FROST & SULLIVAN

Technology Innovations Driving Future Growth for the Semiconductor Industry

Brian Cotton, PhD | Senior Vice President & Partner

October, 2018

Today's Growth Drivers for the Semiconductor Industry

Technology We can See Today

RF GaN forecast to hit $750 million in 2022: 5G networks, data center applications

Semiconductor ATE forecast to hit $5.5 billion in 2022: SoC products for smartphones, wireless/wired communications devices, consumer electronics

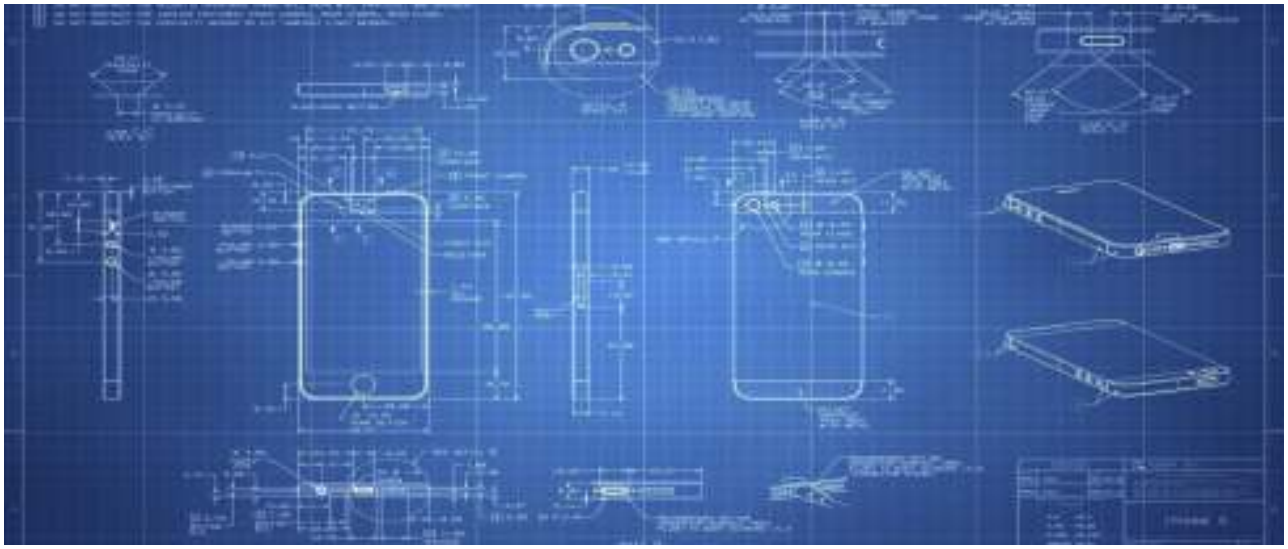
PMICs for wearable technology forecast to hit $1.8 billion in 2022: Smart accessories, health technology , VR/AR sets applications

What about Tomorrow?

Agenda in Brief

- Digital Transformation is the Future of ICT
- Today's Growth Drivers – The Engines of Digital Transformation
- Tomorrow's Growth Drivers – The Engines of Digital Disruption
- The Big Picture of Growth – Big Challenges

Why all the Hype around Digital Transformation?



Digital Transformation is a Fundamental Driver of Growth

- A market worth **hundreds of billions of dollars**, but how do you really measure it?
- New **products and processes**
- Changing **insights**
- **Cultural shifts**

"I think that the most secular, deep trend that we're seeing play out is the increasing digitization of everything…and the most important transformation, perhaps, is that **business models themselves are being changed**"

Microsoft

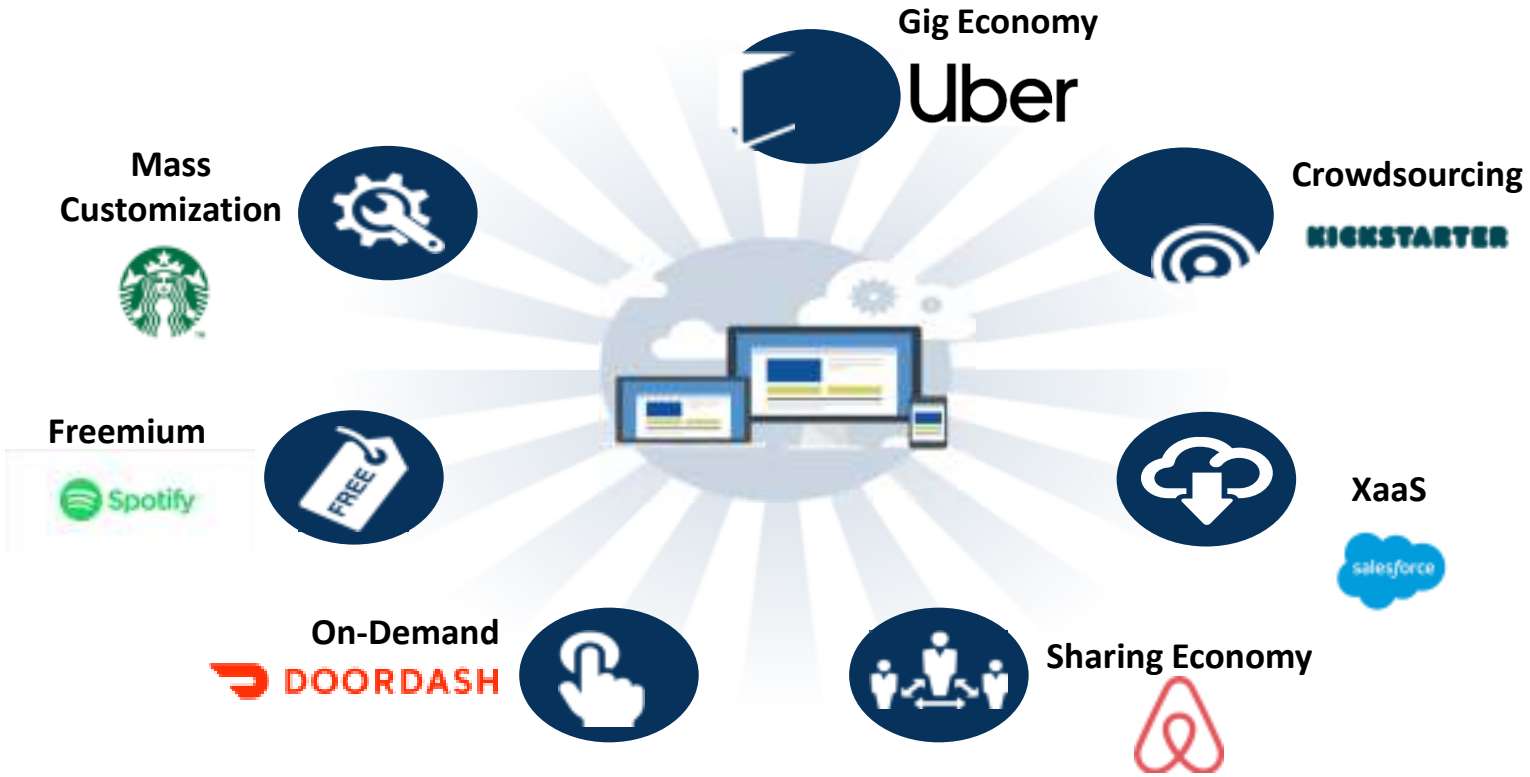
Satya Nadella

"At least 40% of all businesses will die in the next 10 years…if they don't figure out how **to change their entire company to accommodate new technologies**"

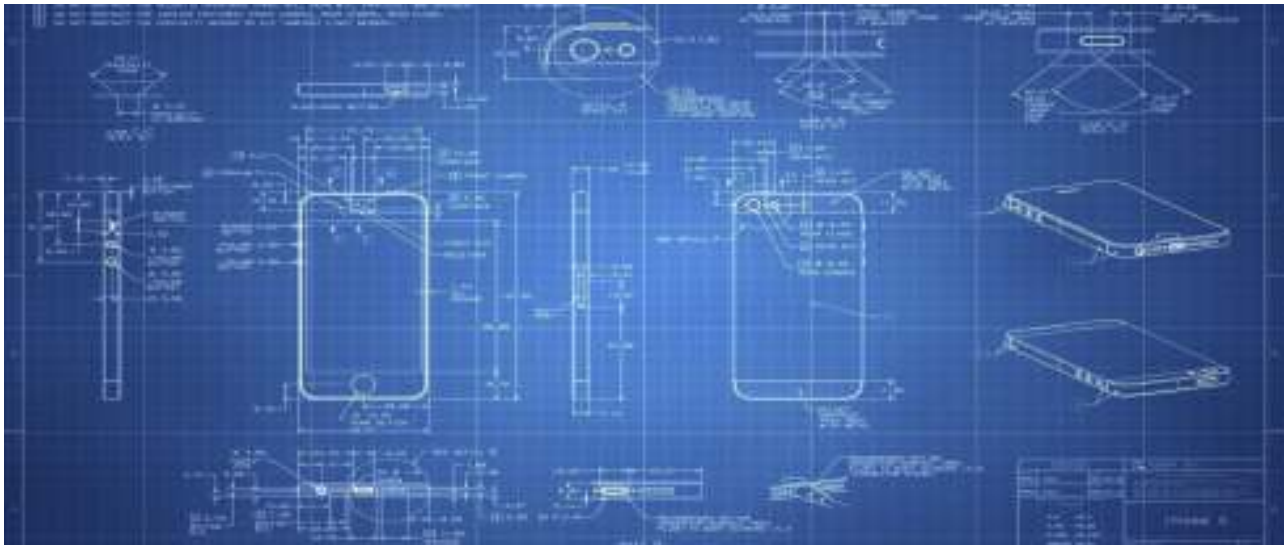
CISCO

John Chambers

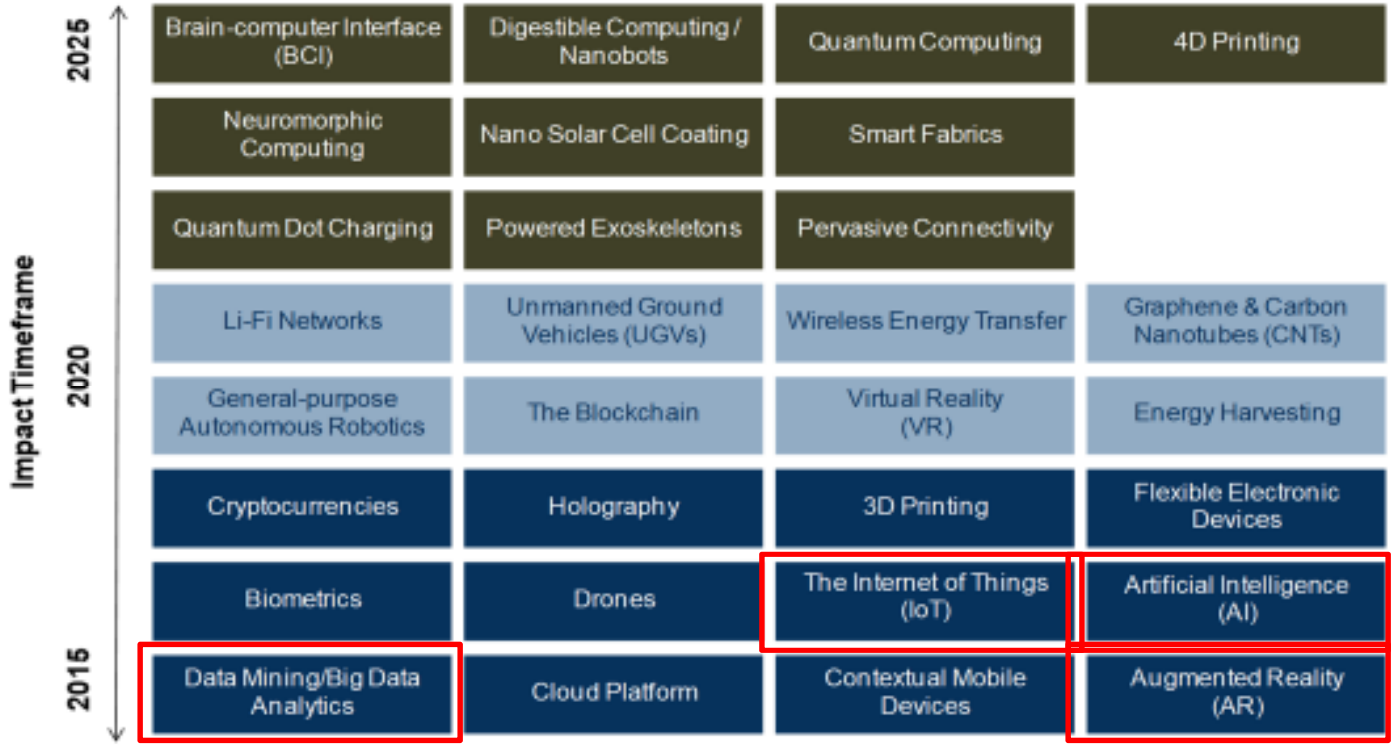
Business Models for a Digital World



Today’s Growth Drivers

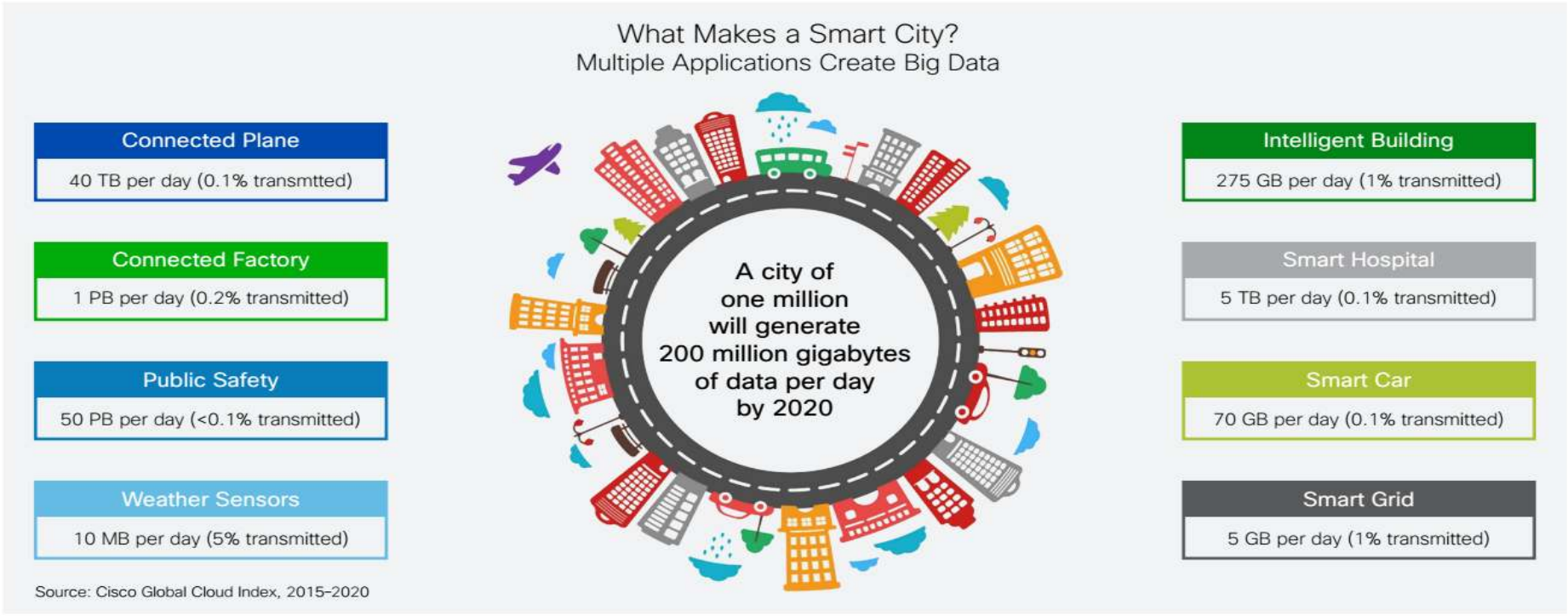


The Engines of Digital Transformation (1Q2015)

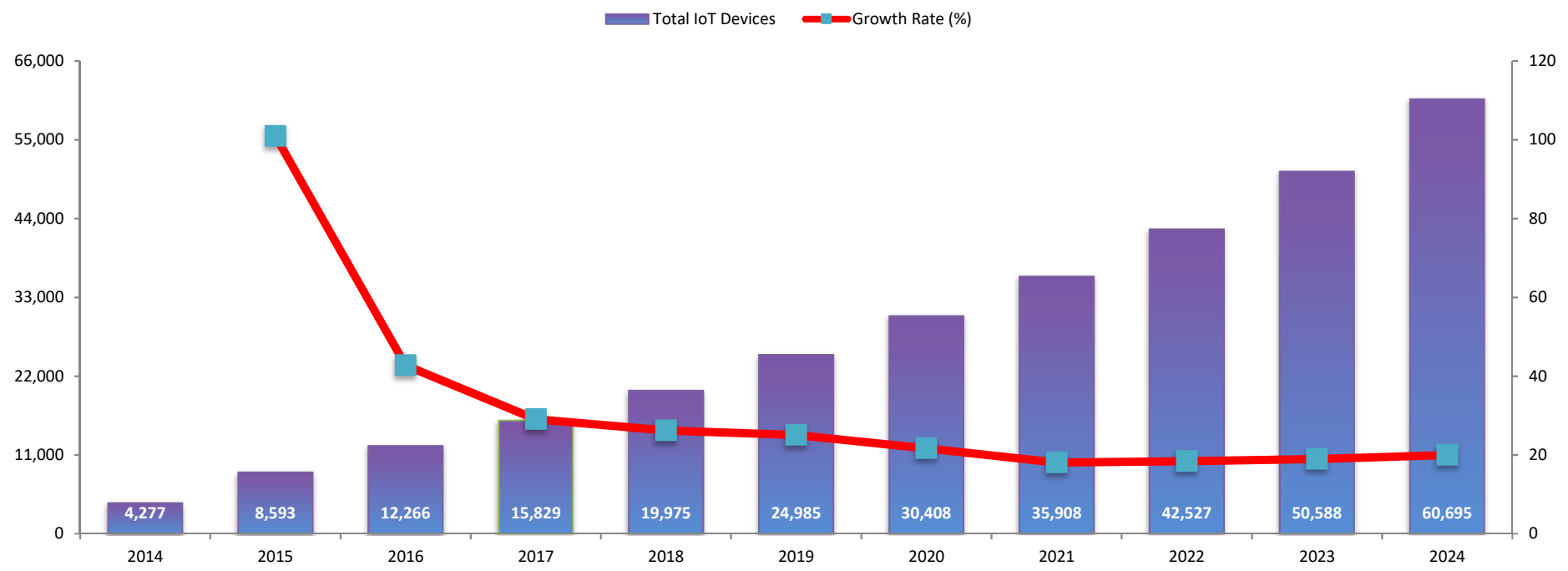


Source: Frost & Sullivan

Growth Driven by Data – Big Data Story in Numbers



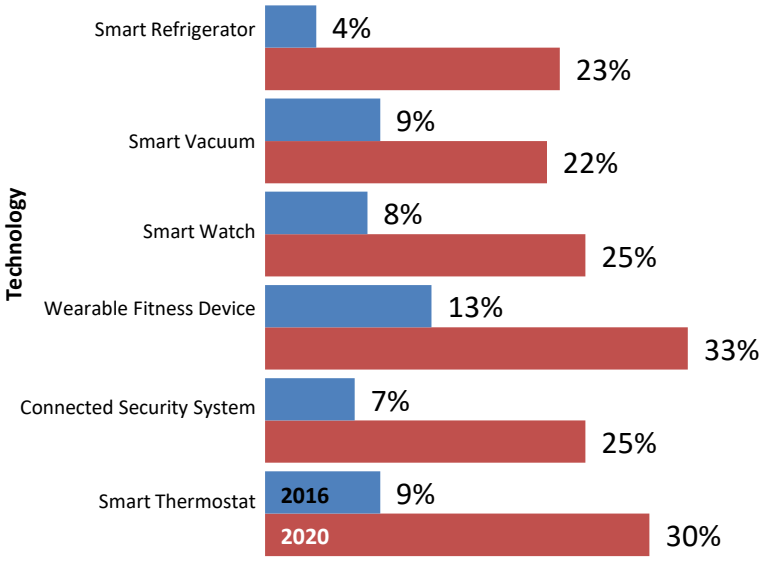
IoT Device Market Size and Forecast (Global), 2014-2024



Source: Frost & Sullivan; all figures rounded; values in millions; Total devices = all types of connectivity

Connected Home, a $120 Billion American Market in 2020

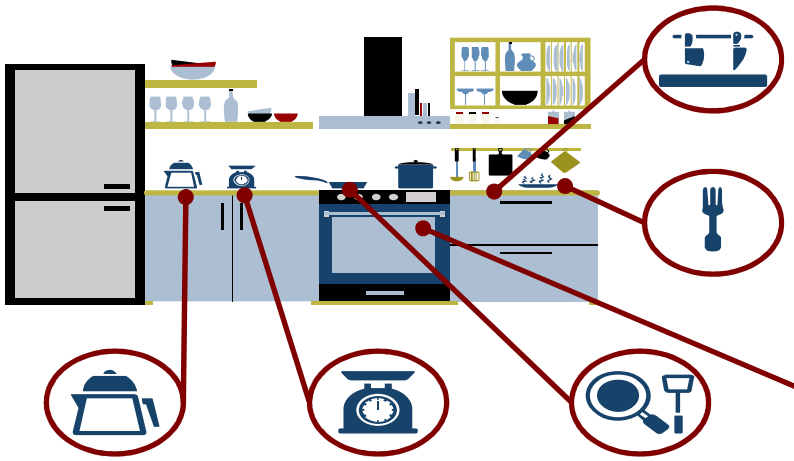
Consumer Adoption Rates of Smart Technology, US, 2016 and 2020



Companies, such as Google, use machine learning algorithms to refine the operation of data systems, improving efficiency by **15 to 25%.**

The Connected Kitchen

The connected kitchen links kitchen gadgets to information on the Internet, contributing at least **15% savings** in the food and beverage industry by 2020.



Smart Countertop
Calculates nutrient values in the food

Smart Fork
Monitors how much and how long it takes to eat

Smart Coffee Pot
Controls the start of brewing from a cellphone

Smart Scale
Links quantity values to a cellphone via Bluetooth

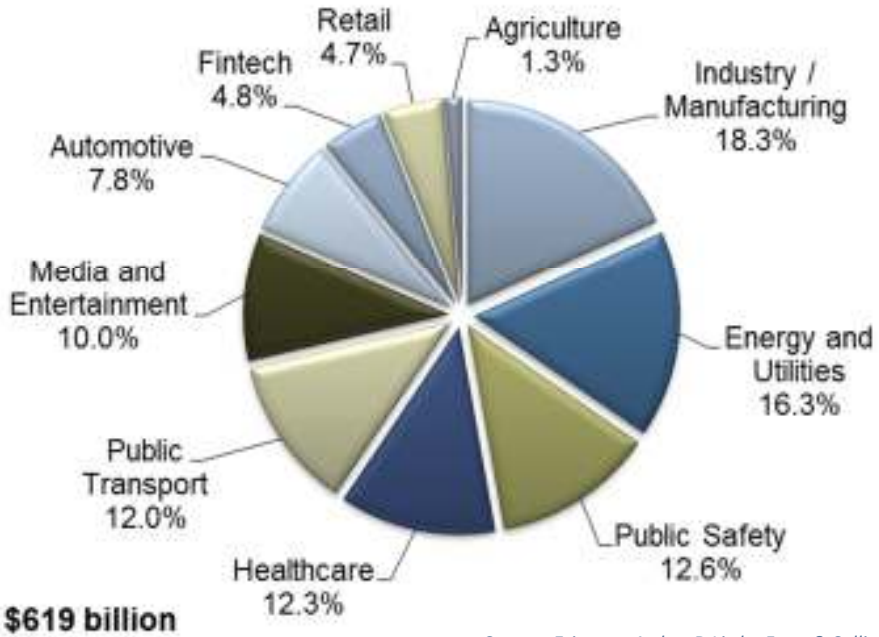
Smart Frying Pan
Automates temperature control according to food

Smart Oven
Offers product-regulated heat and timer monitoring

Source: Harvard Business Review; Acquity Group; Frost & Sullivan

5G: Going Far Beyond Cellphones to Enable Massive IoT

5G Opportunities for Telecom Operators, Global, 2026



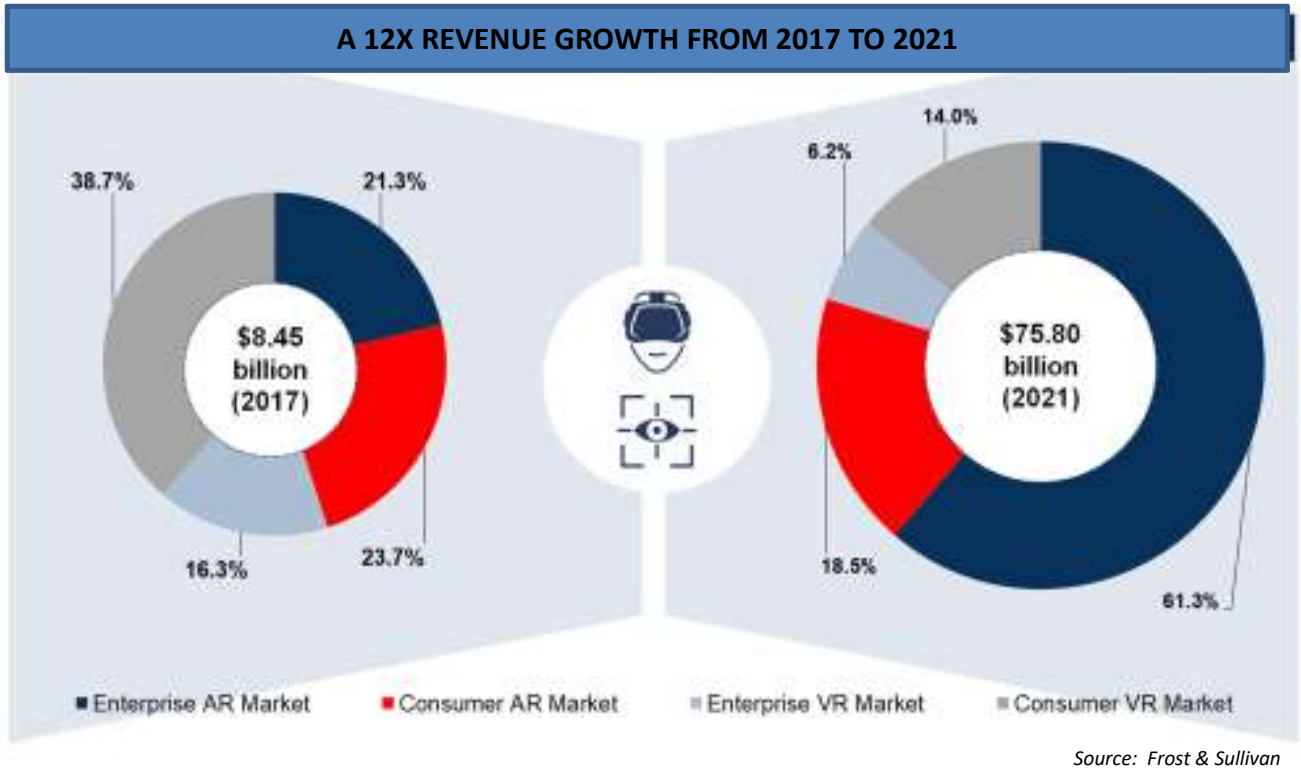
Total = $619 billion

Source: Ericsson, Arthur D Little, Frost & Sullivan

Almost $620 billion in applications revenues by 2026

- ❑ Smart meters, grid management
- ❑ Supply chain monitoring
- ❑ Telemedicine, remote diagnostics, health telemetry
- ❑ Traffic monitoring, enhanced navigation systems

Digital Reality Enables Immersive Experiences



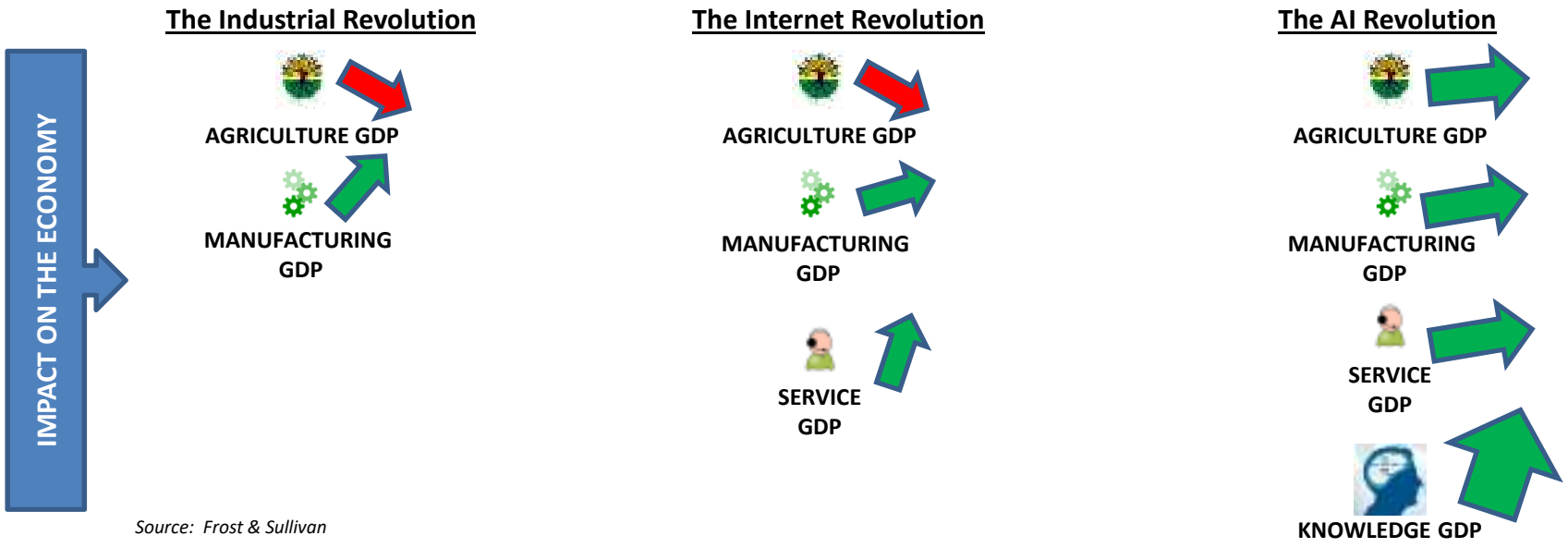
Source: Frost & Sullivan

The Big Winners for A/R: **Defense, Automotive, Manufacturing**

The Big Winners for V/R: **Entertainment and Gaming**

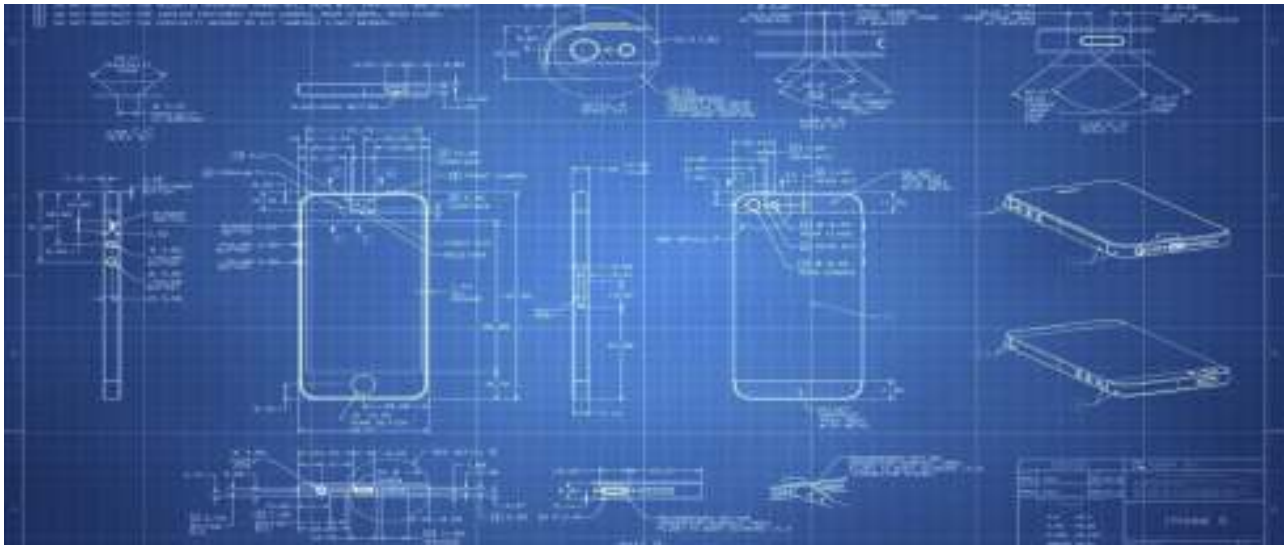
AI Disrupts the Economy to Boost the Knowledge GDP

"AI could potentially create **$3.5 trillion** to **$5.8 trillion** in annual value in the global economy."
McKinsey Global Institute (2018), Notes from the AI frontier: Insights from hundreds of use cases

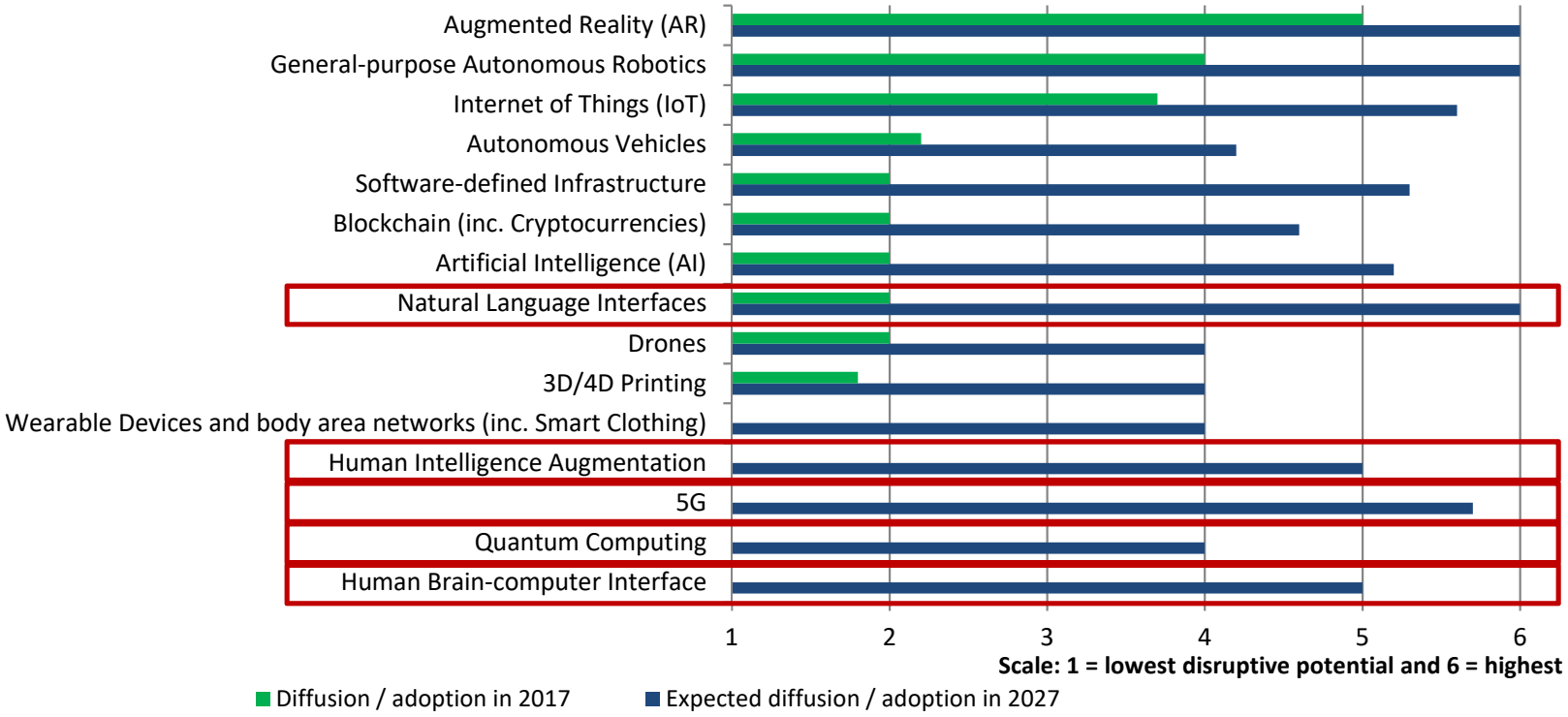


Source: Frost & Sullivan

Tomorrow’s Growth Drivers



The Engines of Digital Disruption (1Q2018)

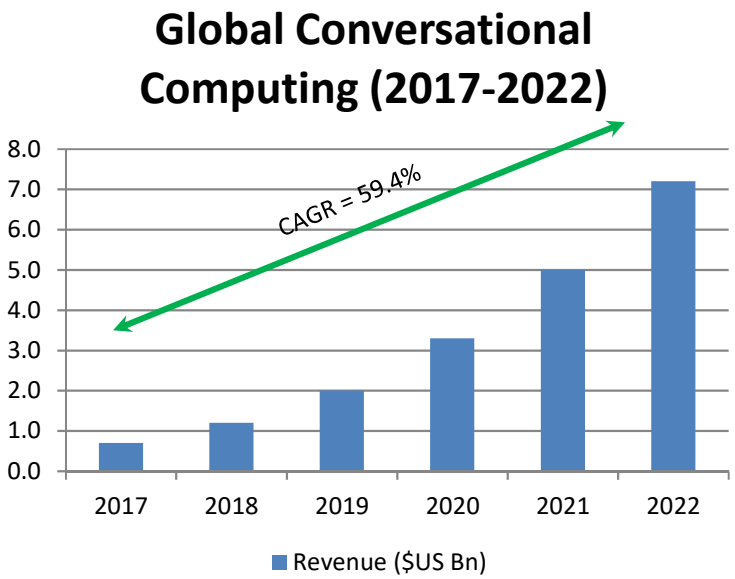


Q: Please estimate for the following technologies [you previously indicated as most disruptive in your industry] their current adoption and expected adoption in 2027 in your industry N = 105

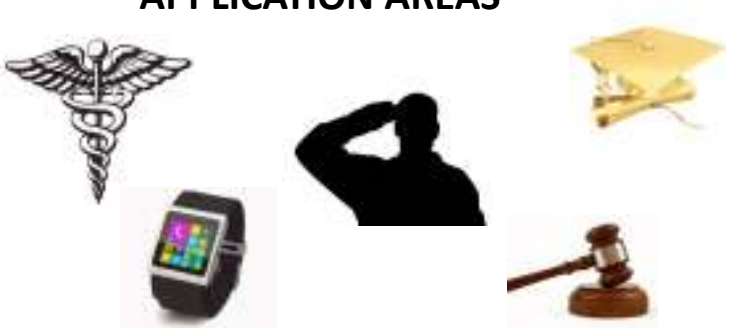
Source: Frost & Sullivan

OK Computer: The Rise of Conversational Computing

NLP and AI-Enabled Voice Assistants

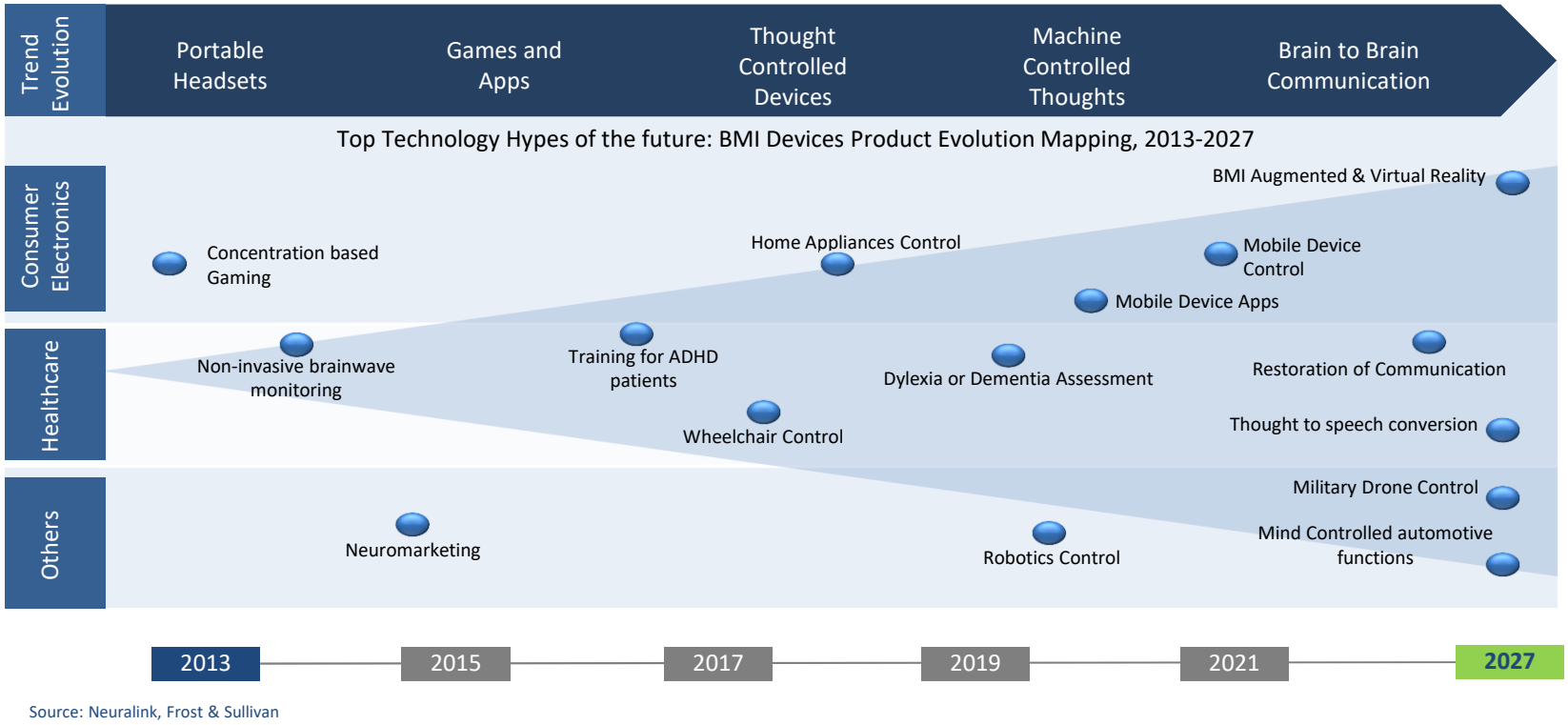


APPLICATION AREAS



Source: Frost & Sullivan. "OK Computer" from Radiohead.

Taking it all in: Biology Meets Computing



Source: Neuralink, Frost & Sullivan

The Hopes and Promises of Quantum Computing

	Quantum Annealer	Analog Quantum	Universal Quantum
Computational Power	About the same as classical computers	Higher than classical computers	Much higher than classical computers

5,626 Patents and Patent Applications from 2007-2017

Top 7 Patent Holders (as of 09/2017)

1. D-Wave Systems (406)
2. Toshiba Corp. (258)
3. IBM Corp. (179)
4. Northrop Grumman Corp. (177)
5. Microsoft Corp. (161)
6. NTT (154)
7. Mitsubishi Electric Corp. (96)

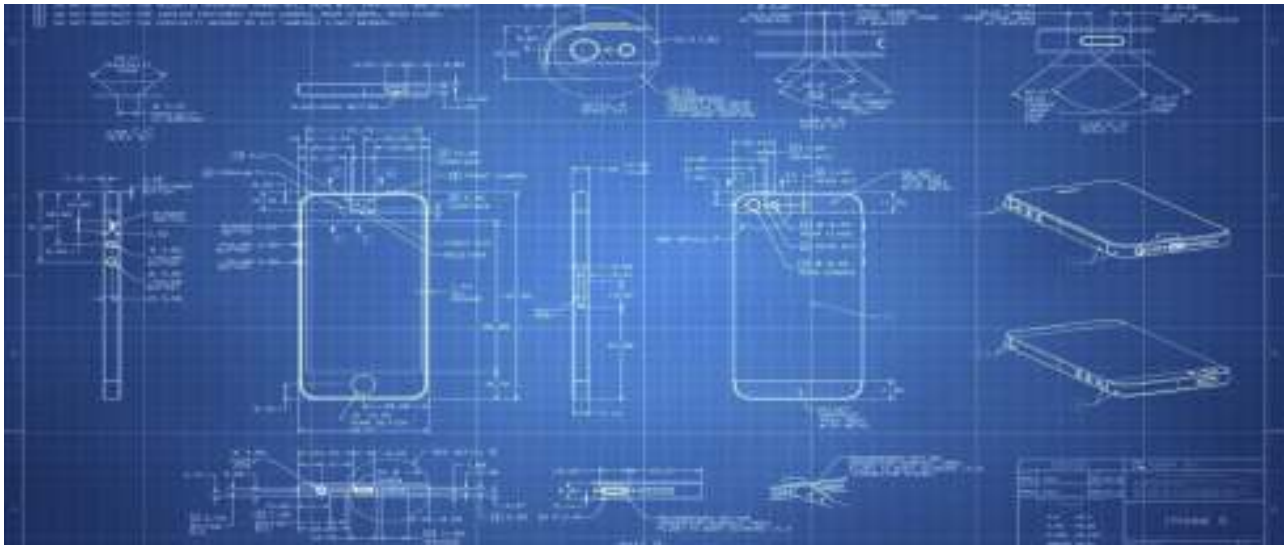
The Pace of Development is Accelerating

- From 2007-2013, an average of 387 patents were published annually.
- From 2104-2016, this pace almost doubled to an average of 734 patents published annually.

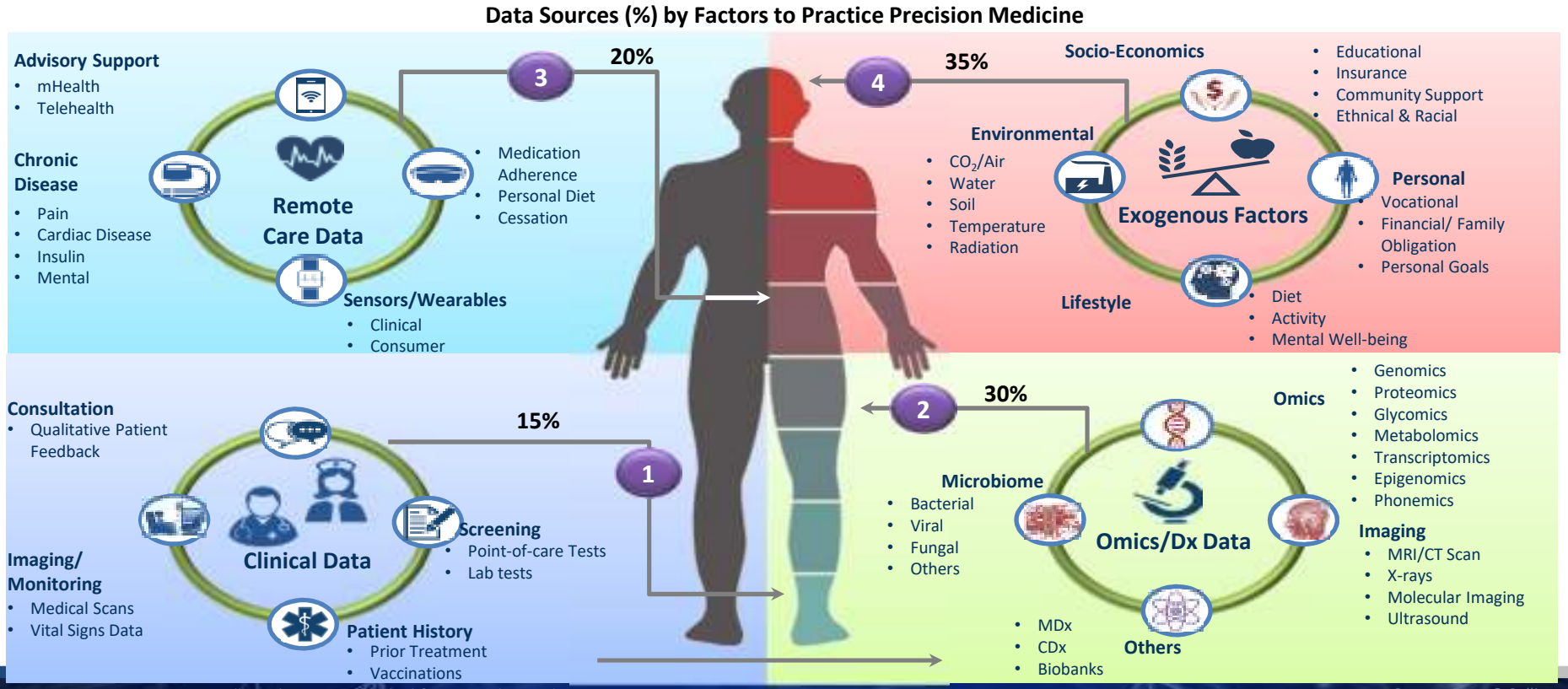
- "When quantum computing pans out, we'll be able to control the very building blocks of the universe." *Peter Diamandis, 2016*
- Implications for Enterprise
  - Reimagine analytic workloads
  - Hybrid HPC-quantum computing architectures
- Revenue forecasts range from a few billions to tens of billions by 2025.

Sources: IBM Research, Deloitte, Frost & Sullivan

The Big Picture of Growth



Precision Medicine for Anyone



Note: Data sources not mutually exclusive to individual factors and not exhaustive in nature

Source: Frost & Sullivan

Feeding a World of Eight Billion

Autonomous Machinery

Urban Hydroponic Farm

Agricultural AI

The cost of food production and distribution needs to be substantially reduced.

- **Drones** in crop monitoring and management, water management and pest control. Developing areas can skip mechanization, fresh food can be produced quickly and cheaply in urban areas.
- **Unmanned agriculture equipment** for planting, fertilization and harvesting.
- **Hydroponic farms** can be show higher yields than traditional farms, reduce distribution and storage costs in urban centers.
- **Agile agricultural robots** in hydroponic farms to reduce labor costs and raise productivity.
- **3D printing** for meat and other foodstuffs used for emergency and remote applications.
- **AI** will be used to coordinate production (drones, robots) and distribution (drones, unmanned trucks) across all types of farms to avoid local shortages or gluts. Geological and historical data used to improve yields.

Easing the Congestion of Commuting

Connected Vehicles

Mobility Integration

Autonomous Cars

Transportation is already starting to be disrupted by robotic vehicles, AI-controlled systems and a shift toward transportation as a service.

- **Self-Driving Cars** will see a steady adoption, first in commercial settings to lower labor costs and make long haul transport safer, then in consumer settings as regulatory and insurance pressures seek to lower accidents and costs.
- **Access wins out over ownership** means fewer people will buy their own cars, opting to take advantage of on-demand access to transportation (TaaS).
- **AI** will form a single network of transportation. The AI will provide better-than-human route optimization and will actively route, and reroute, vehicles in real-time. AI-controlled transportation systems will reduce traffic congestion while increasing average road speeds.
- **Connected homes and wearable sensors** will collect data to be analyzed by the AI for predicting transportation demand, and will update demand in real-time for morning and evening commutes.

What's Restraining Growth Driven by Digital Transformation?

My experience with emerging and disruptive technologies tells me that we all tend to think they will adopted more quickly than they end up being adopted... these three (most game changing technologies) have some serious hurdles to get over before they become adopted.... **most of which are people/cultural related hurdles**.

Sales & Marketing Executive, USA

Source: Frost & Sullivan


Brian Cotton
bcotton@frost.com
https://www.linkedin.com/in/briancotton1/