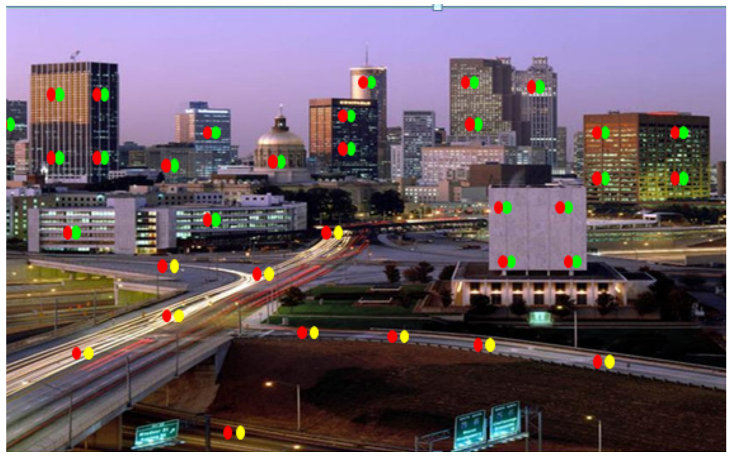
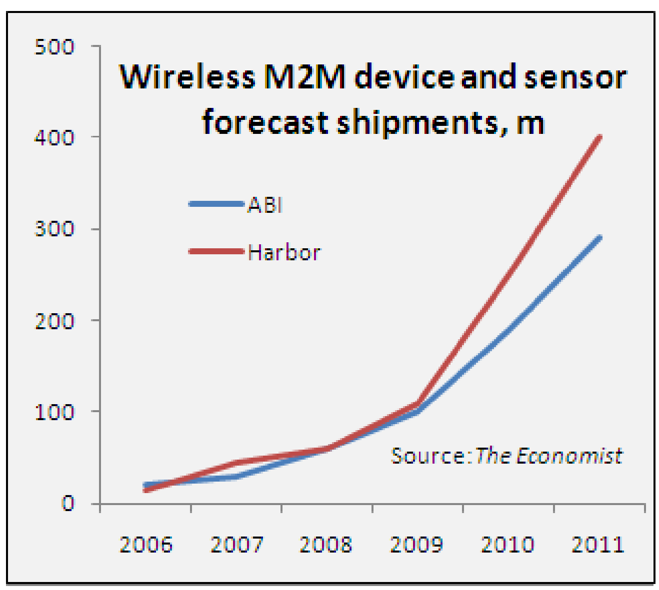
Brainlike Sensing: Enabling Technology for the Wireless Revolution

Over the years, each major information revolution, from the printing press to the search engine, has fueled its successors. Today, wireless technology, the Internet, remote sensing, and automated processing are fueling the newest movement, variously called The Wireless Revolution (*The Economist,* April, 2007), **Smart Services**, and **The Internet of Things**. Today, the Internet is flooded with billions of Things. Keyed computer data was the first Thing. Audio-visual data was the next big Thing. Sensor data has already become the Internet Thing of the future.



Rapidly evolving, sensor-based applications range from defense and security surveillance networks to equipment and human health monitoring systems. Large scale defense sensors, such as radar and sonar, have been finding threats for decades. Increasingly, however, many more, much smaller sensors are taking their place, especially on autonomous land, air, and undersea vehicles. On the commercial side, data from your vehicle may already be **warning your mechanic** of developing problems. Sensor data from your air conditioning unit will soon email you when your unit needs a new filter, and sensors on bridges will warn engineers of developing weaknesses. Body sensors will warn you and your doctor of developing health problems. Many other equipment, security, and environmental sensors will send you all kinds warnings and alerts, not to mention sensor-based signs that the timing may



be right to seize opportunities by taking decisive action**.** Demands for sensor-related products and services, priced at $48 Billion in 2007, are doubling every two years.

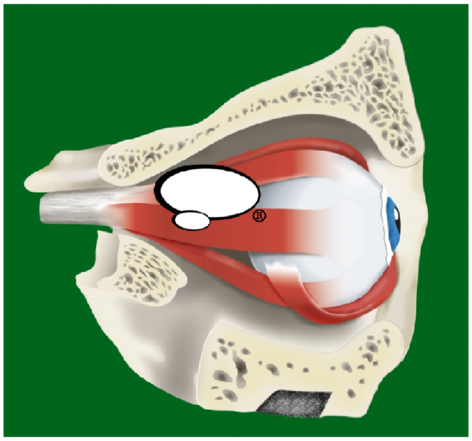
Along with huge sensor-based opportunities come major business challenges, the biggest being how to convert massive amounts of sensor data to clear and manageable information. Soon, anticipated needs for sensors connected to the Internet will far outstrip the four billion addresses that are currently available. That problem will soon be solved upon delivery of the new, **IPv6 Internet Protocol**. IPv6 will connect devices at no added cost. With infrastructure cost significantly reduced, businesses will look for ways to leverage sensors. As a result, however, the problem of reducing sensor data to useful information will become even more important.


(from *The Economist*)

Individual sensors installed in the environment, on equipment, and on people, can each each measure billions of values per day. Many of them run on small batteries that cannot be economically replaced. Other sensors transmit data continuously and clog wireless channels. Still other sensor systems control their own activities such as medical dosage control, only after monitored data has been transmitted to a central server and control signals have been sent back to sensors. Resulting transmission bottlenecks and related expenses are already stunting the growth of smart services. For example, developers of "smart band aids," which could in principle monitor everyone's vital signs continuously, are constrained by telemetry and battery replacement costs. Developers of equipment monitors such as bridge and building strain gauges, along with developers of defense and security networks and radios, face the same problem.

Thus, sensor-based smart services will become scalable only after tons of sensor data can be reduced to nuggets of useful information. Brainlike sensing, in the form of **Brainlike Processor™** computing, can do just that. Designed for deployment on low power chips, Brainlike sensing continuously distinguishes useful events from background clutter. Once such events have been flagged at remote sensor locations, key event information can be transmitted and processed, while avoiding the expense of transmitting nearly all other sensor data. As a result, remote sensor systems can use less transmission power, transmission bandwidth requirements can be greatly reduced, energy challenged sensor systems can be much more efficient, and operators can spend much less time being distracted by useless clutter.

Brainlike sensing technology learns continuously and efficiently from massive amounts of sensor data, in real time. In that regard, Brainlike sensing resembles visual processing. Neurons on the eye reduce millions of light signals from sensors on the retina to a smaller number of features, such as edges and other basic shapes. They also recognize overall changes in intensity and control activities such as light flow through the lens. Neurons on the eye also continuously habituate to changing conditions, sending the strongest signals to the brain only when novel features are seen. As a result, data transmitted to the brain from the eye is greatly reduced. Inside the brain, reduced information from they eye is further processed by combining it with information that is either stored or available from other sensors, to form insights which in turn control decisions.



Likewise, Brainlike sensing is equipped to (a) reduce many sensed values to a small number of feature values at remote sensor sites, (b) continuously learn what kind of features to expect, and (c) transmit only unexpected, interesting information. Brainlike sensing can further combine feature values at central processing locations, such as network operations center (NOCs) servers, as well as at router or radio nodes between sensors and NOCs. Brainlike sensing adds clutter reduction value when installed on server platforms in command, control, surveillance, and network operations centers. However, Brainlike sensing adds much more telemetry, energy reduction, and sensor persistence value when installed on remote sensor arrays.

Brainlike, Inc., is pursuing a "Brainlike inside" value delivery model. Brainlike sensing will soon reside inside many receiving platforms and remote sensors. Brainlike sensing will add the most leveragable value, however, when they reside on or near remote sensor arrays, upstream of telemetry. With Brainlike inside remote sensor arrays, telemetry will be reduced, energy will be saved, sensor persistence will be increased, and useful feedback information will be available at or near remote sensor locations. When processed on remote sensor arrays, Brainlike sensing information will be useful for display as well as remote sensor control.

Besides supplying computer processes that will reduce data to useful information, Brainlike tools and training enable managers and analysts to decide just what kind of information to produce. Business developers must decide when investments in remote sensing will be worthwhile, while their analysts must decide how to generate alerts and identify opportunities economically. Brainlike has developed tools, training, and services to meet these challenges. The **Brainlike Studio™** toolkit has been designed to develop, evaluate, and deliver Brainlike sensing models, simply and effectively. Along with Brainlike Studio™ tools, Brainlike analysts and educators have developed **training materials and courses**, for broad circulation.

Brainlike sensing provides a unique and valuable combination of processing options, analysis tools, and related services for reducing sensor data to clear information. Thus, *Brainlike Sensing* provides enabling technology for the *Wireless Revolution.*