

A Day in Your Life, 2028: Technology Assumptions

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As part of our research examining life in the year 2028, we identify key technological advances that are likely to occur during the next 20 years, along with the capabilities that exist today in each area. The resulting analysis provides a basis for long-range strategic and technology planners to evaluate the implications beyond the normal three- to five-year planning horizons.

Key Findings

- Advances in home and office environments will include computing capabilities embedded in furnishings and fashions, personal manufacturing through 3-D printers, mobile service robots, and embedded sensors that broadcast status information.
- Advances in personal information access will include fully wireless connectivity, gesture and touch interfaces, seemingly unlimited storage, and biometrically enabled identification.
- Advances in lifestyle technologies will include automated highway systems, physical and cognitive augmentation, and medical genetic profiling.

Recommendations

- Use these assumptions about the future environment to explore likely scenarios for key roles among your employees and customers.
- Based on these scenarios, identify opportunities to deliver value-added services, avoid dead-end investments and spot disruptive trends.

ANALYSIS

As part of the Emerging Trends research initiative (see "A Day in Your Life, 2028"), we have created a set of assumptions about the technological environment in the year 2028. The main focus of the Day in Your Life initiative is to examine the consequences of key technology changes, rather than the exact evolution of each innovation; thus, we have presented the assumptions as "given" capabilities in the year 2028. In reality, some of the technologies will be more widespread than we anticipate, while other technologies will be flailing in the Trough of Disillusionment as they try to find the particular functionality, price point, business model or fashion appeal to trigger mass adoption. In addition, there will certainly be major technological advances we have missed that will have a significant impact on the world of 2028. However, most of these probably exist in some form today — in the labs or in a niche application (for example, all of the top 25 innovations that CNN featured in its 25th-birthday list existed in some form prior to that 25-year period). Emerging Trends research will continue to scan early-stage technologies for such advances, including those that may, at first, seem peripheral to mainstream IT. Technology planners should incorporate similar scans in their own planning processes to help business leaders consider the strategic implications to markets, customers and employees.

In addition to describing the projected technology assumptions, we have supported each assumption with evidence that the technology is headed in the directions we describe — listed under "2009 precursors." These examples of today's products, laboratory demonstrations or leading-edge applications showcase the potential of future capabilities.

2028: The Office and Home Environment

The mind-set of consumers "using a computer" vanishes as computing becomes an integral part of furnishings, fashion accessories and other everyday objects.

Displays are embedded in home appliances and furnishings and play multiple roles (for example, for lighting, artwork, information, entertainment, room partitioning or privacy screens). A range of technological approaches are competing for standards ubiquity, although various evolutions of electronic ink are becoming dominant because of their low power consumption.

2009 precursors:

- Surface and touch computing capabilities such as Microsoft Surface, TouchTable and Savant Rosie Surface
- Gesture interfaces such as Nintendo Wii
- Electronic paper from E Ink
- Glanceable displays such as those from Ambient Devices
- Embedded fabric controls such as ElekTex

Home electronics are completely wireless for data; many use near-field induction for wireless power recharging.

High-definition video and audio are available within the home through wireless networks, with any remaining distinctions between TV/cable and Internet sources indistinguishable to customers. Wires to the home are still common. Many devices are able to draw power from near-field-

induction-charging mats and panels on countertops, tables and walls, although the most power-hungry devices still require wired power for continual use.

2009 precursors:

- In-home Wi-Fi
- Wireless home theater systems — for example, Sonos, Apple TV and Windows Home Server
- Wireless inductive power charging — for example, Powermat and Fulton Innovation

Homes and offices contain hundreds of objects and locations transmitting information — for "object twittering."

Low-cost sensors are embedded in many objects and physical locations, wirelessly sending information to other nodes (in a mesh network), to nearby people, or into a wireless LAN or WAN. Sensors can detect location; environment (heat, moisture, movement and chemicals); and many other features of an object or its surroundings. Moving objects (such as people, cars, clothes, accessories and mobile equipment) form ad hoc networks with other objects in their vicinity.

2009 precursors:

- Mesh sensor networks — for example, from Ember, Millennial Net and Dust Networks
- Home automation control from Zensys
- Consumer environmental sensing — for example, PlantSense

Most households have one or more service robots.

Various types of cleaning, monitoring, communications, medical care and security robots are commonplace in the home. Many are task-specific (for example, vacuum cleaners and walking assistance), while others are designed as companions in pet, humanoid or whimsical forms.

2009 precursors:

- Humanoid and walking assistance robots from Honda
- Mobile communications robot from Nabaztag
- Multiple types of cleaning robots from iRobot
- Videoconferencing robot from InTouch Health

Most offices and middle-class households have a personal manufacturing capability.

3-D printers cost a few hundred dollars and can create physical objects up to about 12 inches in each direction (for example, toys and spare parts) from multiple materials (such as plastic, resin and metal), based on a downloaded 3-D computer model or a copy of an item scanned in with a handheld 3-D scanner. Larger and more-sophisticated items, including bound books, can be printed on demand at midsize company offices or at a local chain (for example, UPS, Staples and Lowe's).

2009 precursors:

- 3-D printers cost \$20,000 (compared with hundreds of thousands of dollars a few years ago) — for example, from Z Corporation. Models have been announced at below \$10,000 for later in 2009. Service bureaus offer custom 3-D models (for example, a Second Life avatar) at less than \$100 each.

2028: Personal Information Access

Instant connectivity is ubiquitous, although bandwidth is variable.

The average citizen has 1 Gbps in his or her pocket 95% of the time, and 1 Mbps 99% of time (due to the lack of network coverage). Devices support multiple personal or home area wireless networking technologies and switch between them seamlessly to find the best performance. The incremental cost of adding wireless networking to electronics is negligible, because wireless is integrated onto chips that perform other functions. Wireless is cheaper than wires for low to medium data rate communications.

2009 precursors:

- Third generation (3G) cell phones with 1.4 Mbps.
- Fourth generation (4G) has been demonstrated in labs, delivering 100 Mbps to a stationary client and 1 Gbps to a moving client (deployment will start around 2014 to 2020), with 16GB storage and 620MHz CPU. The 2028 scenario assumes a 1,000 times improvement in all aspects (that is, doubling every two years during the next 20 years).

Always-on displays, cameras and audio feeds are integrated into eyewear and headwear.

Various forms of wearable IT are inconspicuous and socially mainstream. Some people wear glasses with built-in cameras to record audio and images all the time. Inconspicuous displays provide a continuous stream of information to the user — for example, biographies of business acquaintances, the identity of people he or she meets, information about things in the vicinity and augmented reality for task support.

2009 precursors:

- Pioneering individuals who use wearable computing constantly (see ["Thad Starner: Wearable Computer Pioneer"](#))
- Wearable computers — for example, from Xybernaut and Motorola (Symbol Technologies)
- Consumer-oriented heads-up displays — for example, from Myvu

Context about the user and other relevant entities (such as places, objects and applications) is collected and analyzed constantly to focus information access.

A person's information needs are constantly inferred from a continuous collection of contextual information, including location, mood, physical condition, environment and performance metrics (for example, work-related performance metrics). Automated agents offer suggestions and support to those who want it, and they can be switched off or ignored by those who don't.

2009 precursors:

- GPS embedded into phones, cameras and other devices

- Beginnings of context-aware computing (see "Fundamentals of Context Delivery Architecture: Introduction and Definitions")

Direct human communication interfaces (for example, touch, gesture, speech and scan) take over as the dominant computing input modality set from Windows, icons, menus and pointing device (WIMP).

Direct manipulation interfaces (touch and gesture) have taken over from separate mouse or touch pads for navigation and selection. Keyboards are still common for large amounts of text entry, particularly where voice input is too intrusive. A growing portion of the population has adopted fully mobile input techniques (for example, speech, gesture and one-handed keyboards) for use while walking. Many devices and displays can scan items, using camera-readable or radio frequency identification (RFID)-style tags to identify them.

2009 precursors:

- Touch technology, which is used in Apple and HP devices
- Gesture technology from Nintendo Wii
- Twiddler, a one-handed keyboard used by wearable-computer aficionados
- Speech recognition technology, which is increasingly standard in mobile phones

Storage of digital assets is never an issue — everybody stores everything.

Through a combination of cloud-based and on-person storage (which is automatically synchronized and backed up), individuals can store and access their entire "life stream" (that is, real-time video, audio, medical monitoring and transactional records) without concern that they will run out of space. On-person storage of terabytes of data is commonplace.

2009 precursors:

- Mobile devices with 16GB of storage
- Eight-gigabyte flash memory sticks for \$50
- Cloud storage capabilities from Amazon.com for 15 cents per gigabyte

Biometric identification is required for official activities and widely used for others.

A combination of active biometrics (for example, fingerprint and DNA); passive or distance biometrics (for example, face and iris); and monitored biometrics (for example, blood flow, heart rate and respiration) is used for government and financial transactions to uniquely identify an individual. There is no single standard, and the science of perfecting biometric identification, with minimal error rates across the global population, is still evolving. There is still an active area of the market that is not based on biometric authentication, but it is rapidly becoming limited to "gray market" transactions, such as off-the-books payment to casual or undocumented workers.

2009 precursors:

- Requirement of biometric authentication of visitors and immigrants to the U.S. and other nations
- Face and fingerprint recognition used in some U.S. states' driver's licenses

2028: Lifestyle

Automated highways are operational.

Select sections of highways have dedicated lanes for vehicles with autopilot or automated highway functions. In these lanes or designated roads, drivers must hand over control of their vehicles in return for significantly faster commute times.

2009 precursors:

- Automatic parallel-parking function from Lexus and Prius
- Success of Defense Advanced Research Projects Agency (DARPA) self-driving vehicle competitions

Human physical and cognitive augmentation is routine (pharmacological and surgical augmentation).

Many lifestyle pharmaceuticals are legal and believed to be safe — for example, to focus attention, bolster confidence or increase relaxation. Some individuals embrace implanted devices for identification, storage of medical history and sensory augmentation, while others passionately avoid and denounce them.

2009 precursors:

- Identification chips from Applied Digital
- Use of the drug Ritalin (intended to treat attention deficit disorder) by some students and professionals to enhance attention
- "Body hacking" physical augmentation culture (see www.wired.com/gadgets/mods/news/2006/06/71087)

Genetic diagnosis is commonplace. Genetically customized medicine is mainstream but expensive.

A DNA scan for disease susceptibility and overall health profile is performed at birth in developed nations. Many lifestyle and medicinal interventions are well-understood and routinely used to avoid inherited tendencies. However, genetically targeted medicine and surgical interventions are expensive and available only to the wealthy or those who have high levels of health insurance.

2009 precursors:

- DNA analysis for genealogy costs less than \$200. Testing for genetic diseases is commonplace.

This research is part of a set of related research pieces. See "A Day in Your Life, 2028" for an overview.

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