EE6223
Computer Control Networks
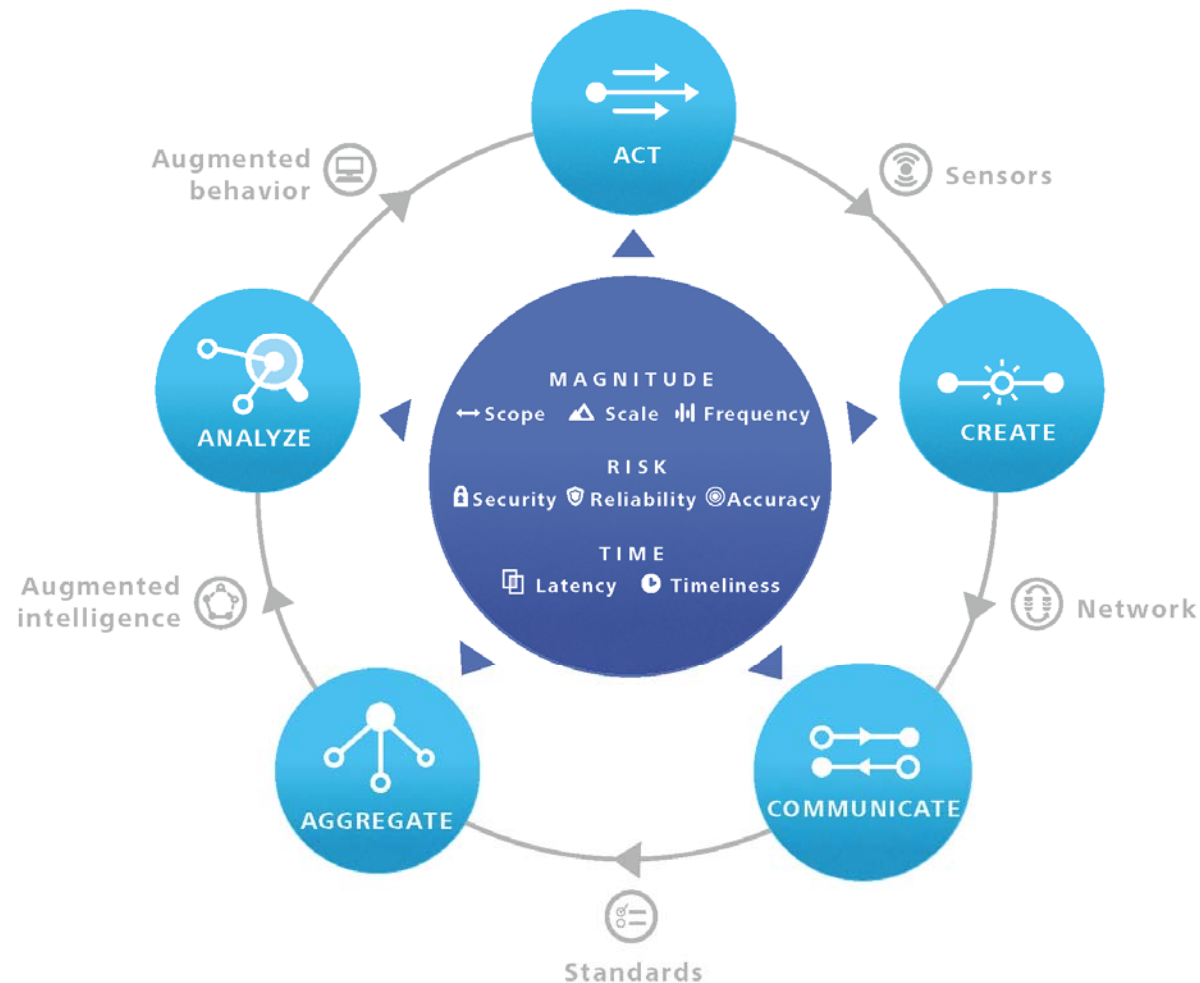
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INTERNET OF THINGS (IOT)

From http://dupress.com/collection/internet-of-things

Information Value Loop

Enabling Technologies

| Technology	Definition	Examples
Sensors	A device that generates an electronic signal from a physical condition or event	The cost of an accelerometer has fallen to 40 cents from $2 in 2006.[2] Similar trends have made other types of sensors small, inexpensive, and robust enough to create information from everything from fetal heartbeats via conductive fabric in the mother's clothing to jet engines roaring at 35,000 feet.[3]
Networks	A mechanism for communicating an electronic signal	Wireless networking technologies can deliver bandwidths of 300 megabits per second (Mbps) to 1 gigabit per second (Gbps) with near-ubiquitous coverage.[4]
Standards	Commonly accepted prohibitions or prescriptions for action	Technical standards enable processing of data and allow for interoperability of aggregated data sets. In the near future, we could see mandates from industry consortia and/or standards bodies related to technical and regulatory IoT standards.
Augmented intelligence	Analytical tools that improve the ability to describe, predict, and exploit relationships among phenomena	Petabyte-sized (10^{15} bytes, or 1,000 terabytes) databases can now be searched and analyzed, even when populated with unstructured (for example, text or video) data sets.[5] Software that learns might substitute for human analysis and judgment in a few situations.
Augmented behavior	Technologies and techniques that improve compliance with prescribed action	***Machine-to-machine*** interfaces are removing reliably fallible human intervention into otherwise optimized processes. Insights into human cognitive biases are making prescriptions for action based on augmented intelligence more effective and reliable.[6]

Sensors prices on the decline over the last 25 years
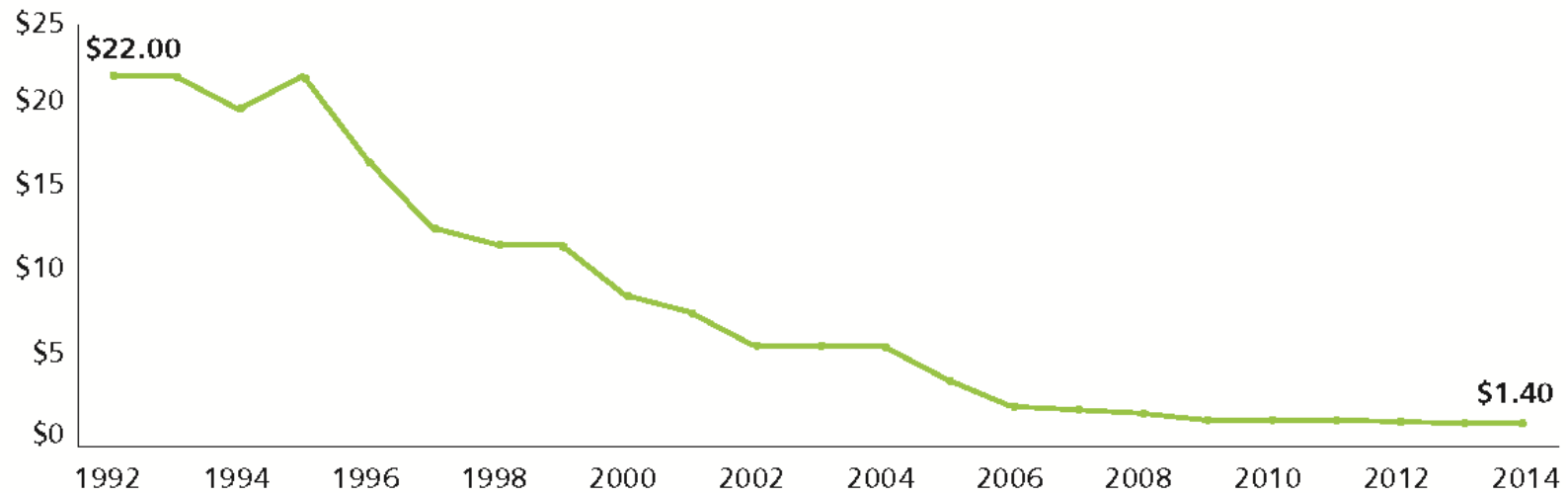
Note: Prices shown above are average selling prices for image sensors and accelerometers.

Computing speed continuously increasing
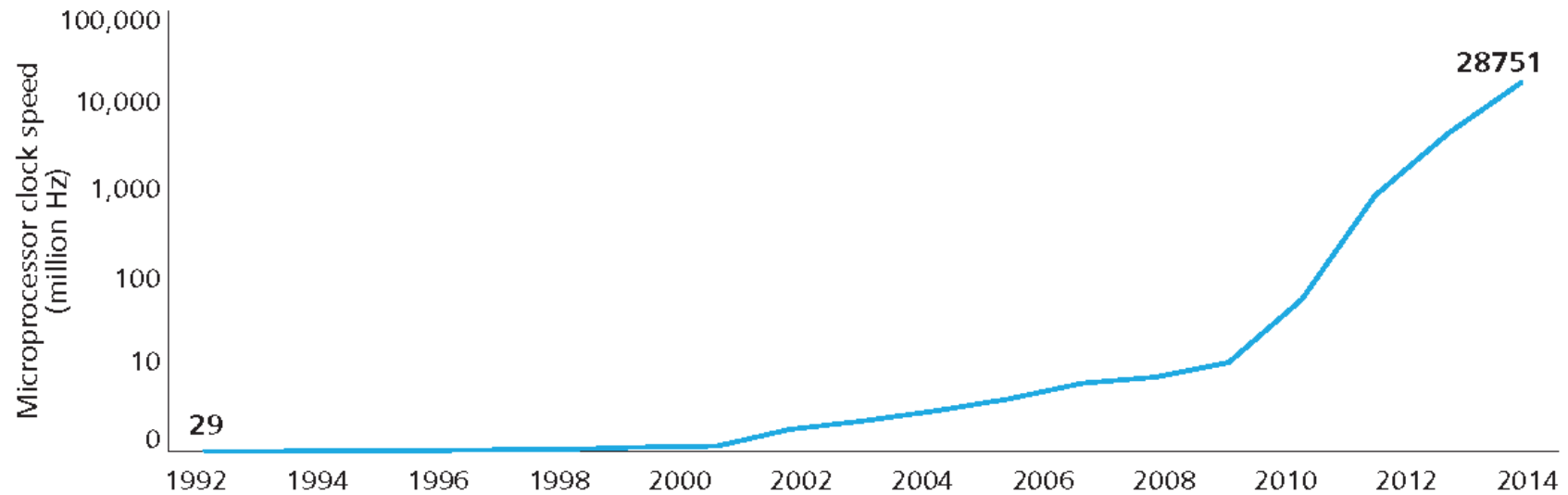
Networks

	Personal area network (PAN)	Local area network (LAN)	Wide area network (WAN)
Wired connections	USB	Ethernet	Not applicable
Wireless connections	Bluetooth, ZigBee, Near Field Communication, Wi-Fi	Wi-Fi, WiMAX	WiMAX, weightless, cellular technologies such as 2G, 3G, 4G (LTE)

Microwave Access (WiMAX)

Data rates
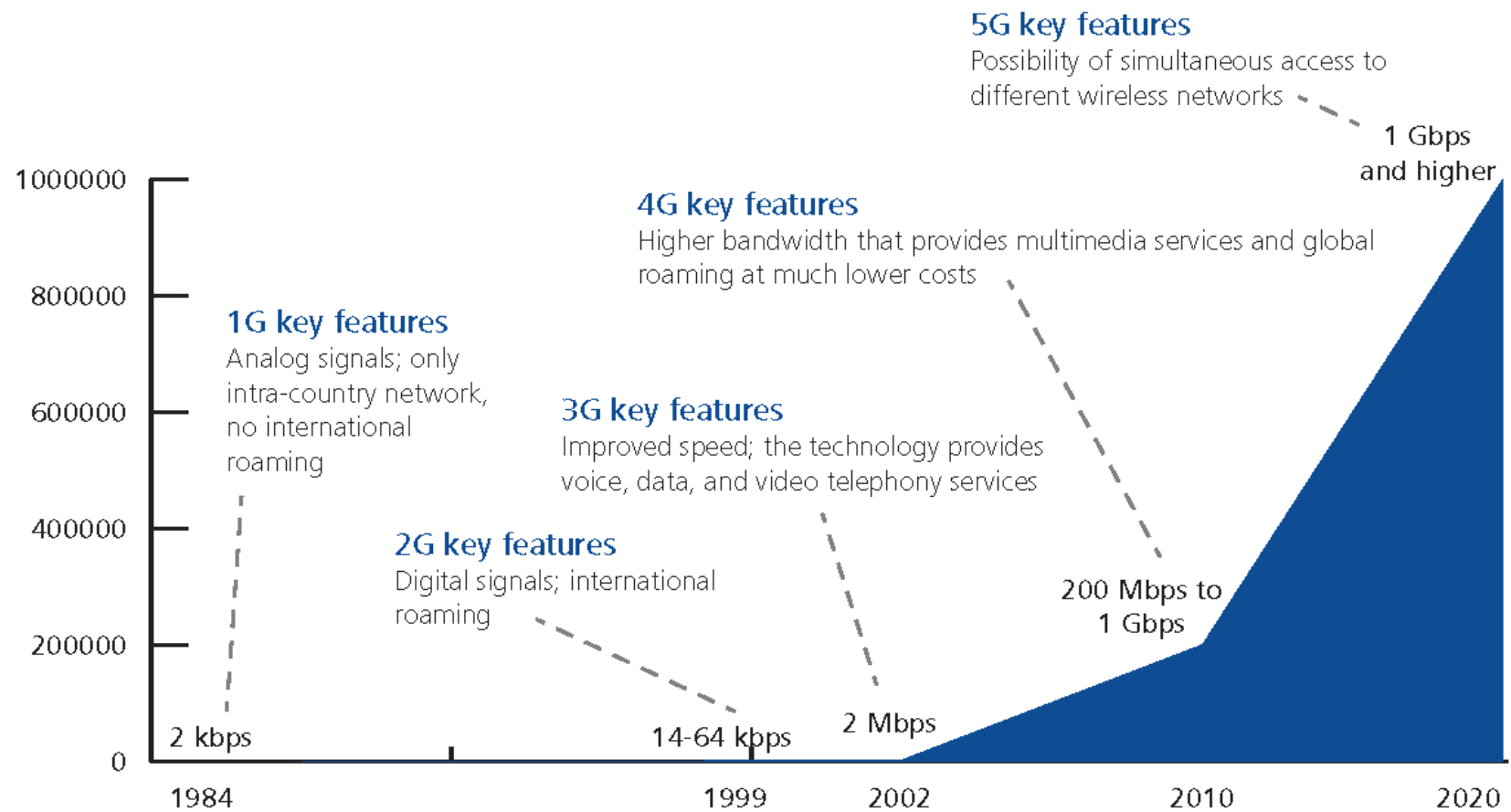
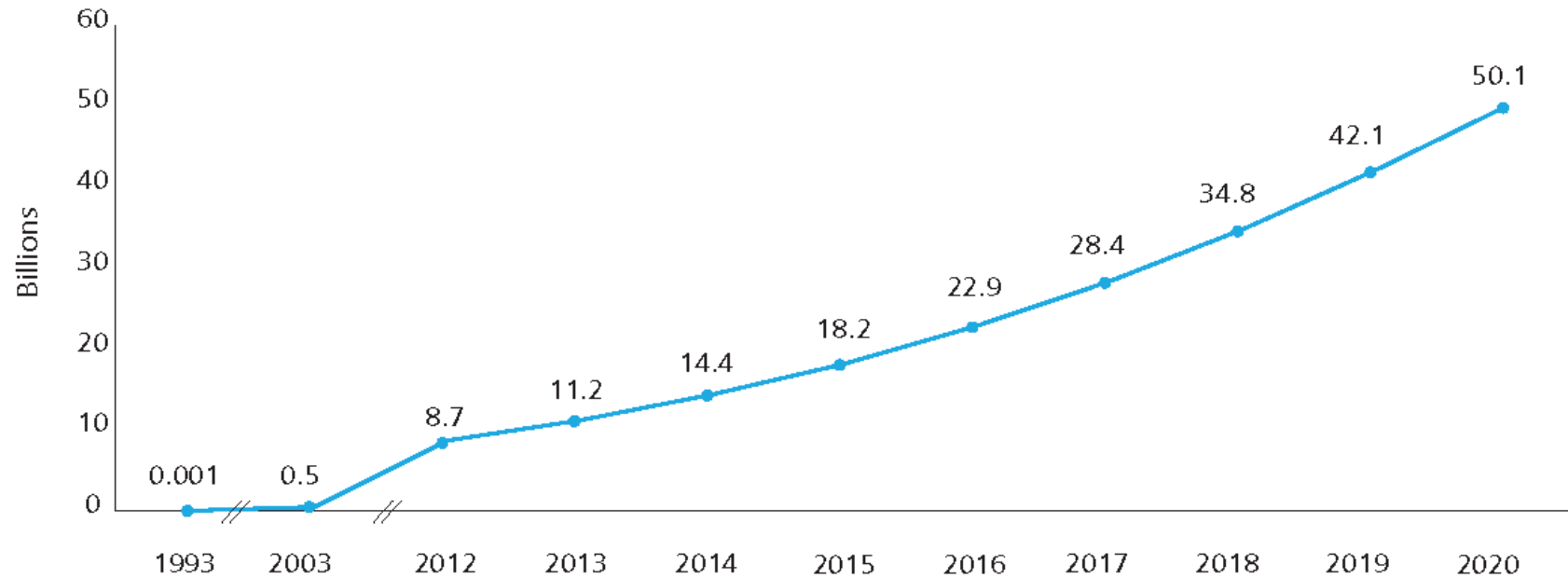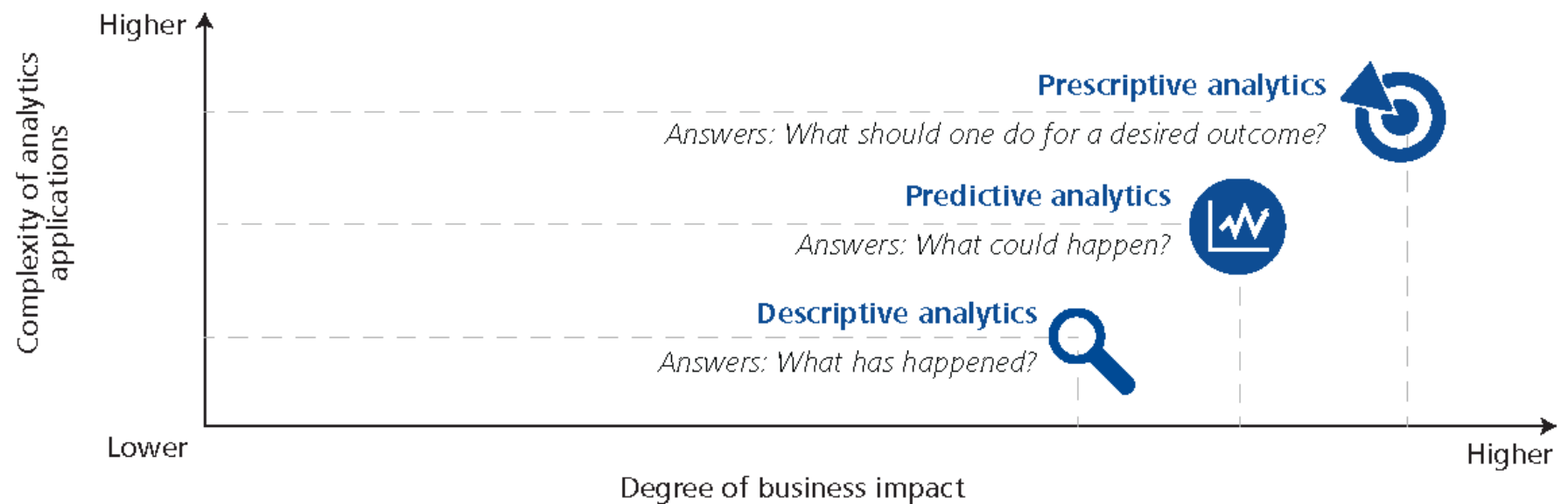# Internet transit prices in the United States
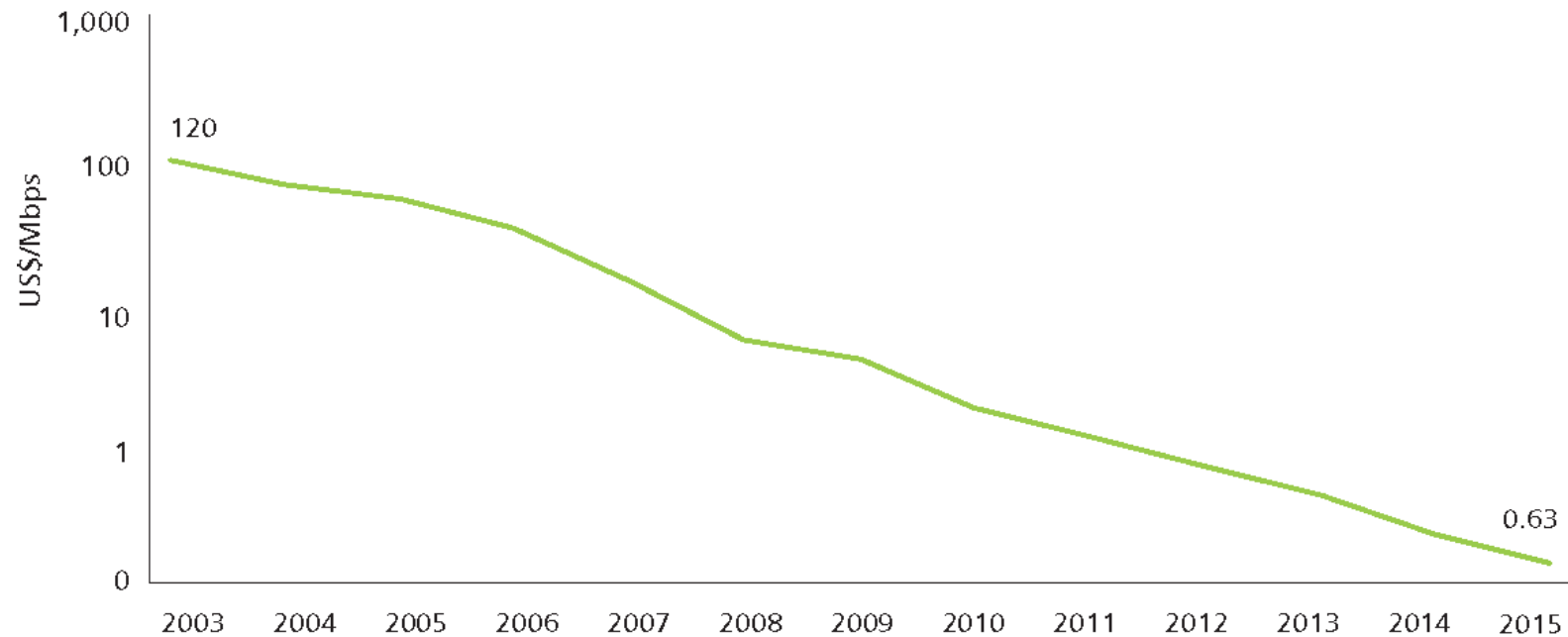
Number of connected devices globally

Types of analytics

Storage cost (US$ per gigabyte)
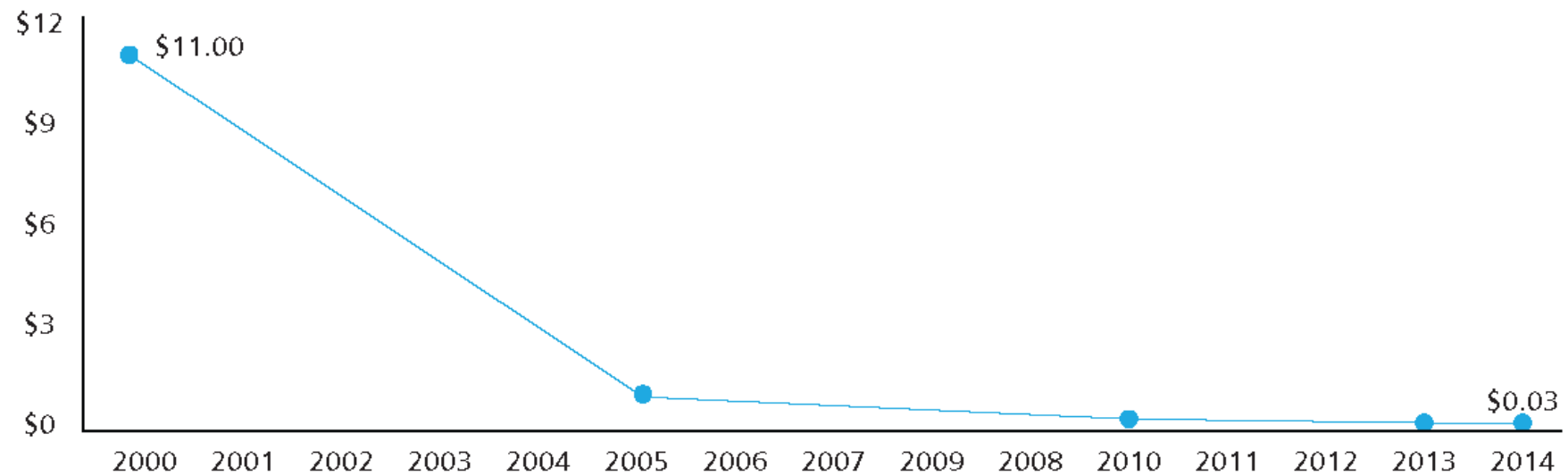
Enterprise data generated globally
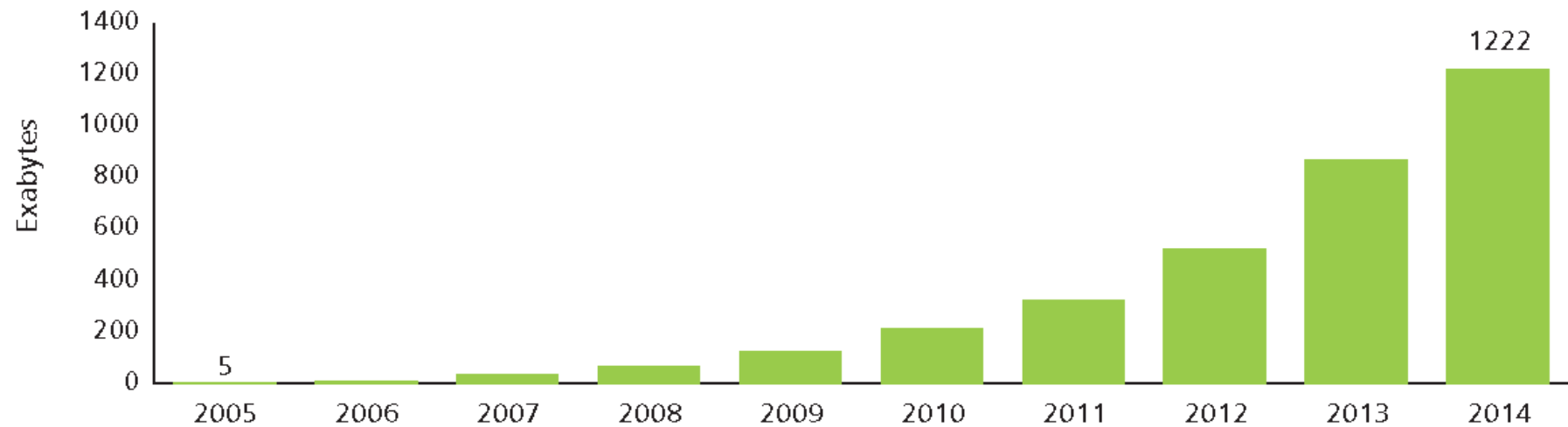
Note: 1 Exabyte = 10^{18} bytes.

Growth of open-source analytics
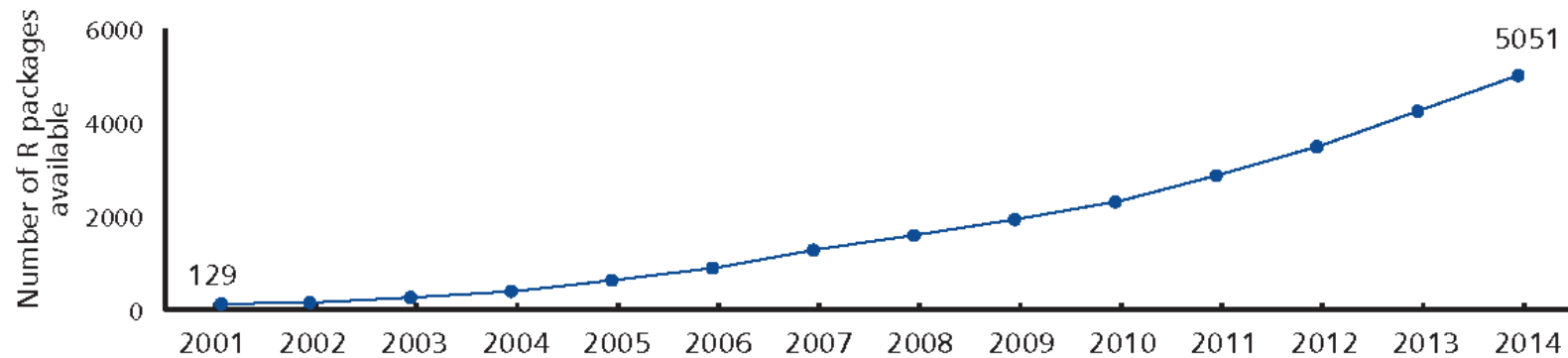
Representative examples of M2M and M2H applications

Average selling price of industrial robots
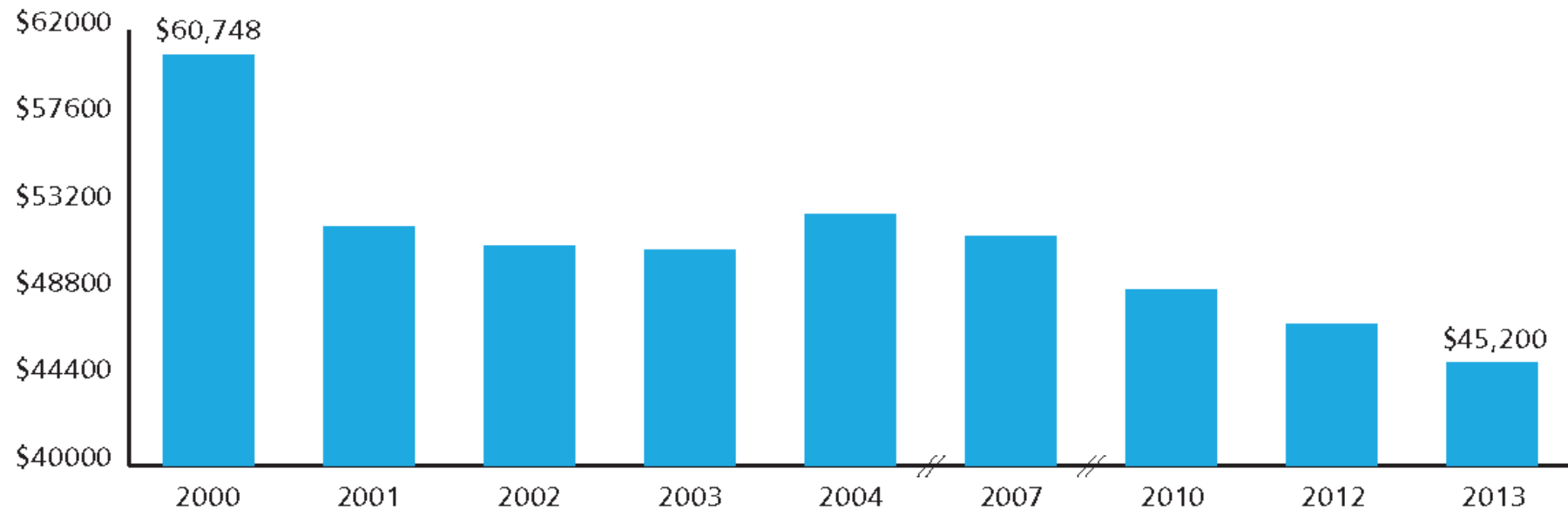
Unit sales of industrial robots globally
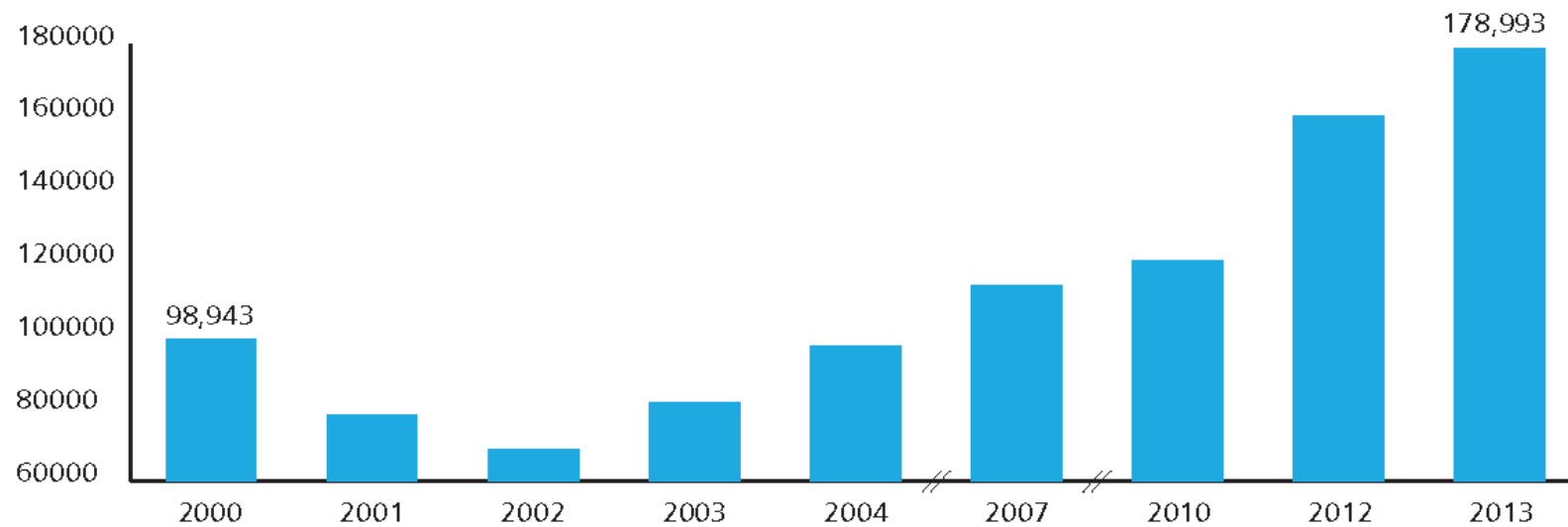
Machine enchantment hierarchy

Level of enchantment

Storyification: The machine narrates a personalized story that appeals to the user.

Gamification: The machine involves the users through games; participation is encouraged through reward points.

Socialization: The machine enables users' social connections and shares information with a chosen group of people.

Personalization: The machine develops an understanding of the users' preferences over a period of time and delivers customized experience and service.

Connection: The machine provides the users a ubiquitous connectivity and access to resources on the cloud.

IoT functional view

IoT usage view

KNOW ME
Beacons enable customers to be recognized entering and navigating the store and mapped to their CRM profile and browsing history.

INSPIRE ME
Customers experience a customized home screen and targeted special offers.

GUIDE ME
Once a product is selected, a guided store map will allow customers to easily find their way to the selected product.

CONNECT ME
The app allows customers to review social media trends and update their own feeds.

INFORM ME
Customers can access product information and reviews to help make their decision.

EXPEDITE ME
At the completion of the shopping experience, customers have the capability to pay for the product using the in-app payment service.

IoT implementation view

SENSORS	NETWORK	INTEGRATION		AUGMENTED INTELLIGENCE	AUGMENTED BEHAVIOR
Create	Communicate	Aggregate		Analyze	Act
Data acquisition	Data transmission	Cold data storage	Data preparation/ calculation	Analytics	Visualization

SENSORS
- Store floor beacon
- POS beacon

CONNECTIVITY
- Mobile apps/ devices
- Beacons
- Bluetooth LE

COMPLEX EVENT PROCESSING

Data processing engine   Message broker

DATA IN MOTION PATH

MQTT

Push notification

MOBILE REPORTING
- Mobile apps/ devices
- Real-time messaging

DATA AT REST PATH

BATCH INGEST
Batch ingest API

HADOOP CLUSTERS
0101010
1101010
DFS cluster

Distributed file system

DATA OS/ IN-MEM DB
Cluster mgmt. platform

BATCH
Parallelized data store

Parallel processing

General engine

ANALYTICS & DISCOVERY
Analytics engine

Analytics libraries

AGGREGATION
General engine

VISUALIZATION
- Business intelligence & analytics
- Customized dashboards
- Store POS system

INTERNAL
- Cloud
- On-premise

EXTERNAL
- Social data
- Demographic data
- Browsing data

IoT specifications view