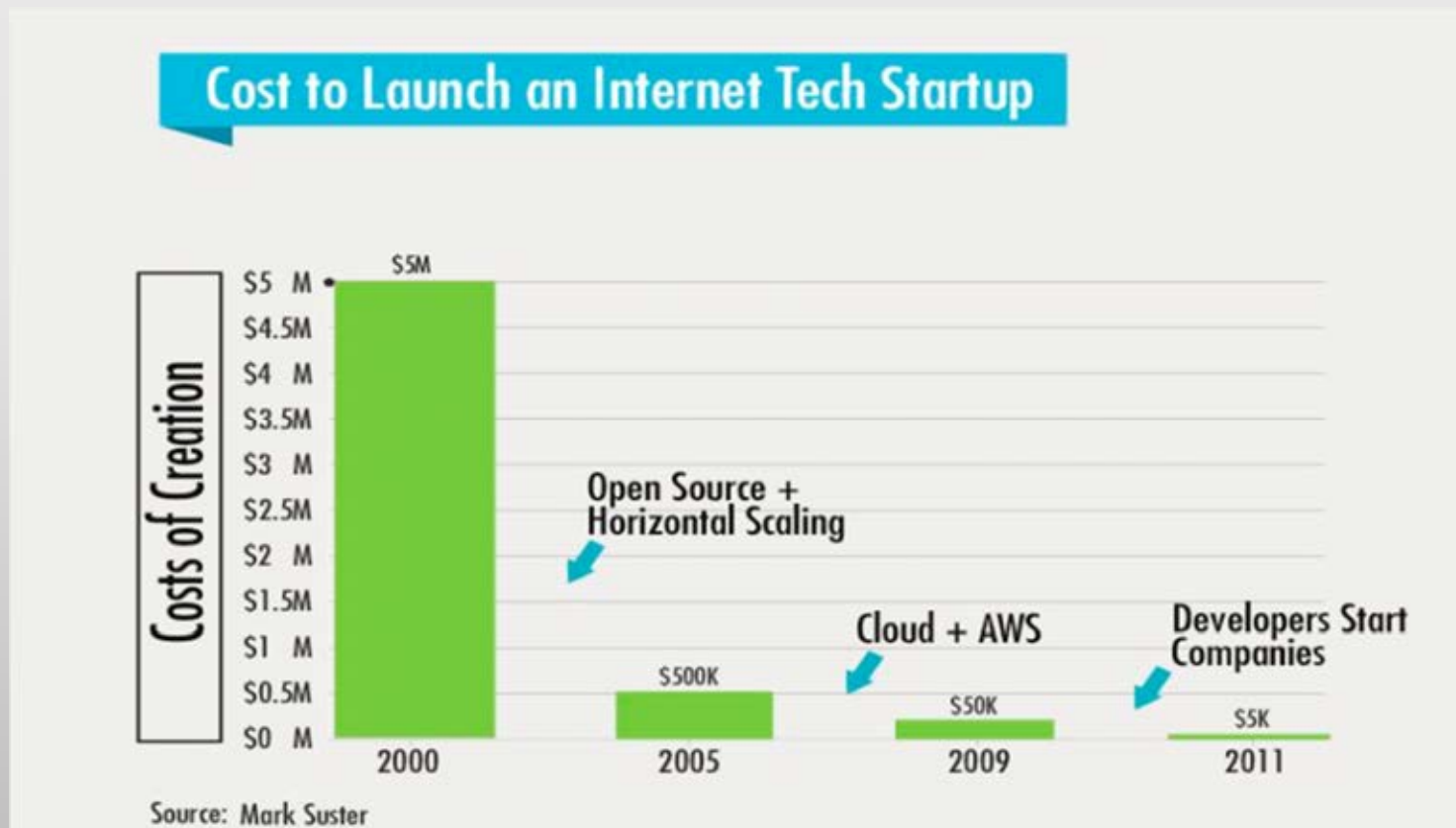
Moore's Law at Work in Lowering Cost of Internet Connectivity

Bandwidth Cost-Performance (1999-2012)



Source: Deloitte University Press

Democratization of Startup Costs - from \$5m in 2000 to \$5k or less today



Exponential Technologies Are Mutually Enabling

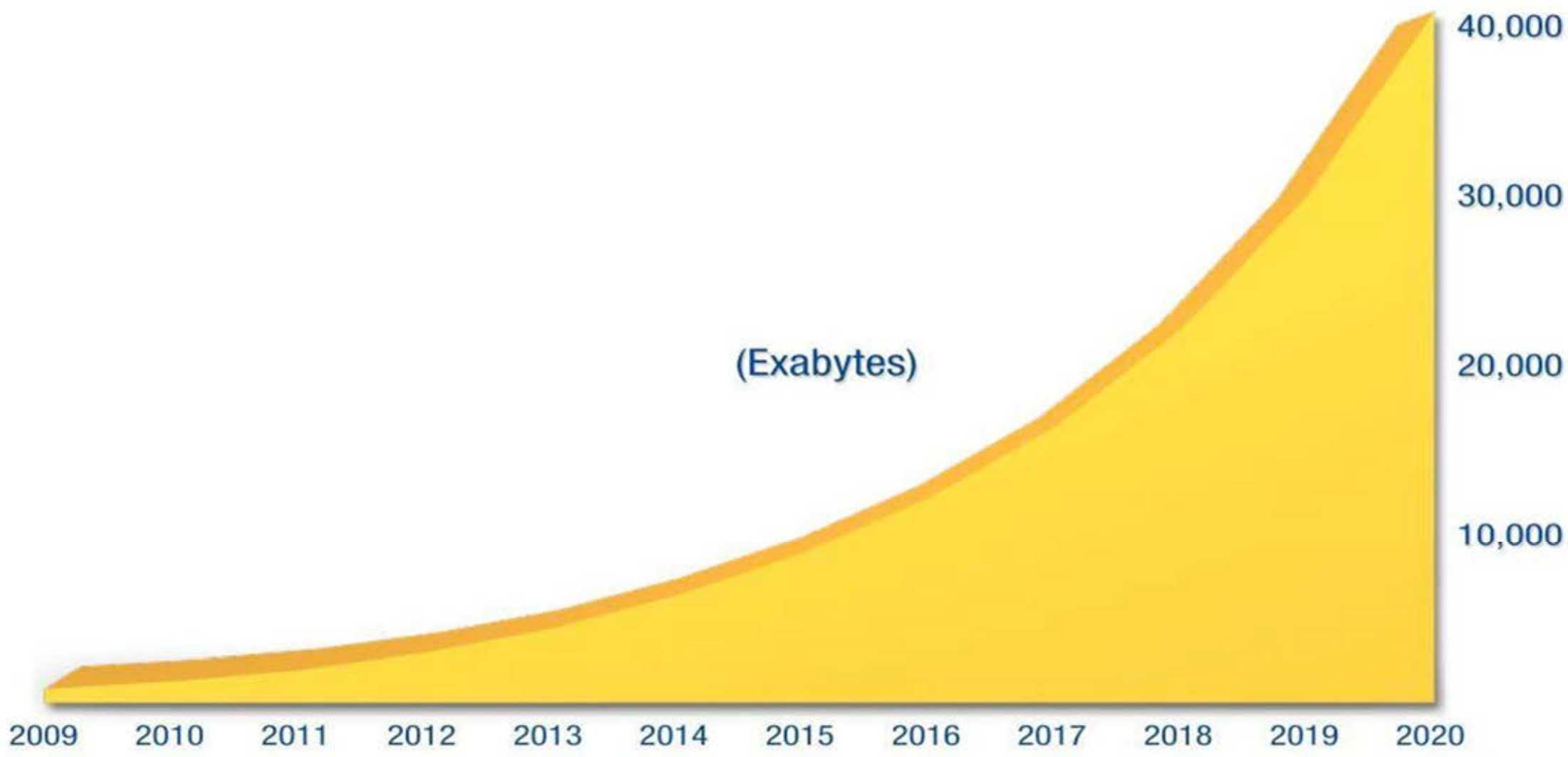
- Technological development accelerated by technological convergence
- Everything that can be “digitized,” will be digitized
- Smartphones made smart by GPS, the Internet, Big Data, Cloud computing and storage, Internet of Things sensors, Artificial Intelligence like Siri & Google Translate
- New Robotics & self-driving cars built around cheap sensors, motors, GPS, big data, AI and other exponential technologies
- 3D Printing explosion built around computer-aided design, cloud computing & storage, new materials, the Internet
- Genomics built on digitization of DNA and massive computing power

Moore's Law Creating New Platforms for Disruptive, Democratized Technology

Internet is the “platform of platforms”

- Social media: Facebook, Twitter, WeChat
- Cloud computing and storage: AWS, Google, IBM
- Artificial Intelligence: SIRI, Watson, Google
- Smartphone apps: More than 1.5 million iOS & Android
- Internet of Things: Trillions of sensors, billions of devices
- 3D printing: from design to manufacturing
- Drones: from farm surveys to humanitarian relief
- Computational Biology: design and print life

The Digital Universe: 50-fold Growth from the Beginning of 2010 to the End of 2020



Big Data

... is made possible by the Internet and a million-fold decrease in storage and computer costs

... is powered by the cloud and data analytics and the Internet of (Farm) Things

... is making possible advances in nearly all areas of S&T, including computational biology

... is accumulating exponentially on individuals
is raising complex privacy issues

Smarter Cities: Turning Big Data Into Insight



\$1 Trillion

global annual savings could be attained by optimizing public infrastructure.
Source: McKinsey

\$57 Trillion

in infrastructure investments will be needed between 2013-2030.
Source: McKinsey

50 Hours

of traffic delays per year are incurred, on average, by travelers.

30 Billion

people all over the world travel approximately 30 billion miles per year. By 2050, that figure will grow to over 150 billion miles.

60%

of water allocated for domestic human use goes to urban cities.

\$14 Billion

in potable water is lost every year because of leaks, theft and unbilled usage.
Source: World Bank

37,000

cloud experts support IBM's industry team alone.

\$6 Billion

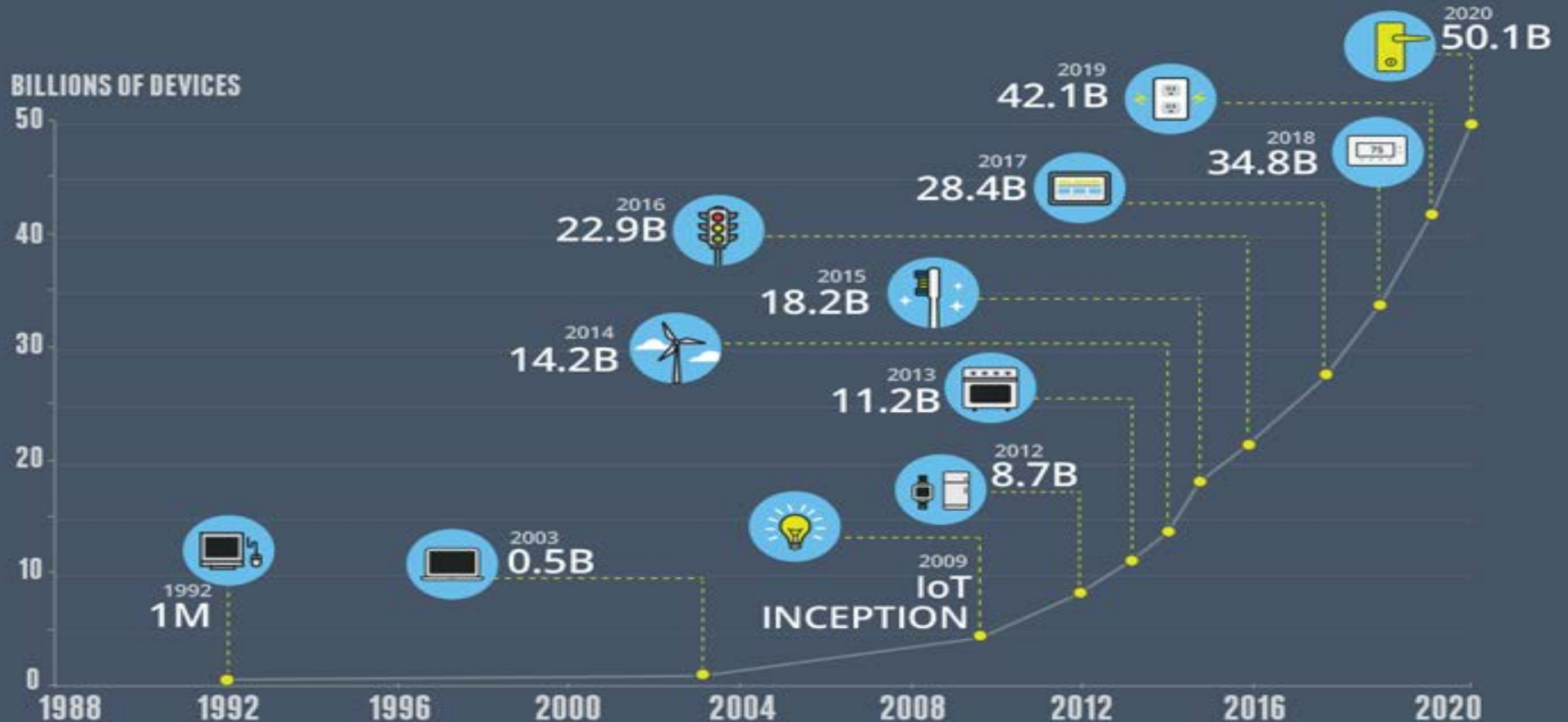
has been invested by IBM in more than a dozen acquisitions to accelerate its cloud initiatives.

IBM Intelligent Operations software is designed with cities, for cities, to provide the tools to monitor, visualize and analyze vital city services such as water and wastewater systems, transportation, infrastructure planning, permit management and emergency response.



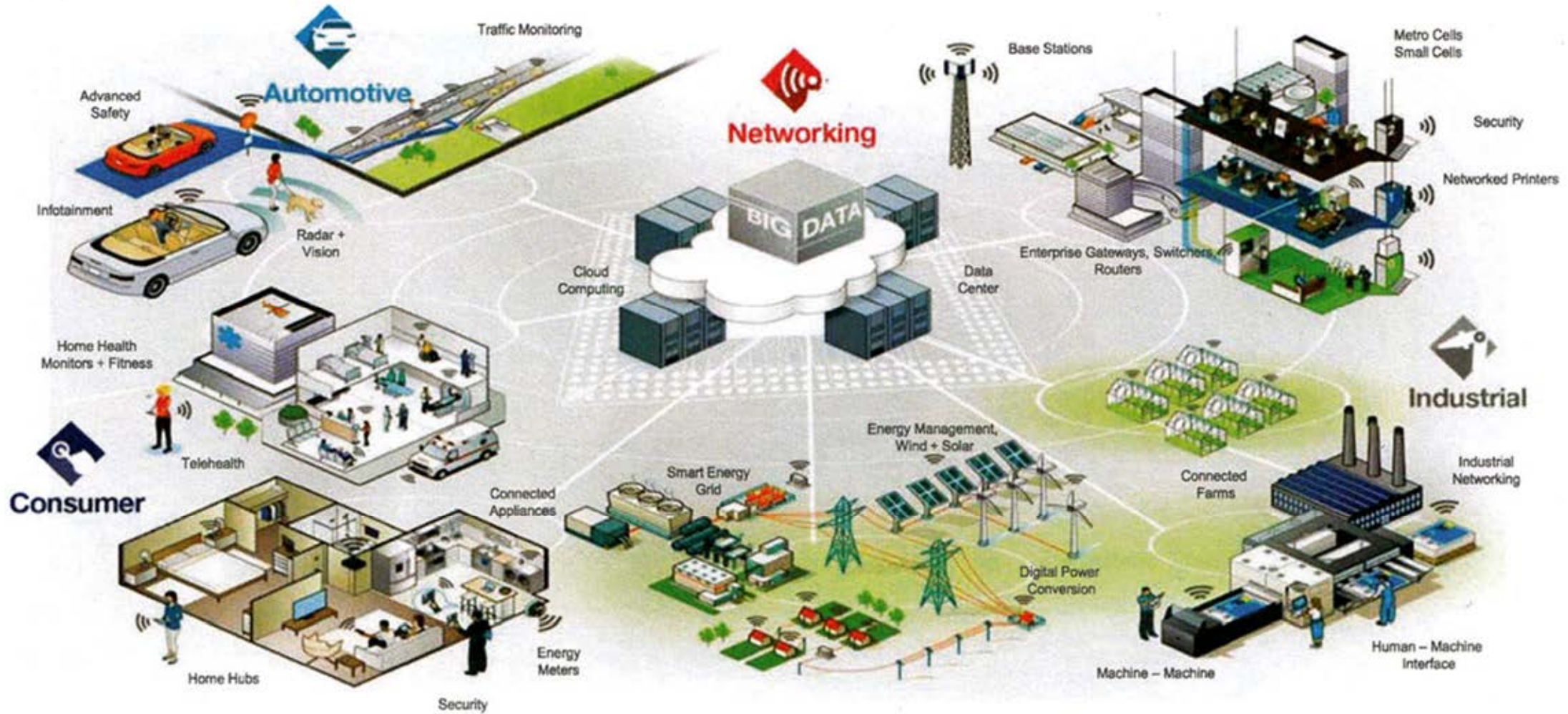
GROWTH IN THE INTERNET OF THINGS

THE NUMBER OF CONNECTED DEVICES WILL EXCEED **50 BILLION** BY 2020



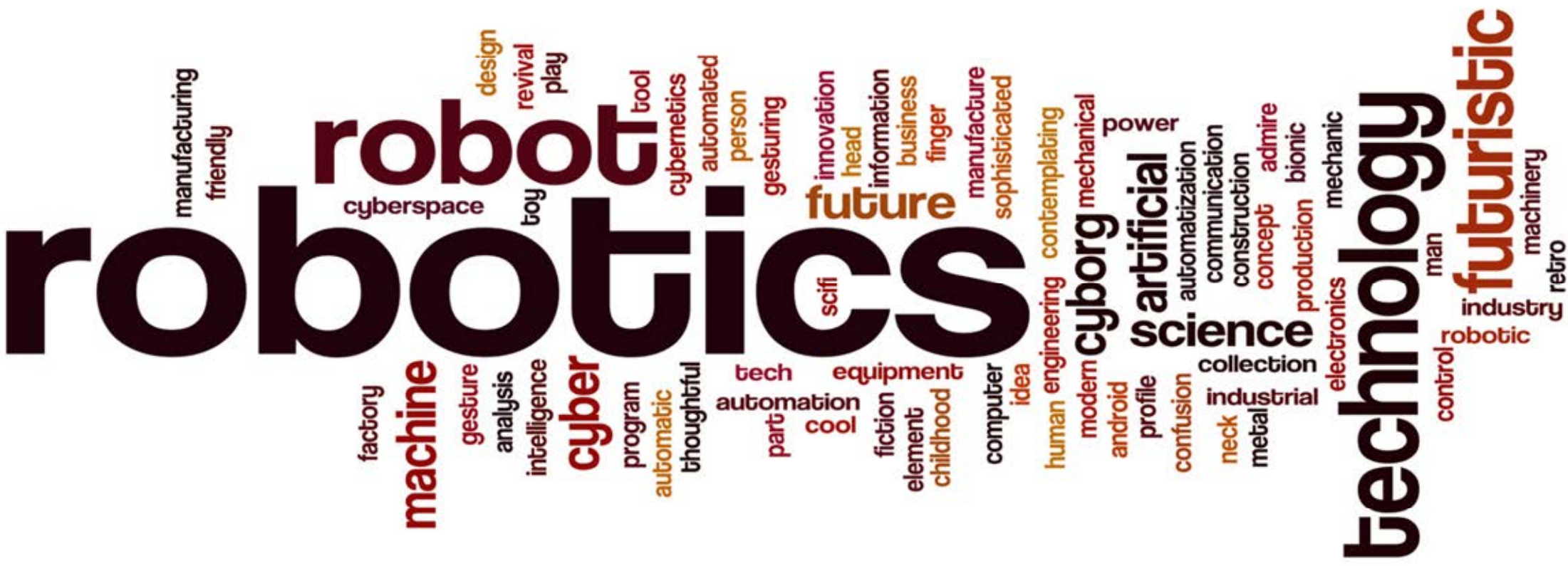
Source: Cisco

The Internet of Things



MIND OPTIMIZATION REASONING COMMUNICATION SOCIAL PERCEPTION AGENT RESEARCH SOFTWARE PLANNING TOOLS
LEARNING RESEARCH KNOWLEDGE
ARTIFICIAL SCIENCE
DESIGN ACTION INTELLIGENCE
NETWORKS SOLVING TECHNOLOGY COMPUTER MACHINES SEARCH
APPROACH NEURAL INTELLIGENT AI SYSTEM
CYBERNETICS LOGIC SIMULATION



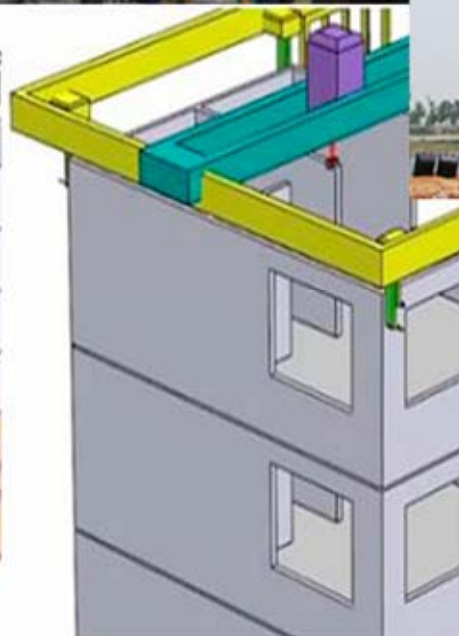
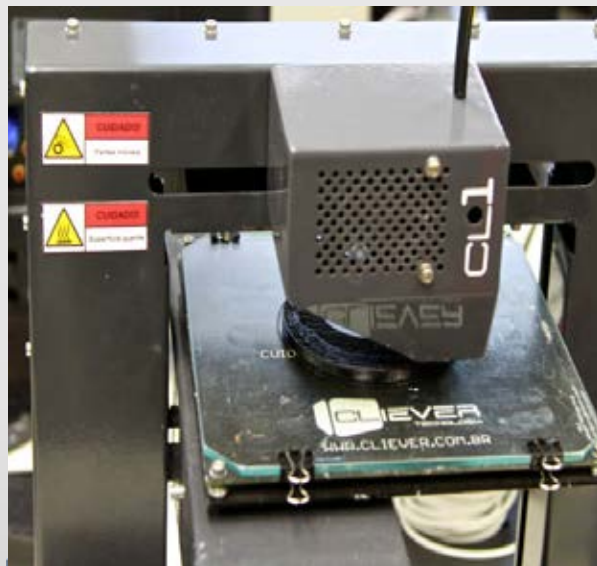


The New World of Robotics and Drones

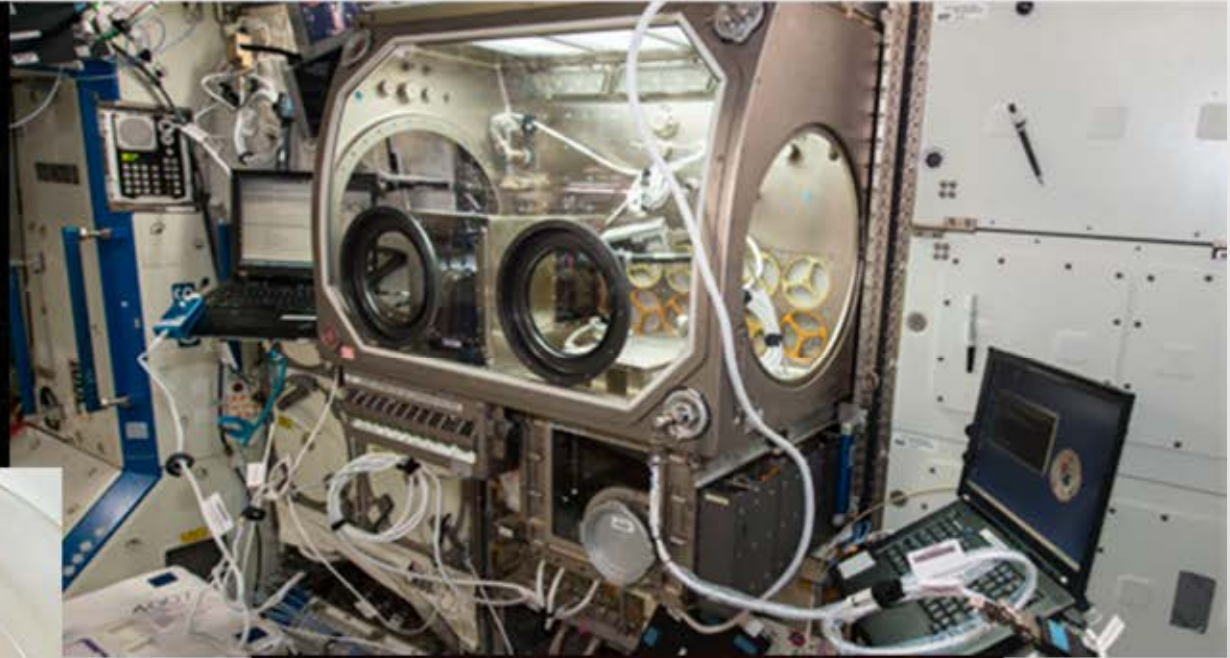


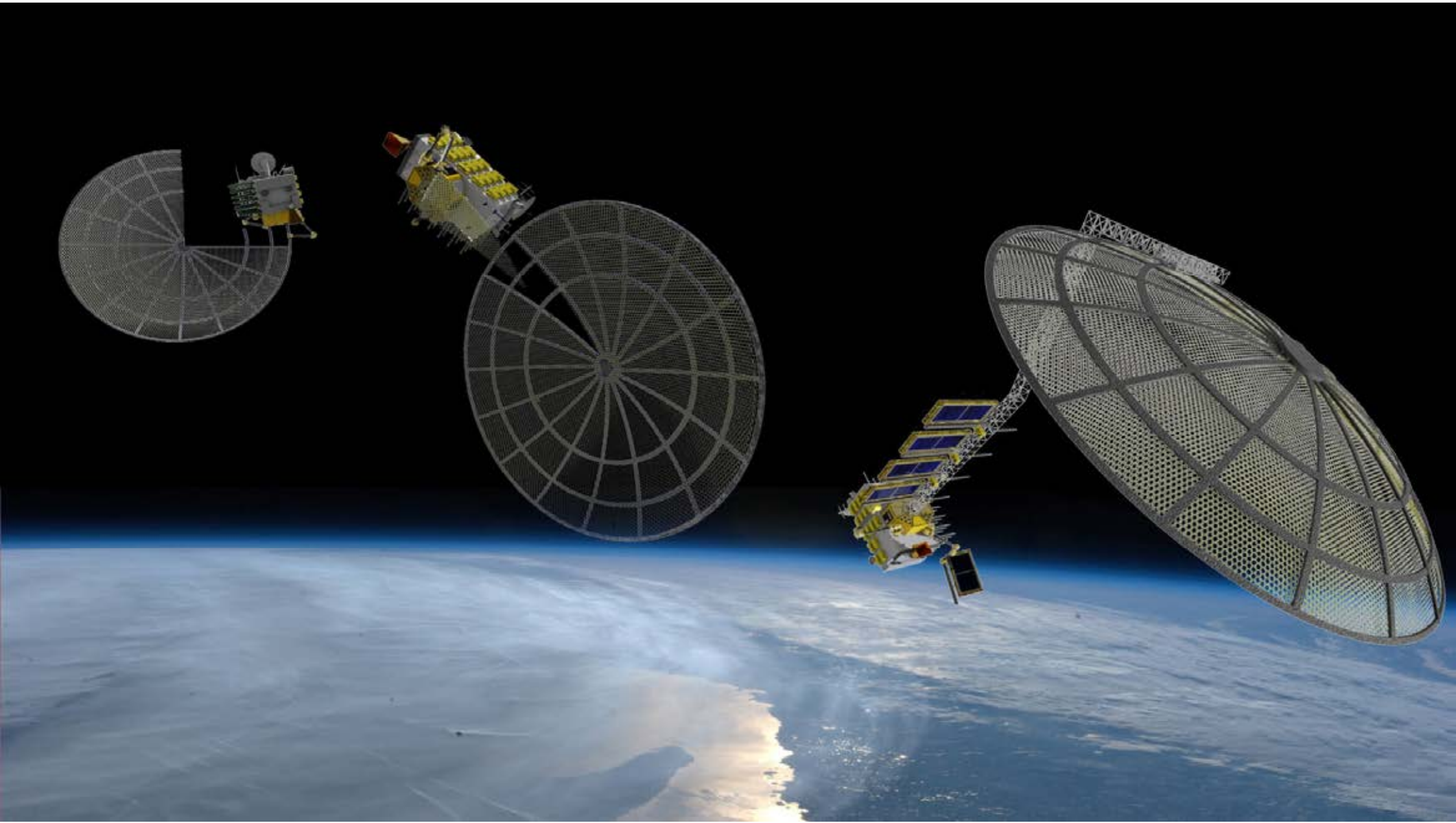


3D Printing – from DIY & Small Business to Industry & Construction



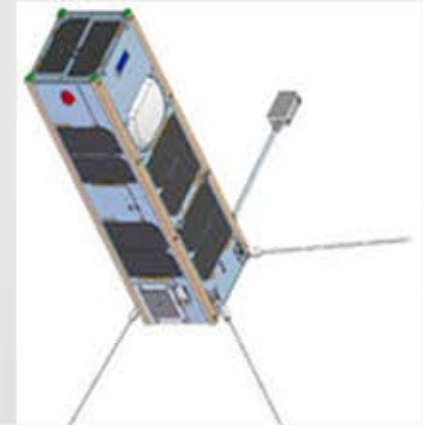
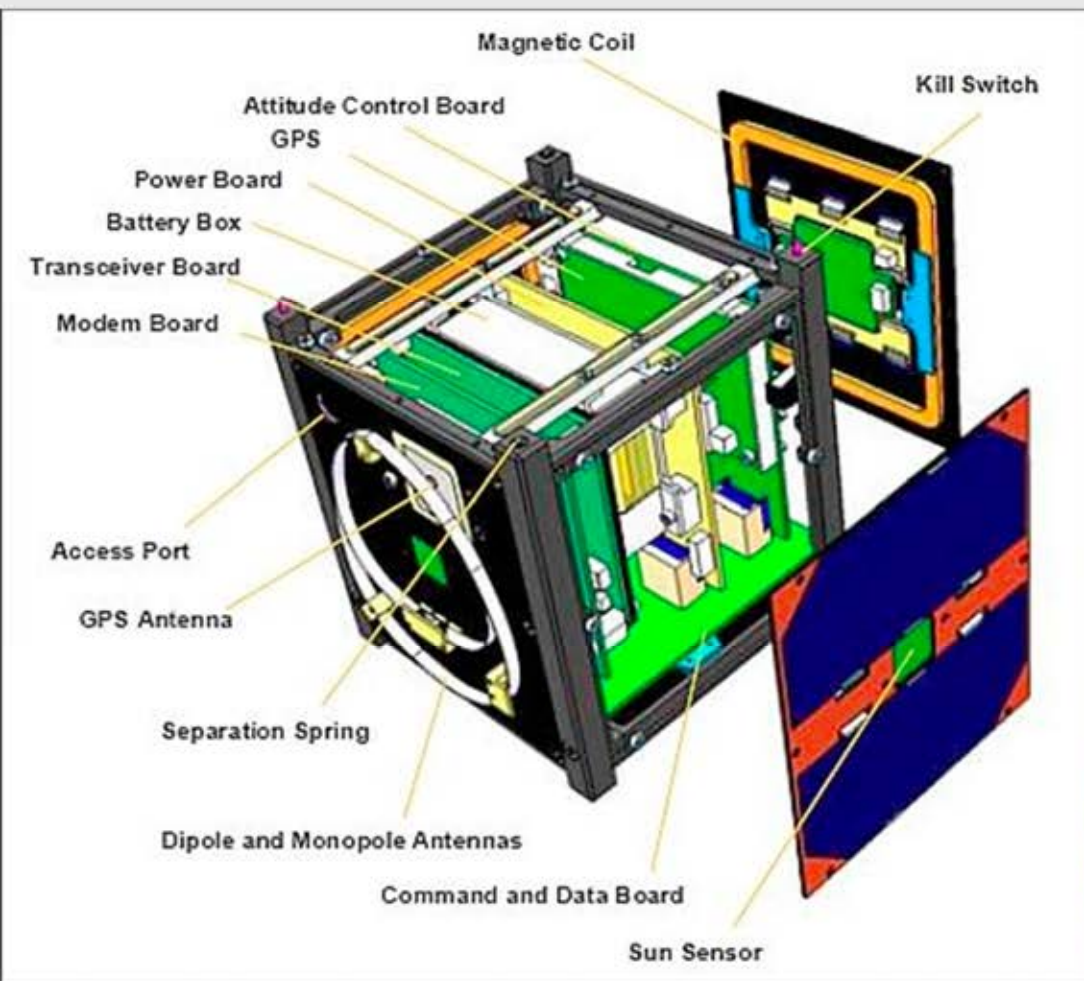
DIY 3D Printing - Even in Space 4-Year Old Startup Builds Printer for ISS



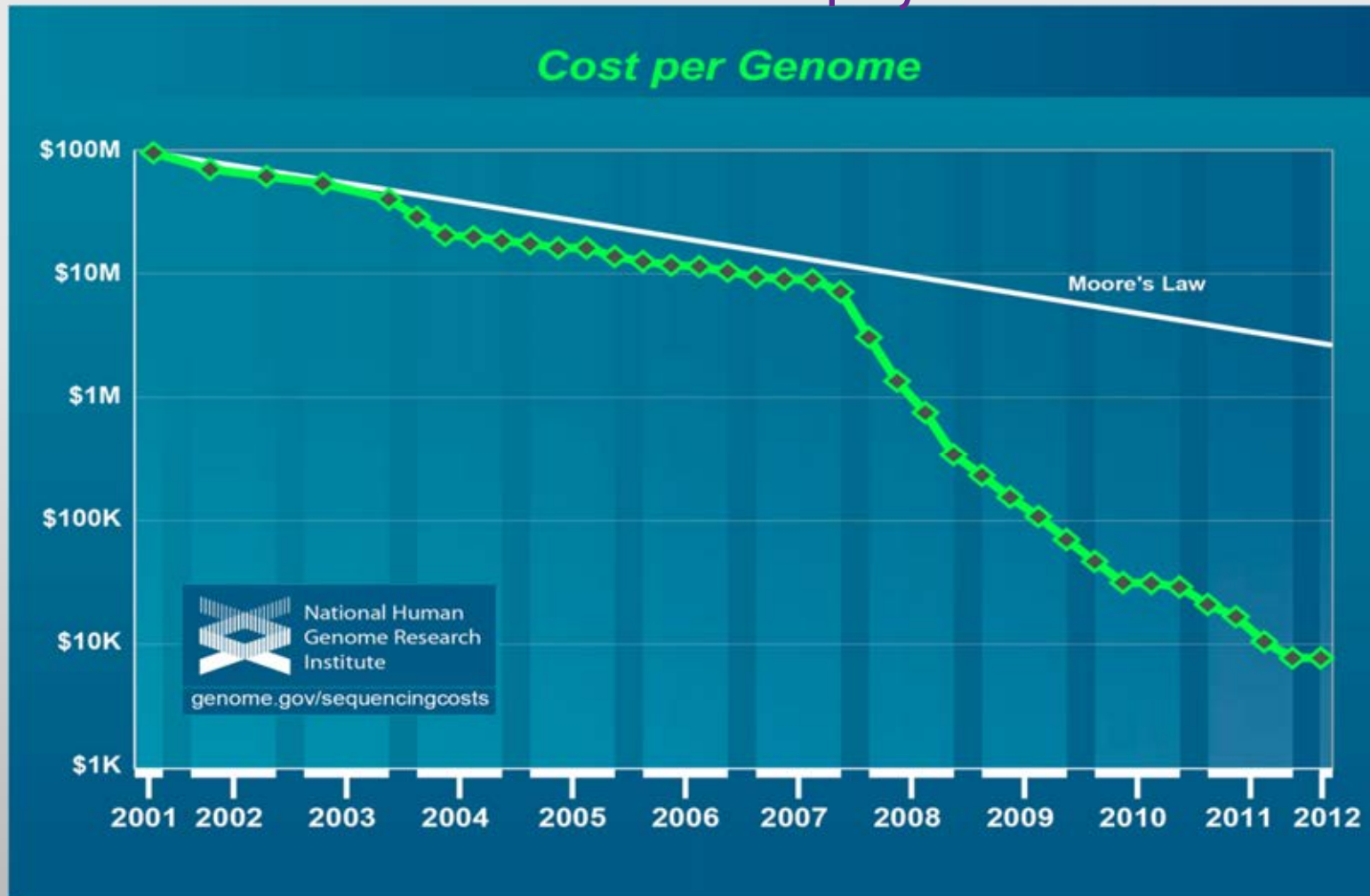


DIY Even in Building Satellites

Thousands of Cubesats Will Soon Orbit Earth



Genome Sequencing Cost Declining Faster than Moore's Law: From \$3 billion in 2003 to \$100 million in 2007 to less than \$1,000 in 2016



The Synbio Revolution

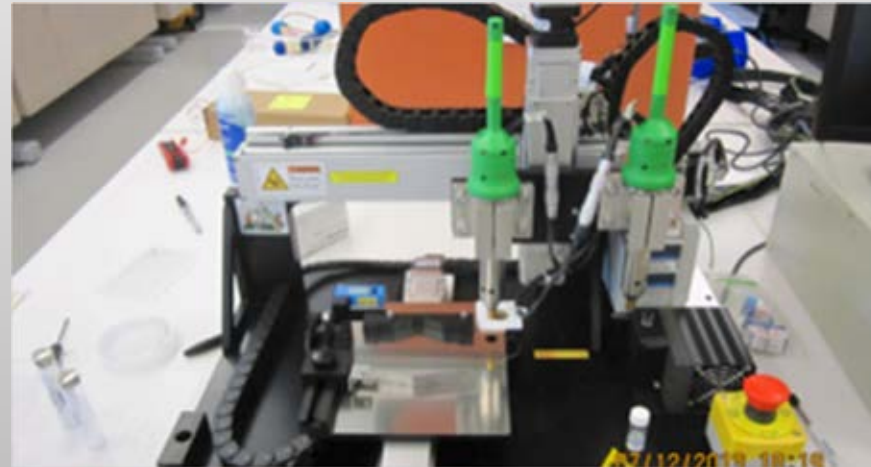
BioBricks – modular design of organisms

3D printing life – computer-designed “life”
emailed to printer

3D printing – tissue, organ replacements

CRISPR – gene editing: food, humans

DIY Bio: Bio Hacker spaces



Organovo bioprinter

Impact of Exponential Technologies

- First order – New technology and inventions based on technology
- Second order – How that technology is used
- Third order – How the use of that technology impacts society
- Fourth order – How one technology's impact combines with others

Second, Third and Fourth Order Impacts

Robots, AI, drones, self-driving cars: urban redesign, economic disruption, political unrest

App world: peer-peer, “sharing economy,” more efficient use of resources, better governance, virtual companies

Block chain: bypassing trusted third parties to reduce friction in the economy & government, bypass traditional banks

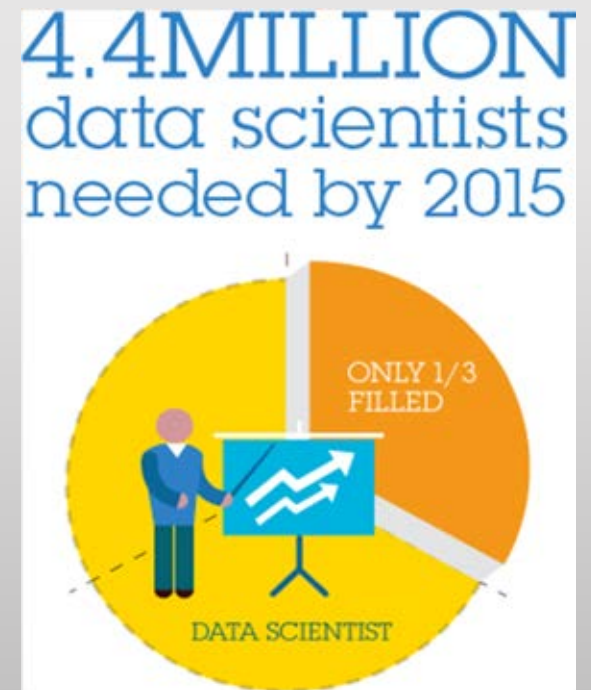
3D Printing: elimination of supply chains, customized production at point of consumption, bring manufacturing home

Exponential Organizations: leverage technology and people with few assets - Uber, airbnb

From a world of scarcity to a world of abundance?

Job Destruction, Job Creation

- Robots could replace people in nearly half of current job categories
- Knowledge jobs as well as manual labor threatened
- Impact will vary by industry, country
- Working *with* robots will be critical
- New industries, jobs will be created
- Education for new jobs will be critical
- Will more jobs be created than destroyed?
- Will income inequality increase?



http://www.ibm.com/big-data/us/en/images/bigdata_infographic.png

“The Tree Prefers Calm, But the Wind Will Not Subside”

- Exponential acceleration of technology development will continue
- Technological disruption of society will accelerate
- Democratized technologies are leveling global playing field
- Technology producing new dangers and threats
- But technology is the *sine qua non* for successfully addressing global grand challenges
- Technology holds promise of a future of greater abundance and sustainability

Thank You!

Banning Garrett

banninggarrett@gmail.com

@banninggarrett

Suggested Reading

Abundance and Bold, Peter Diamandis and Steven Kotler

Exponential Organizations, Salim Ismail

Second Machine Age, Andrew McAfee and Erik Brynjolfsson

The Entrepreneurial State, Mariana Mazzucato

Peers Inc, Robin Chase, co-founder of Zipcar

The Industries of the Future, Alec Ross

The Fourth Industrial Revolution, Klaus Schwab

Life at the Speed of Light, Craig Venter

Global Trends 2030, National Intelligence Council