ITIF | INFORMATION TECHNOLOGY & INNOVATION FOUNDATION

May 12, 2016

IoT and Smart Manufacturing

Swedish Agency for Growth Policy Analysis

Stephen Ezell
Vice President, Global Innovation Policy
Information Technology and Innovation Foundation

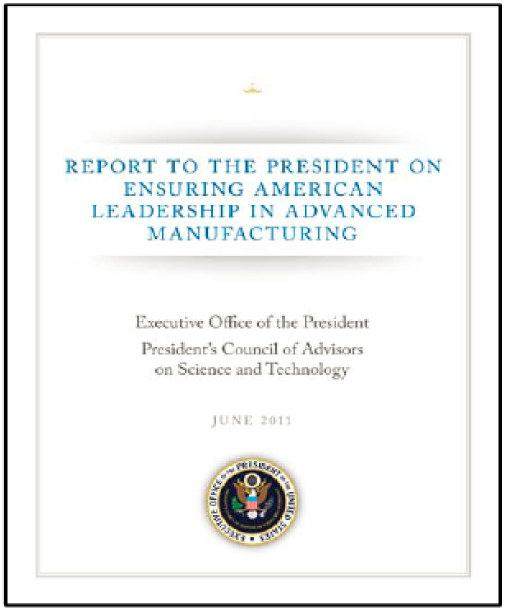
ITIF
INFORMATION TECHNOLOGY & INNOVATION FOUNDATION

Today's Presentation

1	U.S. Advanced Manufacturing Policy
2	Digital Manufacturing & Internet of Things
3	Internet of Things Policy Issues

Obama Administration Focus on Mfg. Policy

Partnership – Academia, Industry, Government

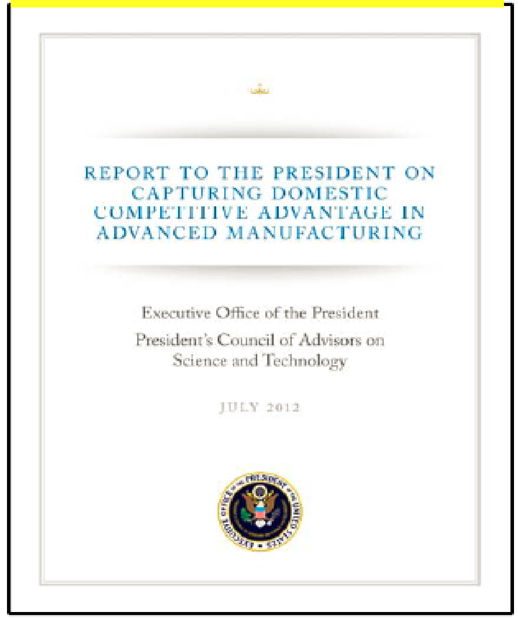

REPORT TO THE PRESIDENT ON ENSURING AMERICAN LEADERSHIP IN ADVANCED MANUFACTURING

Executive Office of the President
President's Council of Advisors on Science and Technology

JUNE 2011

PCAST 2011
Recommends Advanced Manufacturing Initiative as national innovation policy

NNMI as strategic investment

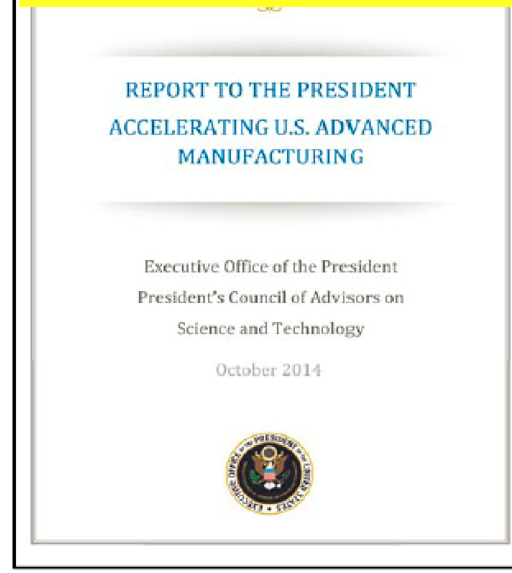

REPORT TO THE PRESIDENT ON CAPTURING DOMESTIC COMPETITIVE ADVANTAGE IN ADVANCED MANUFACTURING

Executive Office of the President
President's Council of Advisors on Science and Technology

JULY 2012

PCAST 2012
Recommends Manufacturing Innovation Institutes to address key market failure

Mforesight as technology voice of adv. mfg sector


REPORT TO THE PRESIDENT
ACCELERATING U.S. ADVANCED MANUFACTURING

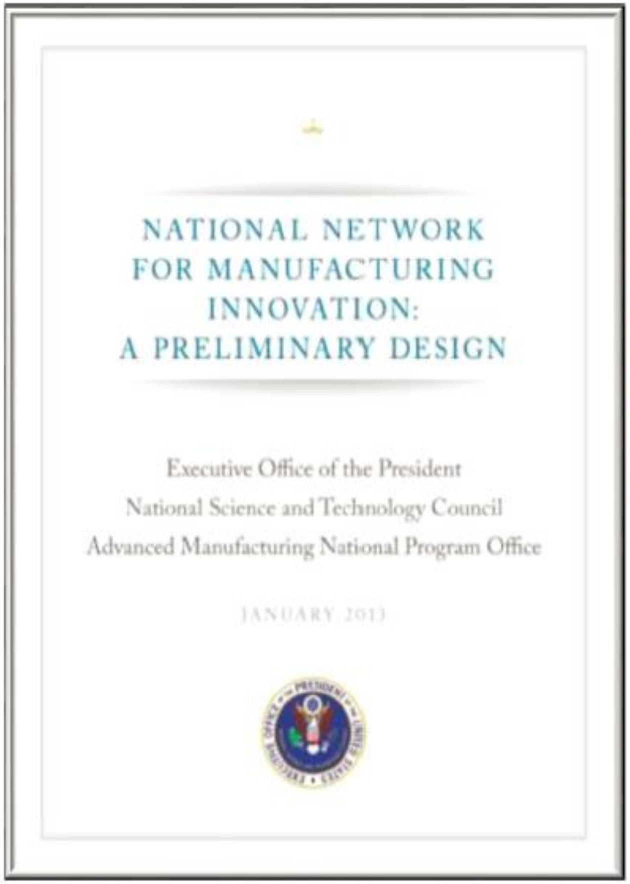
Executive Office of the President
President's Council of Advisors on Science and Technology

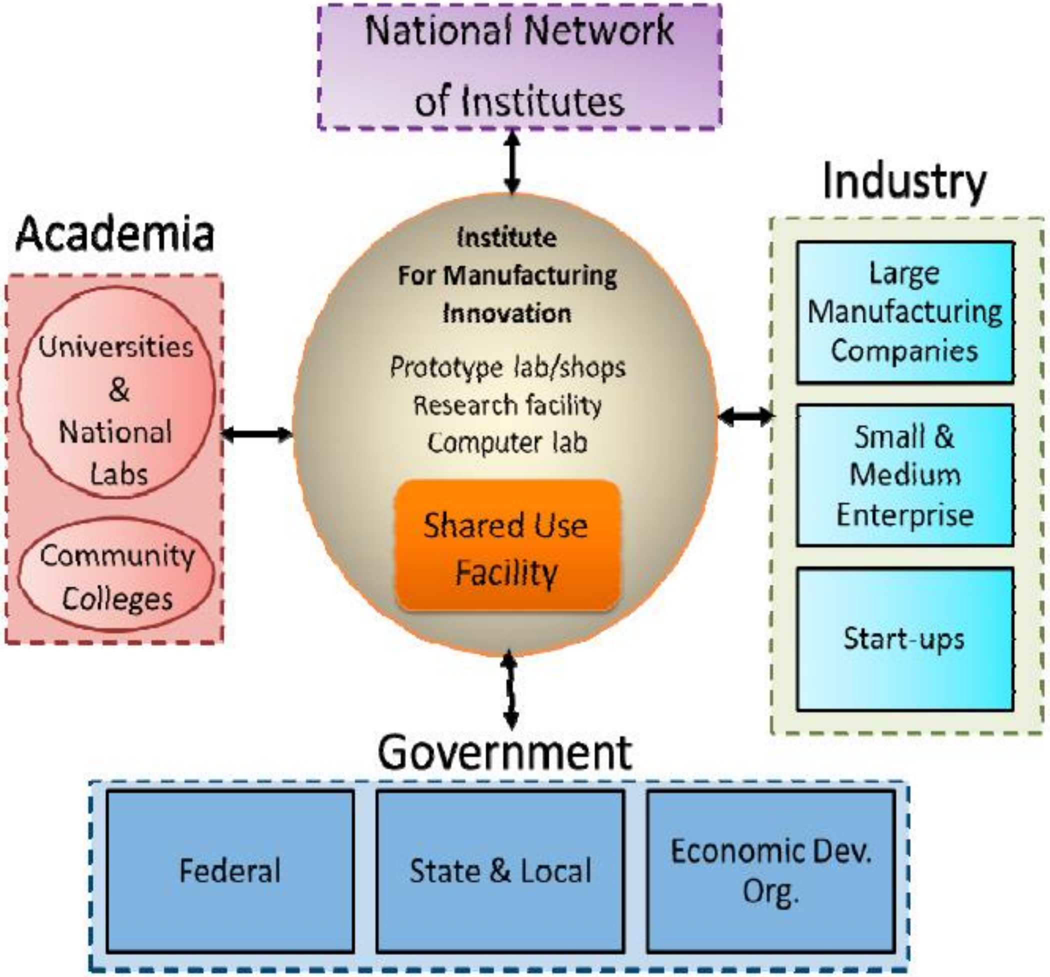
October 2014

PCAST 2014
Recommends strong, collaborative network of Manufacturing Innovation Institutes

The National Network for Manufacturing Innovation

White House Report
NNMI Framework Design
January 2013





Building Out the NNMI Network

America Makes
Additive
Manufacturing
DOD–Youngstown OH

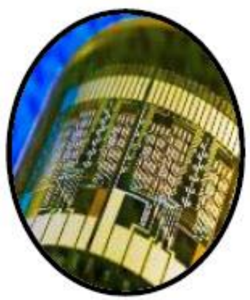
DMDII
Digital Mfg & Design
Innovation
DOD – Chicago IL

LIFT
Lightweight &
Modern Metals
DOD – Detroit MI

PowerAmerica
Power Electronics
Manufacturing
DOE – Raleigh NC

IACMI
Adv. Composites
Manufacturing
DOE – Knoxville TN

Integrated
Photonics
DOD-
Rochester NY



Flexible Hybrid
Electronics
DOD
Solicitation

Smart
Manufacturing
DOE
Award TBA

Revolutionary
Fibers & Textiles
DOD
Award TBA

Open-Topic
NIST
Solicitation

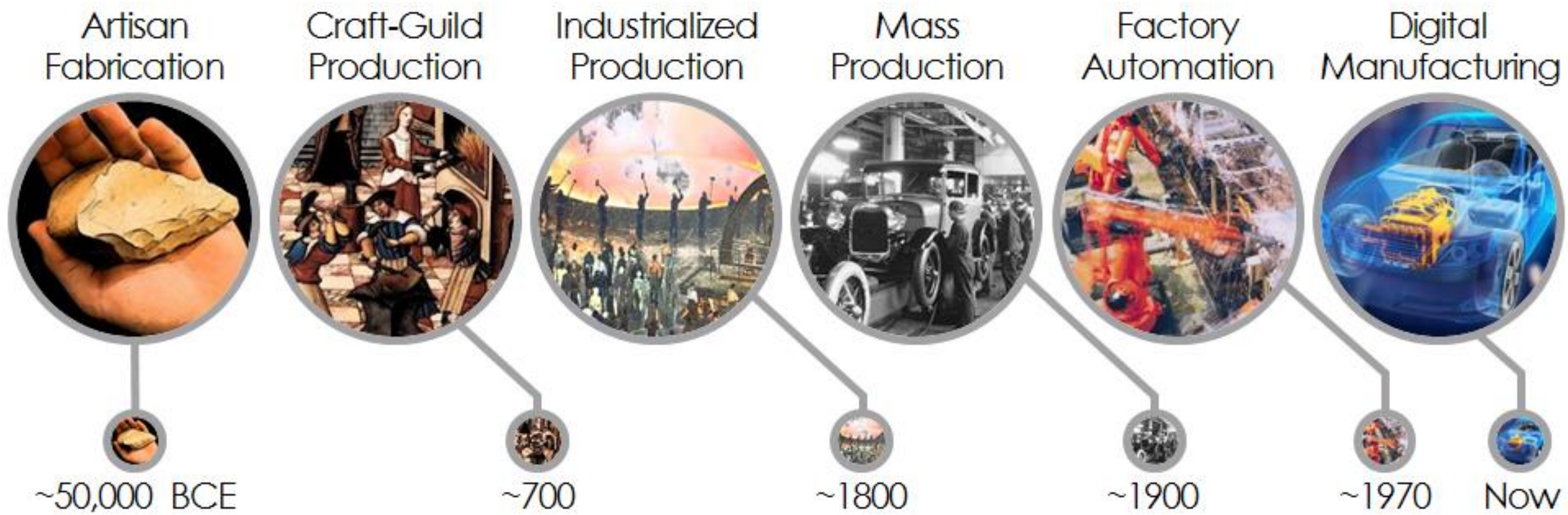
Today's Presentation

1 U.S. Advanced Manufacturing Policy

2 Digital Manufacturing & Internet of Things

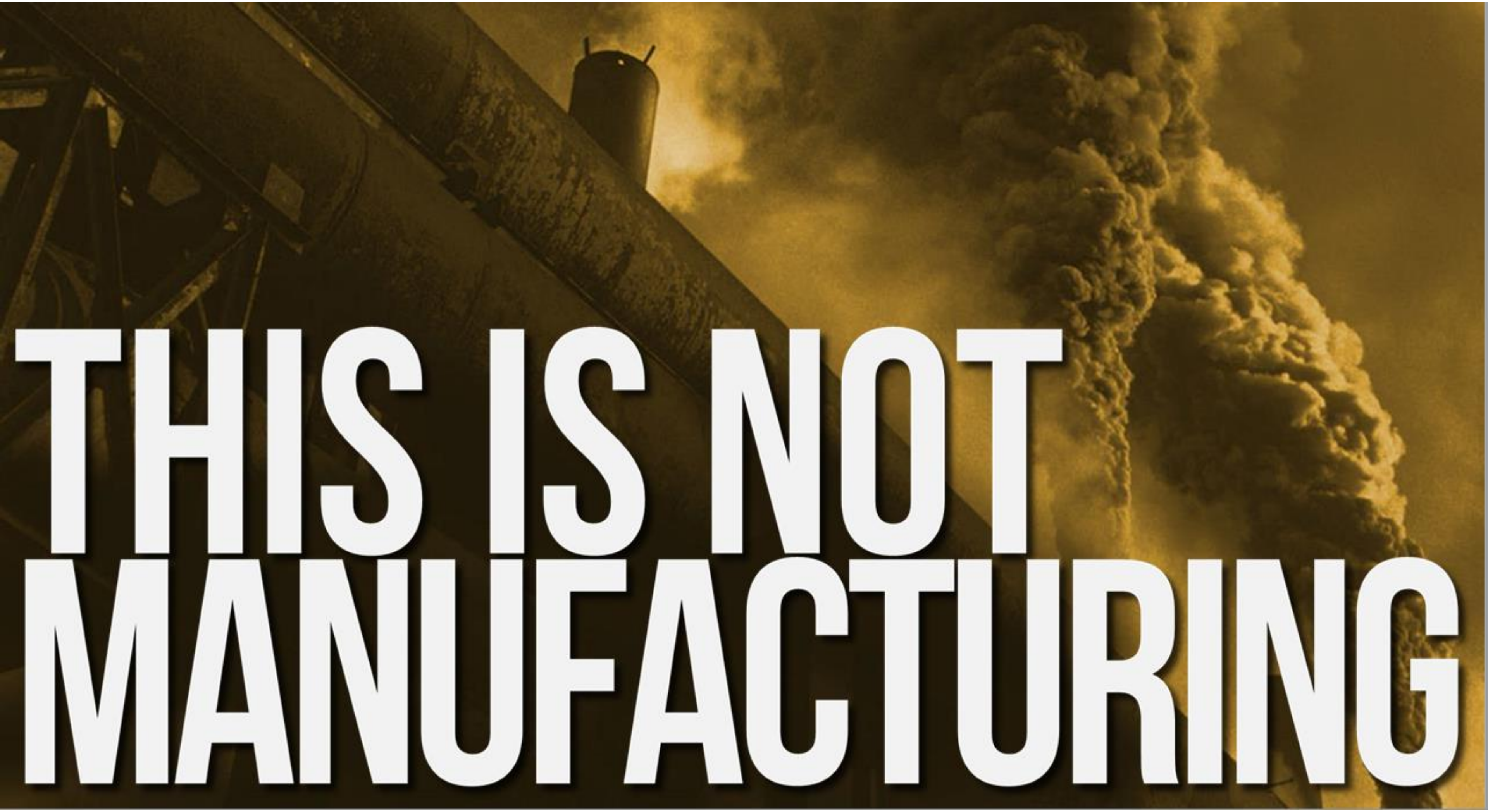
3 Internet of Things Policy Issues

MANUFACTURING PARADIGMS CHANGE



These advances trigger Innovation Bursts.

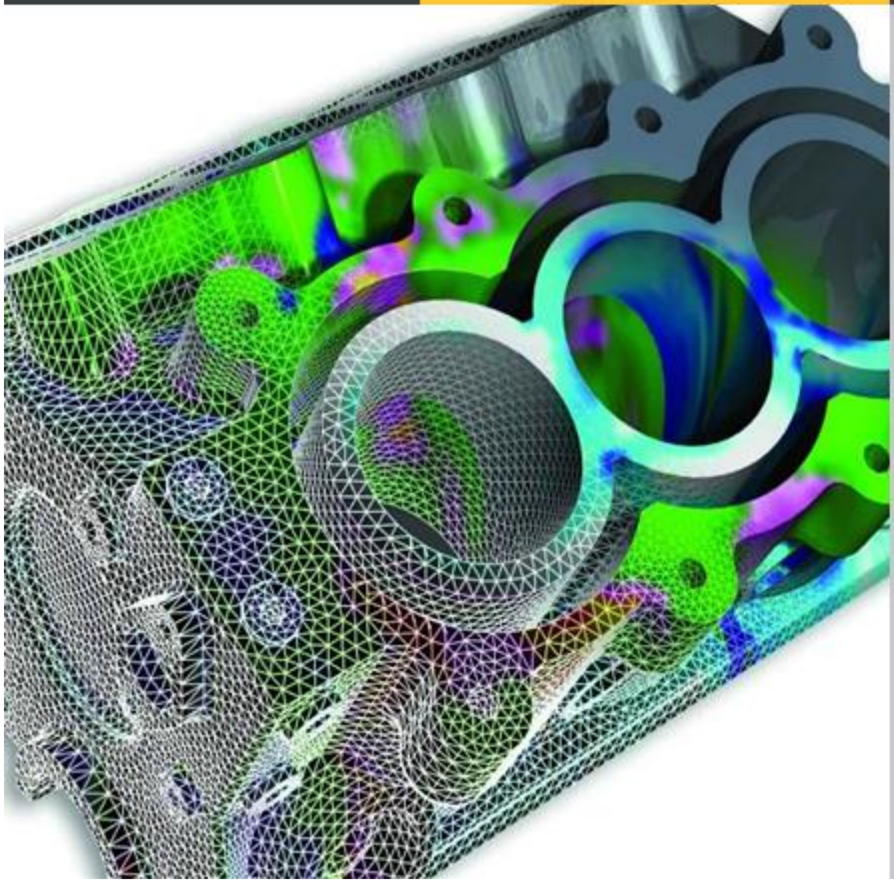
Source: Rebecca Taylor, National Center for Manufacturing Sciences, *Do It In Digital: Virtualization and Tomorrow's Manufacturing*


THIS IS NOT
MANUFACTURING


THIS IS
MANUFACTURING


AND
TOMORROW, THIS

TALK DIGITAL TO ME



Tomorrow's manufacturing is
Smart, Digital Manufacturing:

Big Data

Predictive Analytics

Virtualized Processes

Modeling & Simulation

High-Performance Computing

Robotics

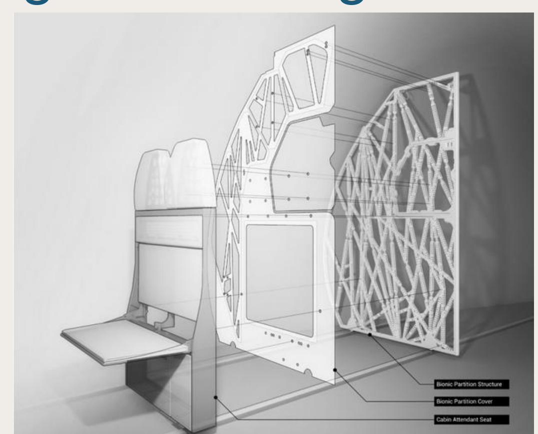
"Smart manufacturing" will generate $371 billion in net global value over the next 4 years: by 1) creating value from data and 2) streamlining design processes, factory operations, and supply chain risks. (IDC)

Smart Manufacturing & Smart Design

Engineering processes like **design**, **testing**, and **optimization** can only go so fast in the physical world.

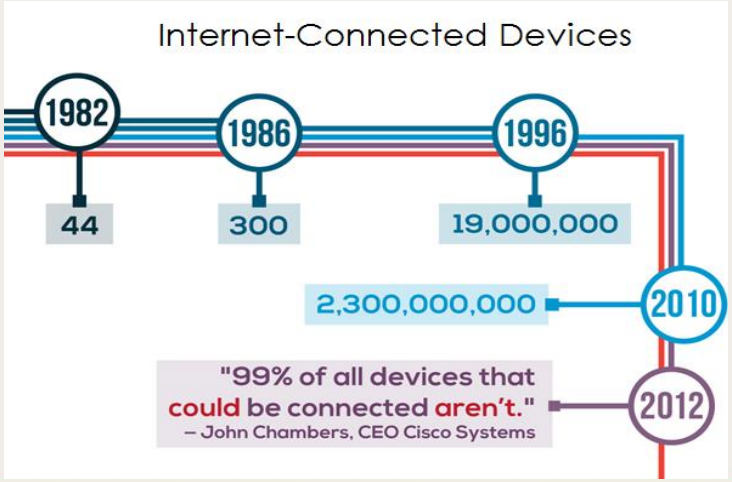
- Autodesk's Project Dreamcatcher: "Algorithmically generated" design software allows designers to generate designs based on a list of material and performance requirements.

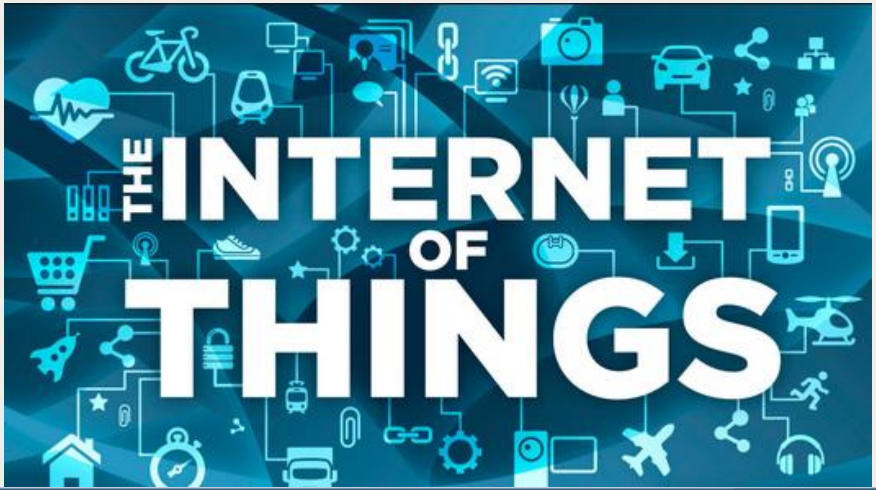
- Airbus and Boeing use such "generative design" modeling and simulation tools.



The Internet of Things (IoT)

- By 2020, somewhere from 26 to 50 billion “things” connected to the Internet.
- Cost of sensor technologies have declined 100X last 10 years.
- In the past three years, the number of sensors shipped has increased more than five times from 4.2 billion in 2012 to 23.6 billion in 2014.





Mfg. Poised to See Biggest Gains from IoT

Potential economic impact of IoT in 2025, including consumer surplus, is $3.9 trillion to $11.1 trillion

Low estimate / High estimate

Size in 2025[1]
$ billion, adjusted to 2015 dollars

Total = $3.9 trillion–11.1 trillion

Settings	Size in 2025	Major applications
Human	170–1,590	Monitoring and managing illness, improving wellness
Home	200–350	Energy management, safety and security, chore automation, usage-based design of appliances
Retail environments	410–1,160	Automated checkout, layout optimization, smart CRM, in-store personalized promotions, inventory shrinkage prevention
Offices	70–150	Organizational redesign and worker monitoring, augmented reality for training, energy monitoring, building security
Factories	1,210–3,700	Operations optimization, predictive maintenance, inventory optimization, health and safety
Worksites	160–930	Operations optimization, equipment maintenance, health and safety, IoT-enabled R&D
Vehicles	210–740	Condition-based maintenance, reduced insurance
Cities	930–1,660	Public safety and health, traffic control, resource management
Outside	560–850	Logistics routing, autonomous cars and trucks, navigation

Source: McKinsey Global Institute, *The Internet of Things: Mapping the Value Beyond the Hype*

The Internet of Things & Manufacturing

- IoT applications in mfg. and factory settings expected to generate $1.2 to $3.7 trillion of economic value annually by 2025.
- *IoT will revolutionize manufacturing processes*.
- *IoT will revolutionize manufactured products and product systems*.

IoT and Manufacturing Processes

IoT will generate 4 primary forms of value in terms of manufacturing processes:

1. Supply Chain Management;
2. Operating Efficiency;
3. Predictive Maintenance;
4. Inventory Optimization.

IoT and Supply Chain Management

- IoT can help manufacturers better manage their supply chains.
  - BMW: Knows the real-time status of all machines producing all parts/components from all suppliers going into vehicles.
  - Toyota: Reduces recalls by knowing exactly what machine produced which components of which vehicles.
  - HP: Integrates network analysis and data visualization into its supply chain management and monitoring; has reduced the time for supply chain management projects by up to 50%.

IoT and Manufacturing Operating Efficiency

- IoT provides manufacturers a comprehensive view of what's occurring at every point in the production process and helps make real-time adjustments.
- Will increase manufacturing productivity by 10-25%.
- Producing up to $1.8 trillion in global economic value by 2025.

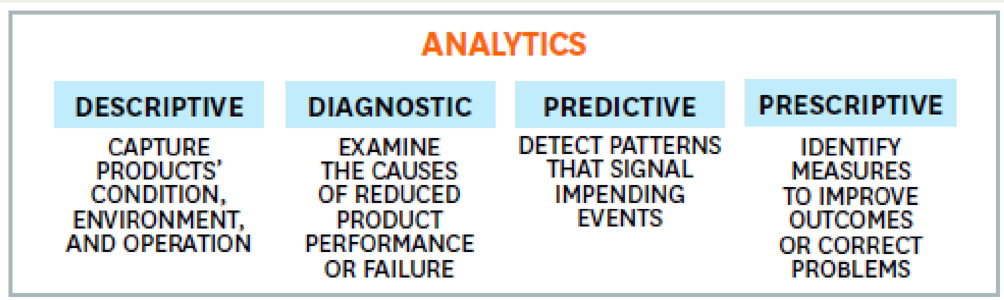
IoT and Manufacturing Operating Efficiency

Explosion of low-cost sensor technologies has made every manufacturing process and component a potential data source.

- Ford: Placed sensors on virtually every piece of production equipment at its River Rouge facility.
- GM: Uses sensors to monitor humidity conditions during vehicle painting; if unfavorable, the work piece is moved elsewhere in plant or ventilation systems adjusted.
- Raytheon: Keeps track of how many times a screw has been turned in its factories.
- Merck: Improves vaccines by conducting up to 15 billion calculations to determine what environmental and process factors influence quality of final product.

IoT and Predictive Maintenance

- *Monitor the status of production equipment in real-time.*
  - Intel: Uses predictive modeling to anticipate failures, prioritize inspections, and cut monitoring costs, save $3M.
  - Ford: Downstream machines can detect if work pieces they receive are off in a particular minute dimension, indicating possible problems in upstream machines.
  - GE "Brilliant Factories" initiative doubled production of defect-free dishwashers and washing machines.



IoT and Predictive Maintenance

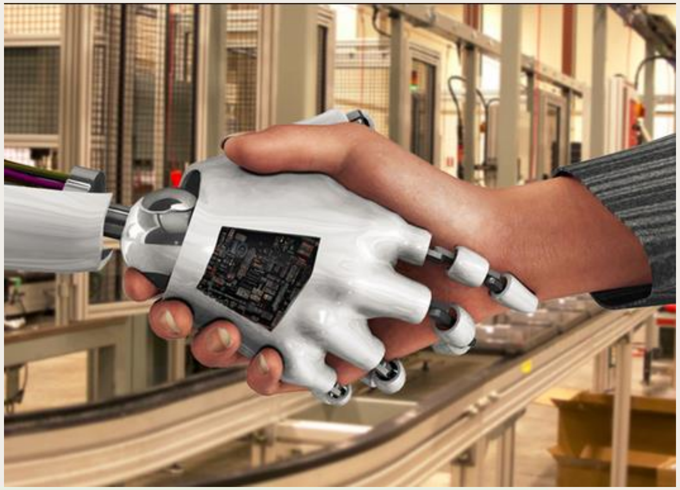
- IoT expected to reduce factory equipment maintenance costs by up to 40%.
- Expected to reduce equipment downtime by up to 50% and is expected to reduce capital equipment investment costs 5%.
- Generating economic value of $630B annually by 2025.

IoT and Inventory Optimization

- IoT helps manufacturers better manage inventory.
- Wurth USA: Developed an "iBins" system that uses intelligent camera technology to monitor the fill level of a supply box and wirelessly transmit the data to an inventory management system that automatically reorders supplies.
- IoT can drive inventory optimization measures that can save 20 to 50% of factory inventory carrying costs.

Other IoT Apps. In Mfg. Processes

- Safety: IoT applied to devices and workers (e.g., badges) can alert or even halt equipment if in too close of proximity.
- Leveraging data on factory equipment for usage-based design (improve equipment performance or reduce parts needed.)



IoT & Smart Manufactured Products

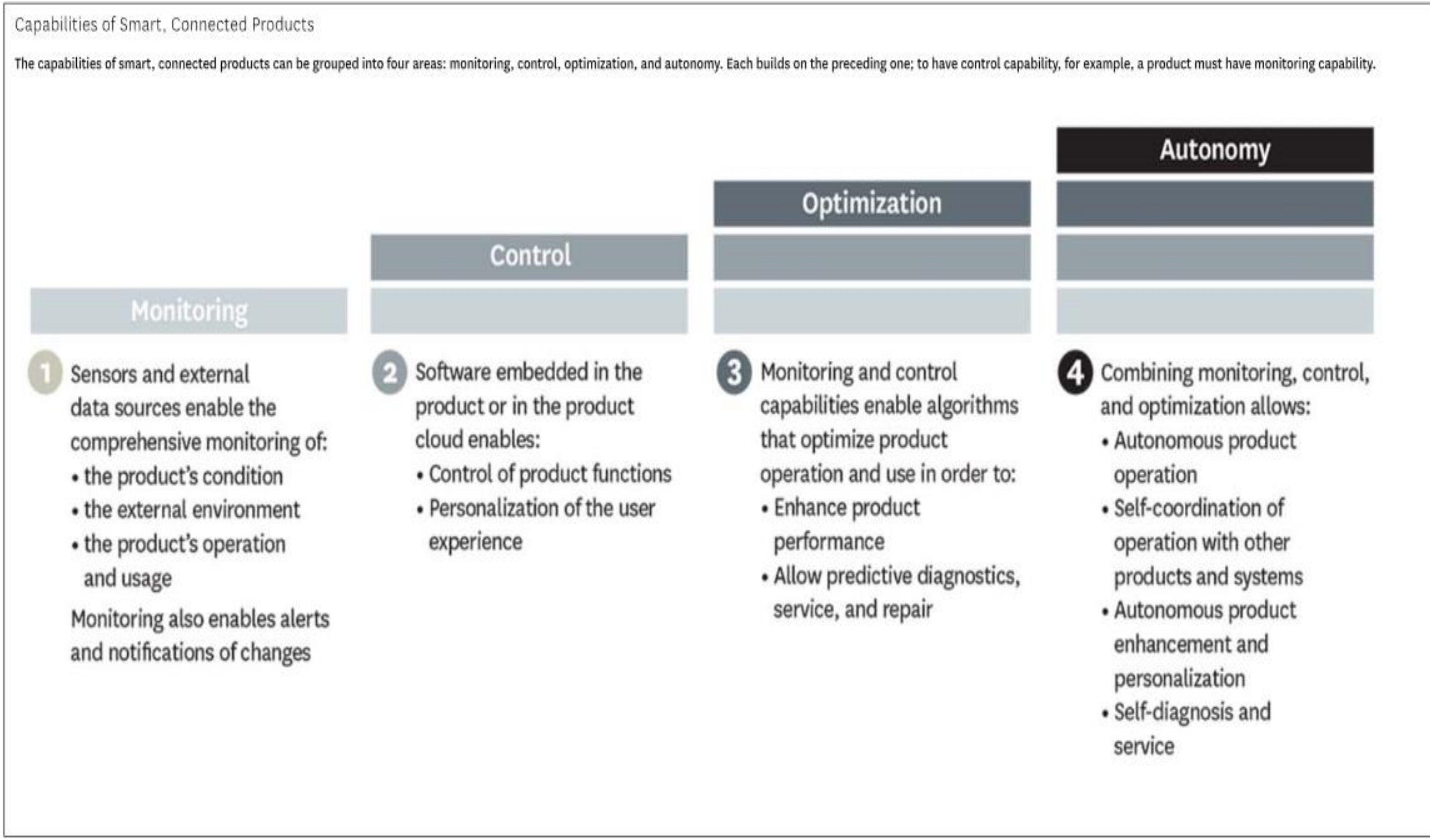
All “smart products” share three key components:

1. *Physical components*: E.g., Mechanical and electrical parts.

2. *Smart components*: E.g., sensors, microprocessors, data storage, controls, software, an embedded operating system, and a digital user interface.

3. *Connectivity components*: E.g., Wireless connectivity, ports, antennas, etc.

Maturity Scale for Smart Manufactured Products



Source: HBR, ***How Smart Connected Products are Transforming Competition,***
http://www.memex.ca/wp-content/uploads/A100129-How-Smart-Connected-Products-Are-Transforming-Competition.pdf

Designing Smart Manufactured Products

- *Design and Product Development*:
  - The mindset of those who design products will have to change from designing a product to designing products that operate within systems.
  - Product development will shift from being largely mechanical engineering to true interdisciplinary systems engineering.

Design Implications for Smart Mfg. Products

- *Low-Cost Variability: The software in smart, connected products can make variability far cheaper.*

  John Deere: Previously manufactured multiple versions of engines with differing horsepower levels, now it can alter horsepower of standard engines with software alone.

- *Evergreen Design: Continually upgrading of existing products.*

  ABB Robotics: Industrial machines can be remotely monitored and adjusted by end users during operation.

  Tesla: Has put an "autopilot" system in its cars with the intention of enhancing the system's capabilities over time through remote software updates.

Business Model Implications

- *Product Servification – Selling Products as a Service (PAAS)*

  Rolls Royce: Sell “power by the hour”
  GE Aircraft Engines: Sell “guaranteed thrust”
  Johnson Controls: Sell “chilled air at 72°”

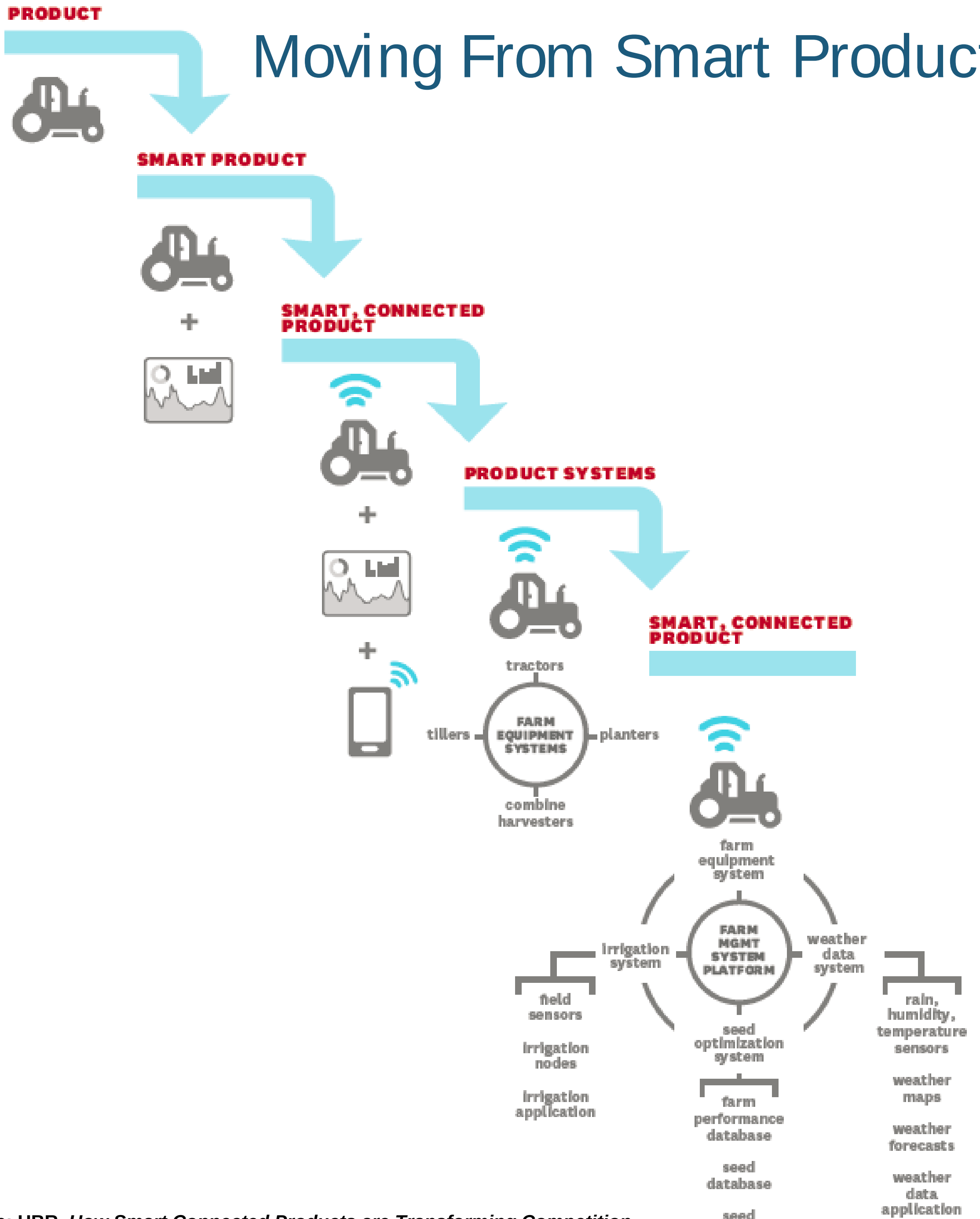
- *Product design/data capture essential for PAAS models*

  Xerox’s Managed Print Services:

  Turns a fixed cost into a variable cost for customers; has helped clients like P&G reduce paper use by 40% and cut costs 25%.

  Added sensors on the photoreceptor drum, feeder output tray, and toner cartridges to enable accurate accounting.

Moving From Smart Products to Smart Systems



Source: HBR, *How Smart Connected Products are Transforming Competition*

Countries' Smart Manufacturing Policies

Country	Smart Manufacturing Policy/Program	Investment Level
Austria	R&D projects associated with Industry 4.0	€250/$300 Million
China	*Made in China 2025 Program* *Implementation Plan for the 2016 Intelligent Manufacturing Pilots Special Project*	"Enormous"
Germany	To help industry associations, research institutes, and companies create Industry 4.0 implementation strategies.	€200/$300 Million
United Kingdom	High-Value Manufacturing Catapult, a network of seven advanced manufacturing technology institutes, including a Manufacturing Technology Centre (MTC).	£140/$220 Million (Over next 5 years)
European Union	Horizon 2020 allocates funds for "leadership in deploying key enabling and industrial technologies."	€16B/$23B (Total seven years to 2020)
United States	2 Related NNMIs – Digital Manufacturing and Design Innovation Institute (DMDII) and New Smart Manufacturing Institute	$140M in federal funds, matched 2:1

Today's Presentation

1 U.S. Advanced Manufacturing Policy

2 Digital Manufacturing & Internet of Things

3 Internet of Things Policy Issues

CENTER FOR DATA INNOVATION

Why Countries Need National Strategies for the Internet of Things

By Joshua New & Daniel Castro | December 16, 2015

The Internet of Things offers many opportunities to grow the economy and improve quality of life. Just as the public sector was instrumental in enabling the development and deployment of the Internet, it must play a similar role to ensure the success of the Internet of Things. Therefore, national governments should create comprehensive national strategies for the Internet of Things to ensure that the technology develops cohesively and rapidly, that consumers and businesses do not face barriers to adoption, and that both the private and public sector take full advantage of the coming wave of smart devices.

A national strategy for the Internet of Things, if designed and implemented correctly, would maximize the opportunity for the Internet of Things to deliver substantial social and economic benefits.

Traditionally, most Internet users have been people: individuals sending email, reading the news, shopping online, and the like. But in the near future, most users will be machines: a vast array of ordinary devices that are equipped with sensors and networking capabilities so they can collect and share data with people and other devices. In fact, we are already well on our way toward building the Internet of Things (IoT). As the cost of deploying smart devices declines, homes, factories, farms, office buildings, and even cities are generating vast quantities of data that can be collected, analyzed, and acted upon. Data from these connected devices is creating tremendous opportunities to generate economic and social benefits, ranging from sensor-equipped bridges that can alert authorities if there is a risk of structural failure to waterways that can warn environmental regulators about spikes of fatally toxic algae.[1]

Smart public policies that proactively support innovation—or carefully avoid doing harm by restraining from the impulse to regulate or if needed, regulating with a light touch—have been integral to the success of major

Why Countries Need a National IoT Strategy

1. IoT Suffers from Market Failures and Externality Effects

   E.g., Accrual of societal benefits depend on the broad adoption of IoT-enabled solutions (thermostats/health).
   E.g., Competitiveness Externalities

2. IoT Suffers from "Chicken-and-Egg" Challenges

   E.g., The success of many IoT apps depends on the success of complementary technologies/systems (e.g., energy/transit).

3. Interoperability and Standards-Setting Issues

   E.g. Governments have an important coordinating role to play in developing large-scale deployments of sensor networks and smart infrastructure that spans multiple jurisdictions.

Why Countries Need a National IoT Strategy

4. Workforce/Human Capital Gaps

   "By 2018, U.S. will face a shortage of up to 190,000 workers well-educated in data science and 1.5 million managers and analysts able to use data to make better decisions."

   Two-thirds of businesses say they lack "the human capital needed to effectively use new data."

5. Ensuring adequate radio spectrum and coherent regulatory approach.

Countries' National IoT Strategies

Country	Funding
China	$774 million over five years
India	$7.4 billion for smart cities
Germany	$221 million for smart factories
South Korea	$5 billion over five years
United States	$200 million

Table 1: Ongoing and recently launched government funding for the Internet of Things for select countries.

What Should National IoT Policies Address?

Funding

- Funding local government efforts to implement connected technologies and services;
- Funding large-scale national pilot projects for smart cities that focus on integrating multiple smart city applications with scalable and replicable solutions;[72]
- Establishing national challenges with prizes to spur the development of IoT applications with high social or economic impact;
- Subsidizing key connected devices for low-income populations;[73]
- Funding R&D for key underlying technological challenges relevant to the Internet of Things, such as improving cyber security and reducing power consumption; and
- Establishing government-backed venture capital funding for promising connected technologies that could benefit public sector operations.

Source: Dan Castro and Josh New, Center for Data Innovation, *Why Countries Need National Strategies for the Internet of Things*

What Should National IoT Policies Address?

Convening and Planning

- Encouraging robust public-private partnerships for ambitious civic technology projects;
- Facilitating local government smart city deployments, such as by providing best practices and financing guides and freely accessible software tools;
- Coordinating public sector deployments of sensor networks, particularly for applications spanning multiple jurisdictions; and
- Encouraging the development of industry-led voluntary standards and best practices around issues like privacy and security.

Source: Dan Castro and Josh New, Center for Data Innovation, *Why Countries Need National Strategies for the Internet of Things*

What Should National IoT Policies Address?

Agency Action

- Requiring relevant government agencies to develop and follow Internet of Things action plans focused on improving agency mission delivery with connected technologies;
- Revising procurement and grant policies to encourage deployment of connected devices;
- Making "smart" the default for government operations, such as by requiring the use of connected technologies for customs inspections, integrating smart technologies into government-subsidized housing and agency buildings; and embedding sensor networks into infrastructure as part of modernization efforts;[74] and
- Supporting data science skills in high school and higher education.

Source: Dan Castro and Josh New, Center for Data Innovation, *Why Countries Need National Strategies for the Internet of Things*

What Should National IoT Policies Address?

Regulatory Action

- Allocating additional licensed and unlicensed spectrum for connected devices;
- Ensuring that any consumer protection rules are narrow and targeted;[75]
- Minimizing the regulatory cost of data collection;[76]
- Fast-tracking regulatory review and approval for smart devices in regulated industries, such as connected medical devices;[77]
- Enacting regulations to increase the potential for data-driven innovation from connected devices, such as by giving public utility consumers access to their smart meter data; and
- Revising accessibility requirements for people with disabilities based on the opportunities created by connected technologies, such as dynamically adjusting the amount of accessible parking spaces based on sensor data indicating demand.

Source: Dan Castro and Josh New, Center for Data Innovation, *Why Countries Need National Strategies for the Internet of Things*

What Should National IoT Policies Address?

Trade Policy

- Ensuring that companies can freely exchange data across local and national borders;
- Promoting access to the best and most cost effective connected devices and services, such as by eliminating policies that restrict the ability of international device manufacturers to enter domestic markets; and
- Supporting voluntary, industry-led standards and fighting against nation-specific standards.

Source: Dan Castro and Josh New, Center for Data Innovation, *Why Countries Need National Strategies for the Internet of Things*

ITIF | INFORMATION TECHNOLOGY & INNOVATION FOUNDATION

Thank You

Stephen Ezell
sezell@itif.org

Follow ITIF:

Twitter: @sjezell

Facebook: facebook.com/innovationpolicy

INNOVATION POLICY BLOG

Blog: www.innovationpolicy.org

Website: www.itif.org

ITIF
INFORMATION TECHNOLOGY & INNOVATION FOUNDATION