

# Universal Autosophy data formats for network-centric systems

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## ABSTRACT

Conventional platform-centric communication systems are now being replaced by modern network-centric systems such as the packet-switching Internet. A number of problems arise, resulting mainly from the lingering effects of the outdated Shannon information theory. Data has traditionally been communicated in meaningless bit streams according to the Shannon theory. An alternative Autosophy theory communicates data "content" in Internet packets using universal data formats. The new theory evolved from research into self-assembling structures, such as chemical crystals and living trees. Similar natural principles can produce self-assembling data structures that grow in electronic memories without programming -- like data crystals or data trees. The learning algorithms grow hyperspace knowledge libraries for communication and archiving. The advantages include high lossless data compression, unbreakable "codebook" encryption, resistance to transmission errors, universally compatible data formats, and virtual immunity to the Internet's Quality of Service (QoS) problems. A content-based 64bit data format was developed for real-time multimedia Internet communications. Legacy data can be converted to the universal 64bit format using software patches or integrated chipsets. The codes can then be forwarded via any media (cable, radio, satellite, or the Internet) without reformatting. The new data formats could be phased in without disruption to existing communications.

Keywords: Autosophy, Information theories, Omni Dimensional Networks, Self-assembling data networks, Universal data formats, Multimedia communication, Internet Quality of Service, data compression, encryption.

## INTRODUCTION

It may be difficult to accept that our entire communications infrastructure is based on an outdated Shannon information theory, which was originally developed for primitive telegraphy and computer communications. That theory is still being taught at our universities. With the arrival of the packet-switching Internet, Shannon's methods are no longer adequate and must be replaced. Future network-centric systems require a new paradigm based on the Autosophy information theory. The new information systems must be compatible with all media (wire, radio, cellular telephone, satellites, and the Internet) with data able to be forwarded from media to media without reformatting. Merging of information should be enabled so that only new information needs to be transmitted. The systems should provide virtual immunity to the Internet's Quality of Service (QoS) problems, allowing live video with synchronized sound to be transmitted via the Internet's intermittent packet stream. High lossless data compression is essential to reduce bit rate requirements. Unbreakable encryption and security is required to prevent data interception, provide sender authentication, detect intrusions, and tracking faked messages back to their origin.

Most of today's problems with the Internet can be traced to the lingering effects of the outdated Shannon information theory. A holistic Autosophy approach could address all the following issues at once:

- 1 Secure multimedia communication protocols compatible with all future hardware and operating systems.
- 2 Media-independent data formats for wire, radio, cellular telephone, satellite, and the Internet.
- 3 Quality of Service problems for real-time data including live video and sound on the Internet.
- 4 Mixing of data (live video, sound, text, still images, and random bit files) in the Internet's packet stream.
- 5 Universally compatible hardware-independent data formats that will never become obsolete.
- 6 Combining sensor data from many sources into a single coherent picture.
- 7 High lossless data and video compression to reduce bit rate requirements.
- 8 Disturbing visual effects caused by conventional lossy video compression.
- 9 Resistance to transmission errors, such as lost data, gaps, noise, and jamming in noisy radio communications.
- 10 Latency effects in video and sound caused by software encoding and decoding delays.
- 11 Virtually absolute security including sender authentication, denial of data interception, and deception detection.
- 12 Single point failures bringing down a whole communications system or platform.
- 13 Large volume mixed multimedia data recordings and archiving for later playback.
- 14 Software patches and chipsets to convert data formats from incompatible legacy applications.

The various problems were previously investigated around the year 2000 in a project to build a television system for transmitting movies-on-demand via the Internet. Once sufficient video compression was achieved, the problem then arose how to combine the compressed video with compressed, synchronized sound in the Internet's intermittent packet stream. The solution was found in a universal 64bit data format for mixed multimedia communications. The real-time data transmissions are virtually immune against packet latency, dropped packets, out of sequence packets, and transmission errors. All the data compression algorithms (for video, sound, text, still images) are lossless and will not cause data distortion. The bit rates are dependent on data "content" rather than data "volume." Virtually unbreakable "codebook" encryption is provided for all data types by growing private encryption libraries. The 64bit data codes are media independent for routing via satellite, radio, or the Internet without reformatting.

Instead of transmitting meaningless hardware-determined bit streams, as dictated by the Shannon information theory, the new 64bit codes contain "meaning" or data "content," which will remain universally compatible despite evolution in electronic hardware. Indeed all future communications and archiving systems would be compatible. Data records would never become obsolete due to changes in data standards or operating systems. Converting legacy data files into the new 64bit codes would require only simple software patches or chipsets. This research project involves: defining a detailed data standard, getting the new standard approved by a standard-setting committee, and programming the conversion software patches.

## **TWO COMPUTING AND COMMUNICATION PARADIGMS: COMPUTER VS. AUTOSOPHER**

Communication and computing can be defined by two different theories, which yield entirely different results and operational performance. Data processing computers are essentially adding or calculating machines that during the last two centuries have evolved from mechanical devices into electronic computers. However, it has long been realized that our own brains do not behave like calculating machines or computers. Our self-learning, self-organizing brains require no programming or supervision of internal functioning. Processes that are easy for a computer, such as numerical calculations, are very difficult for us. While, on the other hand, learning and pattern recognition, very easy for a human child, is exceedingly difficult for computers. Clearly, computers and our brains work according to entirely different principles. In 1948 Claude Shannon published "A mathematical theory of communication," which defines "information" in binary digits (bits). His information theory now dominates both telecommunications and computing. In 1974 Klaus Holtz formulated a new "Autosophy" information theory, which defines "information" as data "content" or "meaning." In 1988 a hardware model of a self-learning "autosopher" was built to verify the theory. While self-learning, brain-like machines have remained in the laboratories, Autosophy data compression algorithms are widely used in virtually all Internet communications, including the V.42bis compression standard in modems, and the gif and tif lossless image compression methods. When self-learning Autosopher finally emerge from the laboratories they will have a profound impact on both computing and communication.

## **WHAT IS "INFORMATION" AND "COMMUNICATION"?**

The question "what exactly is information and communication?" can be answered by two theories. The outdated Shannon theory explains conventional "platform-centric" systems. Modern "network-centric" systems like the Internet are best defined by the newer Autosophy theory. Most of today's communication problems are caused by the misapplication or mixing of the two different theories.

In 1948 Claude Shannon published "A mathematical Theory of Communication," which defines "communication" as binary digits or bits and bytes. All data (ASCII characters or pixels) are regarded as "quantities," which are converted into binary digits (bits and bytes) for transmission in meaningless bit streams. This allows for "lossy" data compression only -- in which data compression leads inevitably to data distortion or loss of resolution. This method of communication was developed in an age of telegraphy and computer communications via primitive platform-centric systems. The theory is still being taught in our universities even though there is not a single example of that kind of communication in nature. The Shannon theory also explains the modern programmed data processing computer. In 1974 Klaus Holtz developed the Autosophy information theory, in which all data items are regarded as "addresses" to define or create quanta of knowledge, called "engrams," in a hyperspace knowledge library. Communication is with address codes, called "tips," each identifying an engram in the receiver's hyperspace library that can represent any amount of data. Information is only that which is not already known to the receiver and which therefore creates new knowledge in the receiver's libraries. The purpose of a communication is to create new knowledge in the receiver, i.e., to teach it something. That provides high lossless data compression and unbreakable encryption. The new theory will lead to a next generation of brain-like, no programming, and failure-proof "autosopher."

## CONVENTIONAL PLATFORM-CENTRIC SYSTEMS

Conventional platform-centric systems are designed according to the outdated Shannon information theory. All data (ASCII characters, pixels, analog samples) is converted into bits and bytes for transmission in meaningless bit streams. A communication system usually contains a central mainframe computer connected to communication lines, various sensors, and "dumb" operator terminals. A computer failure will cause a total communications blackout.

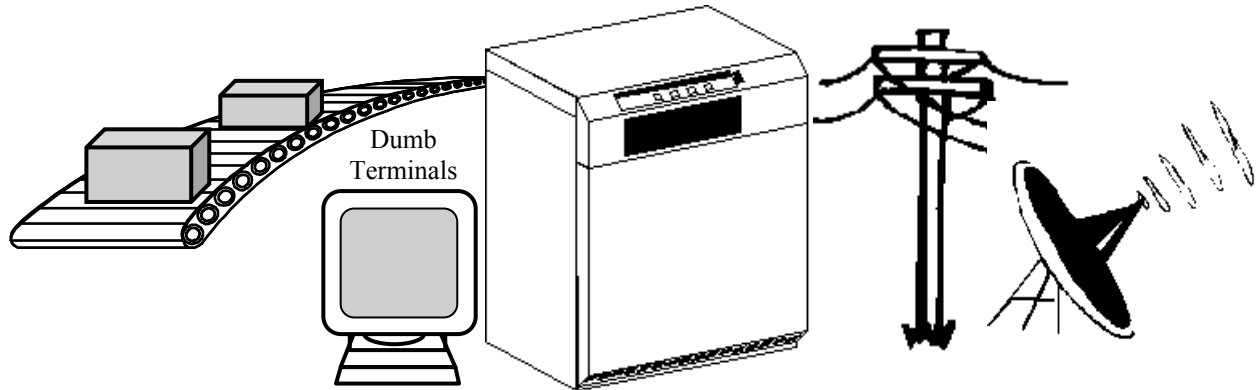


Figure 1. Conventional "Platform-Centric" communication systems

Input and output data is continuously transmitted, at a fixed bandwidth or bit rate, whether or not it actually contains information. The method is similar to moving transport belts, which are continuously running whether or not anything needs to be transported. In telephone communications, for example, the analog signal is sampled at a constant rate and converted into a fixed number of bits per sample. The transmission bit rate is the same for human speech, silence, or random noise. The bit rate in television, likewise, is determined by the imaging "hardware" -- screen size, resolution, and frame rate. The images actually shown on the screen are irrelevant. A blank or static video image would require the same bit rate as random noise (snow) images. This totally hardware determined paradigm is obviously not the way human beings or biological creatures communicate. There are no examples of Shannon-like communications in nature. Communicating that way is very inefficient except in very specialized applications. Problems arise in the conversion of conventional platform-centric systems into modern network-centric systems, such as the packet-switching Internet. Higher bit rate channels, faster computers, and better programming, will not solve the problem.

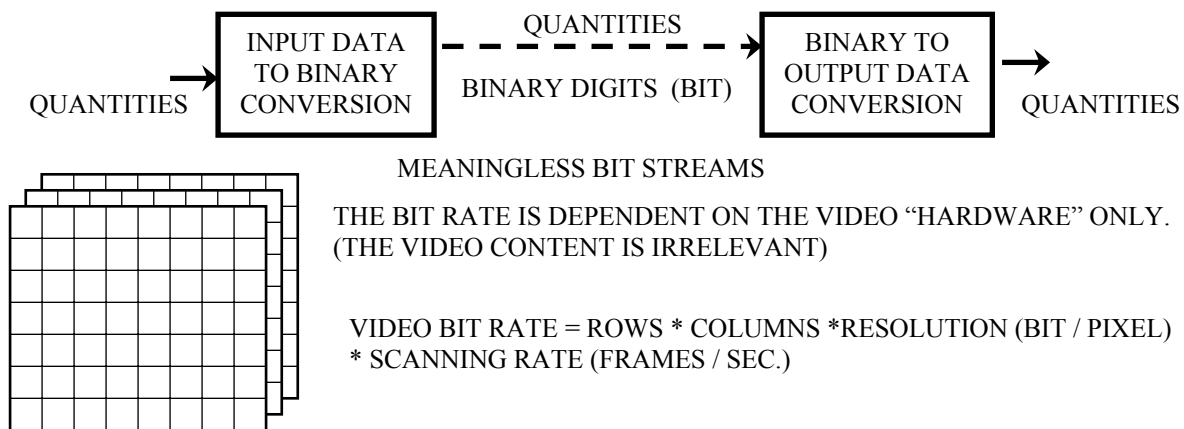


Figure 2. Conventional Shannon data and video communication

Communication, according to the Shannon theory, is mere data in a bit stream that has no "meaning." All data items (ASCII characters or pixels) are regarded as "quantities," to be converted into binary digits (bit) for transmission. According to Shannon's theory, communication "removes uncertainty" in the receiver. The data "quality" is determined by the transmitted bit rate, whether or not the improvements in quality can actually be used or perceived by the receiver.

A unit of communication is a binary digit, called a "bit." In television, for example, the video "information" or bit-rate is determined by the imaging hardware, i.e., screen size (the number of pixels), color resolution (bits per pixel), and scanning rates. The video images actually shown on the screen are irrelevant. A random noise video image would require the same bit rate as a blank screen image. The higher the bit rate being transmitted, the higher the image quality becomes. Any attempt at reducing the bit rate through video compression will cause inevitable image distortion or loss of resolution. The more the video images are compressed, the worse the image quality will become. Lossy video compression methods such as Cosine Transforms (JPEG, MPEG), Wavelets, or Fractals, mainly attempt to hide the distortions from human observers. This method of communication was intended for primitive telegraphy and computers. The video quality is determined by the bit rate, whether or not any improvement in the video quality is actually visible to the human eye. Data encryption is only possible using bit scrambling, such as pseudo random number generators. All such codes can be broken by high speed computing and determined efforts.

### CONTENT-BASED NETWORK-CENTRIC SYSTEMS

Network-centric systems transmit data "content" or "meaning" instead of meaningless bit streams. Data is transmitted only if there is a need for the information. The Internet is only a first generation example, which can be greatly improved. Most Internet problems can be solved following the rules of the Autosophy theory.

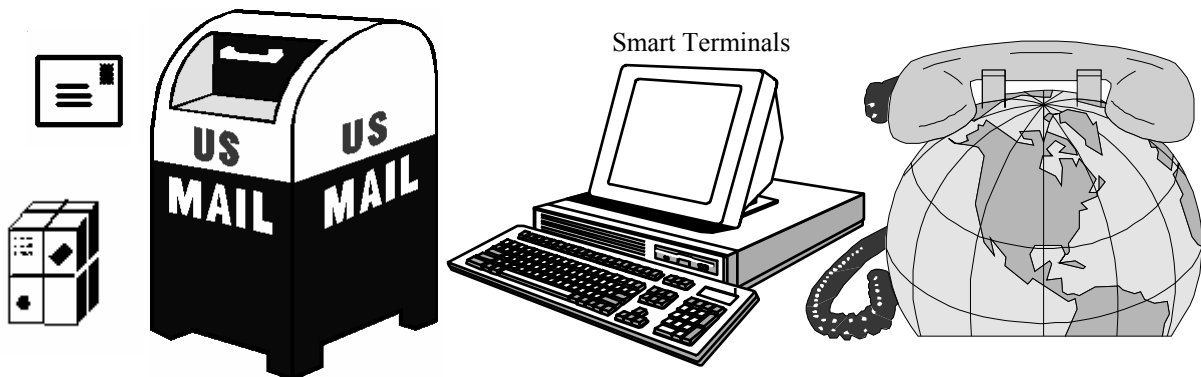
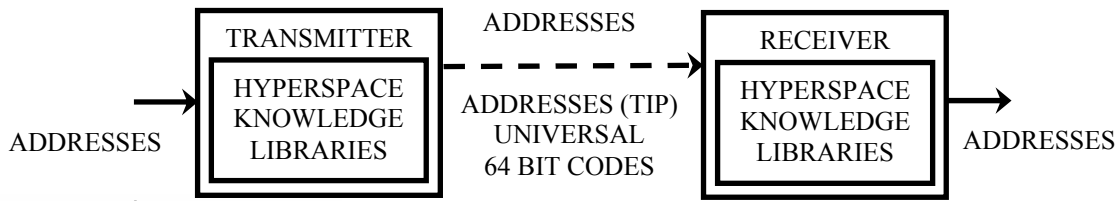


Figure 3 "Network-Centric" communication examples: postal service or the packet switching Internet

Network-centric systems can be compared to the postal service or the packet-switching Internet. In the postal service, for example, letters or parcels are deposited into a mailbox for transport in the worldwide postal system. Each letter is marked with a destination address and a return address. A postage stamp is used to pay for the service. Once the mail is deposited into the box the postal service will then deliver the letters and parcels to the receiver. On the Internet, likewise, data packets are marked with an address (URL) code and a return address for transmission, via telephone modems or high-speed access lines, to the worldwide Internet. Network-centric systems are much more efficient than conventional platform-centric systems. Instead of random bit streams, information involves "meaning" or data content. Information is only that what the receiver does not already know. There is obviously no need to constantly send empty letters, parcels, or data packets. Both the postal service and the Internet are virtually indestructible. Defective mailboxes or terminals will not bring down either the postal system or the worldwide Internet.

In Autosophy communications, all data items (ASCII characters or pixel) are regarded as "addresses" which convey "meaning." The transmission bit rates are determined by the data content. Information in essence is only that which is not already known by the receiver and which can be perceived by the receiver. Video for example is transmitted in tiny pixel clusters, each representing motion and complexity in the images. Each cluster of up to 16 full color pixels (16bit per color) is transmitted with a standard 64bit packet code to be inserted at any location in the output image. High "lossless" video compression is achieved by transmitting only that which is not already known to the receiver, i.e., that which is not already in the receiver's libraries. Additional compression is achieved by transmitting only the portions of the data that are actually perceptible by the receiver. In television, for example, only the moving portions of the images are transmitted. The static portions of the video are not re-transmitted because they are already known to the receiver. A software demonstration is available.



THE BIT RATE IS DEPENDENT ON THE VIDEO "CONTENT" ONLY.  
(THE HARDWARE IS IRRELEVANT)

VIDEO BIT RATE = MOTION AND COMPLEXITY

Figure 4. Autosophy data and video communication

According to the Autosophy information theory, the purpose of a communication is to create knowledge in the receiver, i.e., to teach it something. Each transmitted address code (tip) may generate a new "engram" of knowledge in the receiver. Each engram is unique and can be learned only once: one cannot learn what one already knows. The process can be imagined like the growing of data crystals or data trees in electronic memories. Communication requires special hyperspace knowledge libraries, which must remain identical in both the transmitter and the receiver. Libraries may either self-assemble during a data transmission, or fixed libraries may be pre-grown prior to the data transmission. The hyperspace libraries may also provide unbreakable encryption for communication security. Generic libraries for non-encrypted communications are provided in software packages.

#### DATA COMPRESSION AND ENCRYPTION USING HYPERSPACE KNOWLEDGE LIBRARIES

Very high "lossless" data compression can be achieved by replacing data communication, using meaningless bit streams, with content communication using "engrams" from hyperspace knowledge libraries. Very primitive examples are the V.42bis compression standards for modems and the gif and tif methods for lossless still image compression.

A most basic example would use an English dictionary of up to 64k words where each word is marked with a 16bit index code. Text files could then be transmitted by substitution of each text word in the message with the 16bit index code. Every text word with arbitrarily many characters, including the space character, could then be transmitted by only 16bit resulting in high data compression. Words not found in the library are chopped into smaller fragments. The same method would work for any multimedia data including images and sound. The larger the hyperspace library becomes the fewer codes would be required to transmit the message. There are seven known types of self-learning data networks, or data crystals, each providing a different learning mode. Only the "serial network" and the "parallel networks" are currently implemented in communication applications.

Learning networks store data in a saturating omni dimensional hyperspace mode. Every data pattern, such as written text or an image, is stored only once because one cannot learn what one already knows. The more data pattern already stored in the library the less memory space is required to store additional data patterns. This provides very high data compression for communication libraries or large data archives. The communication libraries are created by software from sample data, such as text files or video clips. The process requires only a few minutes to grow a unique communication and encryption library. Generic libraries for open, non-encrypted, communication are already available for universal communication. The larger the library, the more data is contained in each transmission code (engram), and the higher the data compression. All data compression is entirely lossless and will not cause data distortions.

The method is similar to human communication. Children, for example, have little knowledge and therefore use simple words to communicate. Adults, or experts, have more knowledge and therefore use more complex words and terms for communication. Expert communication is much more efficient than communication with children. Conventional Shannon communication is an extreme case, which requires no prior knowledge of the data and therefore no library. This makes conventional Shannon communication extremely inefficient.

## CONTAINERIZED SHIPPING OF CARGO OR DATA

The future network-centric communication systems will require the simultaneous real-time transmission of all multimedia data including live video with synchronized sound, still images, text, and random bit files from legacy formats. All these data types must be randomly mixed together for transmission in the Internet's intermittent packet stream. Fortunately, solutions are available that resemble the container shipping pioneered in the 1950s.

Prior to the 1950s, cargo was shipped in separate bags and boxes, which were hand stacked into trucks, trains, and ships. Every change in transportation format required unloading and reloading of the cargo. This was replaced by modern container shipping. A large standard size container is parked at a factory to be loaded with any type of cargo. The container is then picked-up by special trucks for further transport via special container trains and container ships. The sealed container is eventually delivered, unopened, to a destination factory. This form of shipping is now used for most international cargo delivery.

The Internet can emulate that process. Portable sensors or hand-held terminals would generate the multimedia data, formatted into standard 64bit codes, for wireless connection to the local Internet. The data codes would then be forwarded via satellites to a distant Internet to be eventually delivered to the receiver's terminal. Such network-centric communications would face all the problems identified previously. Autosophy communications promise solutions by converting all multimedia data into standard 64bit codes, which contain "meaning" rather than meaningless bits and bytes. All 64bit codes can be randomly mixed into the Internet's (TCP/IP) packets and forwarded from media to media without having to be recoded. The advantages would include high lossless data compression, impenetrable security, and virtual immunity to the Internet's Quality of Service (QoS) problems.

### A UNIVERSAL 64BIT FORMAT FOR MIXED MULTIMEDIA INTERNET COMMUNICATION

The Autosophy information theory claims that all data communications can be defined by data "content" only. The hardware parameters (such as screen size, pixel resolution, and scanning rates in television) would become irrelevant. The new 64bit universal data format could make all future communications compatible and virtually eliminate the current Internet's Quality of Service (QoS) problems.

Real time data communication via the Internet is subject to the Internet's Quality of Service (QoS) problems, including unpredictable bit rates, packet latencies, transmission errors, packets being delivered out of sequence, and packets being dropped in a congested network. The future Internet will require the simultaneous transmission of all multimedia communications, including live video with synchronized sound, text, still images, and random data files. All these data types must be randomly mixed together and remain synchronized in the Internet's intermittent packet stream. In addition, data compression and encryption is no longer optional, which will aggravate the problems. The new data format was developed for the purpose of transmitting live video with synchronized sound via the Internet while avoiding its Quality of Service (QoS) problems. The data codes may be used in all media (wire, cellular telephone, satellites, radio, and the Internet) to be forwarded from media to media without needing to be reformatted.

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*Figure 5. Media-independent data formats using a universal hardware-independent 64bit code*

A 2bit header defines the type and priority of the data. Real-time sound has the highest priority because any interruption in sound is particularly disturbing to the receiver. Live video has a lower priority because of its inherent resistance to packet latency. Non real time data such as text and random bit files have the lowest priority. All data types are mixed together into larger packets for transport via the Internet. Lower priority containers may be delayed until data traffic in higher priority containers has eased. All data types contain their own control, timing, and error checking codes.

## AUTOSOPHY SOUND COMPRESSION AND ENCRYPTION

Current digital sound transmission and recordings are based on the Shannon information theory. The analog sound waves are sampled at a fixed rate while the amplitude of each sample is converted into a digital word with a fixed resolution. The digital bits from the analog samples are then transmitted in a constant bit stream using a fixed bit rate channel. The content or meaning of the sound is irrelevant. A random noise sound transmission would require the same bit rate as silence. Such sound transmissions cannot be compressed without reduction in the sound quality, i.e., fewer bits per sample or slower sampling rates. Transmitting such sound via the TCP/IP packet switching Internet is very difficult because of the Internet's Quality of Service (QoS) problems.

Sound codes must be randomly mixed with video codes to achieve synchronized sound in teleconferencing or television broadcast. There is no fixed relationship between the number of sound and video codes. In television, for example, there may be times when the video is changing rapidly with little sound, while at other times the video may move slowly with continuous sound. The code rate is determined by the sound content. Lower frequency simple sound, such as human speech, would require fewer codes than higher frequency complex sound, such as music. Silence would require no transmissions at all. The 64bit packet codes are freely mixed with other codes representing video, text, or random bit files. The sound codes contain all the information required to re-assemble the analog waveform in the receiver. A sound encoding system for open, non-encrypted communications does not require a library. An encryption library may be grown from sound samples, such as speech or music. Without a matching encryption library for both the transmitter and the receiver, sound retrieval becomes virtually impossible. The encryption libraries may be downloaded via the Internet to all authorized users. Each user may have a different library for positive authentication.

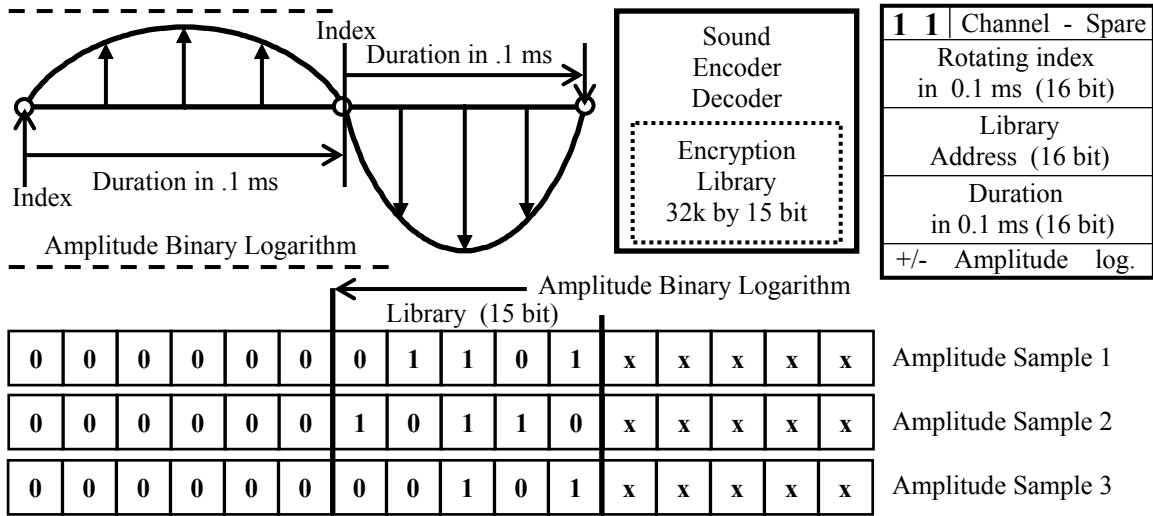


Figure 6. Autosophy sound content-based compression and encryption

Autosophy sound encoding will sample analog sound at a constant 100 Microsecond rate starting from a first "zero crossing" until the next "zero crossing." The digitized samples are saved in a buffer. A "Duration count" in 100 Microseconds is stored in the output code. A free running 16bit "Rotating index" counter is incremented at a constant rate of 100 Microseconds to reach a maximum count of 60,000 every 6 seconds. The index counter is reset at 60,000 where the remaining 5536 counts are reserved as special codes, such as long periods of silence. The "Rotating index" of the first zero crossing is stored into the output code. Each analog waveform is represented by 5 samples including the first and the second zero crossing. The 3 main samples are taken from the buffer locations at 1/4, 1/2, and 3/4. Only the top 5bit of each sample is used as a 15bit "Library Address" in the output code. An "Amplitude Binary Logarithm" value points to the first 1 in the maximum amplitude Sample. Each 64bit output packet will provide all the information to reconstruct a waveform in the receiver. Spare bits are provided for stereo sound or other purposes.

Autosophy sound transmission is tailored to the perception limits of the human ear, which is about 100 Hz to 5kHz. Human perception for sound amplitude is logarithmic. Only 5bit per sample resolution is required to accurately define the waveform, where the overall amplitude is determined by the maximum sample. This "perceptible lossless" compression scheme may produce superior sound compared to Shannon-like sound transmission. The 64bit waveform codes are automatically re-aligned by the "Index" even if the codes are delivered out of sequence on the Internet.

## AUTOSOPHY VIDEO COMPRESSION AND ENCRYPTION

Autosoply video achieves very high data compression by transmitting only the moving or changing portions of the video images. The static portions of the images are not retransmitted. A software demonstration is available.

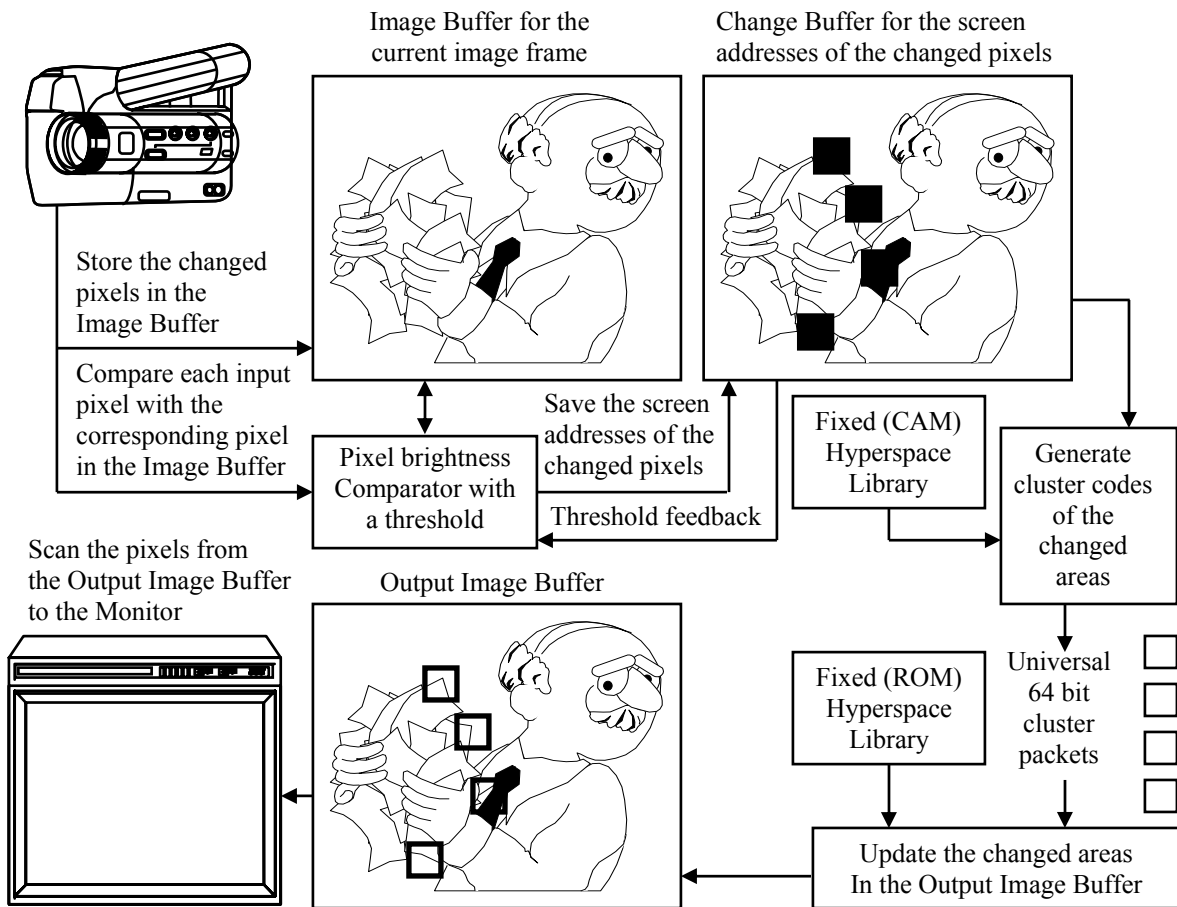


Figure 7. An Autosoply video compression and encryption system

Autosoply television requires an image buffer in both transmitter and receiver containing the current image frame. A new input image frame, from the television camera, is compared with the current image frame to detect the pixels whose brightness or color has changed more than a threshold limit. The newly changed pixels are stored into the image buffer. Non-changing pixels are ignored. The screen location addresses of the changing pixels are accumulated in a change buffer. The encoding process combines the changed pixels into spiral clusters using a fixed hyperspace knowledge library. The output is a universal 64bit code defining a group of changing pixels in a spiral cluster that can be anywhere within the output image frame. The video codes are randomly mixed with other data codes (representing sound, text, or random bit files) for storage or transmission. The receiver retrieves the spiral image cluster from the 64bit code using a duplicate fixed hyperspace library. The changing pixel clusters are used to update small areas in the output image buffer. The output image buffer is scanned at arbitrary intervals to the output monitor.

The packet rate in Autosoply television depends only on the video content, i.e., motion and complexity in the video images. The video hardware (i.e., the screen size, resolution and scanning rates) becomes irrelevant. This is analogous to human or biological vision. A blank or static video image would require no packet transmissions at all. On the other hand, totally random noise video images (snow) would require excessive packet rates. Most video images are composed of larger areas of mostly equal brightness and color. Also, moving objects in the video usually change many adjacent pixels at the same time instead of changing single pixels. The changing pixels can be combined, through spiral scanning, to combine several changed pixels into a cluster code. Simple, evenly colored video images therefore require fewer packet transmissions, therefore increasing data compression performance.



Figure 8. Autoscopy video compression and encryption

Each 64bit packet transmits a small cluster of pixels into the output image, which may contain up to 16 full color pixels (16bit/color resolution) and be located anywhere within the output image. The image on the left in Figure 8 shows the reconstructed video image, which is identical to the input video image because the compression is entirely lossless. The image on the right shows the changed pixel clusters, which are actually transmitted. The compression ratio is approximately the “colored” portion of the left image divided by the “colored” portion of the right image.

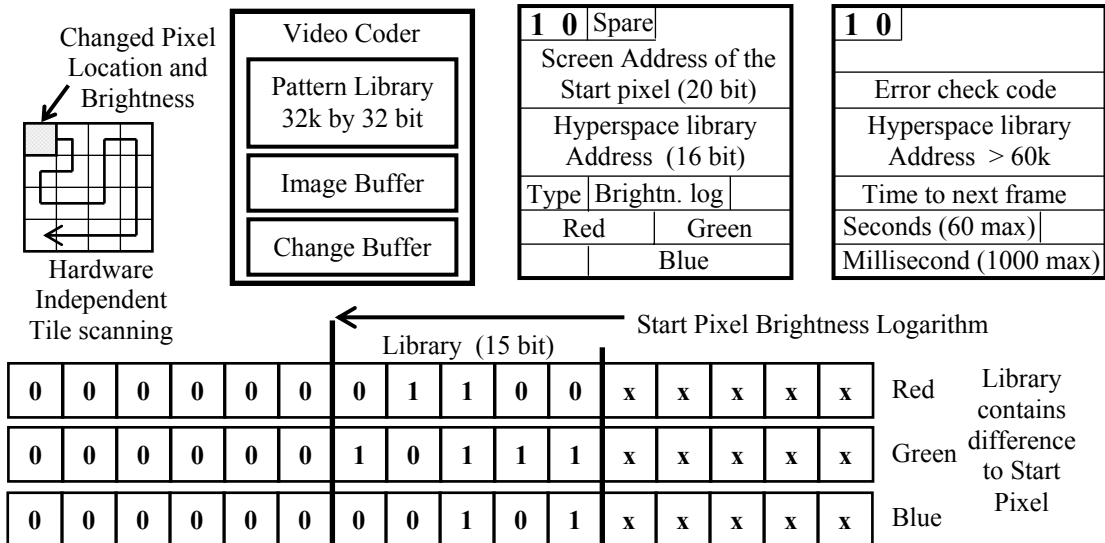


Figure 9. Autoscopy video compression and communication codes

The pixel color and brightness is encoded to conform to the logarithmic sensitivity of the human eye. The color is defined by 6bit/color where the dominant color determines the logarithmic brightness of the pixel. The most significant bit = 1 of the dominant color determines the 4bit "Brightness logarithm" of the pixel. The color of the start pixel of a cluster is therefore resolved with better than 1% accuracy, which is better than human vision, while the brightness resolution is 16 logarithmic levels. This special format can actually improve image color perception and eliminate the black fading effect in very dark images. The following pixels generate a 15bit code, which is the difference to the start pixel for encoding in the hyperspace pattern library. If the difference is too large then a cluster is terminated. Special control codes, with a library address above 60k, are used for frame control and other parameters.

The hyperspace libraries are grown prior to the video transmissions from an assortment of sample images using a software package. The library only contains the most common color difference patterns, which are selected by a special "bubble" algorithm. The library is then distributed via encrypted Internet downloading to all authorized receivers. Open, non-encrypted video can use a generic library, which is part of the software package. Without an exactly matching library copy, video interception is virtually impossible.



Autosophy still image compression systems contain an image buffer in the transmitter and receiver, which holds the images to be encoded or retrieved. Because the image transmissions are entirely hardware-independent, both the transmitter and receiver can have entirely different buffer sizes and resolution.

The input images in the buffer are cut into square tiles. Each tile may be regarded as a separate image. The tiles can be of any size, ranging from a single pixel to the entire image as a single tile. In this example, a 4 by 4 pixel tile is shown, scanned in a special hardware-independent pattern. The scanning sequence starts from a start pixel and proceeds until the entire tile has been scanned. The absolute red-green-blue brightness of the start pixel is stored in a reference register. Differences between the start pixel in the reference register and the next pixel in the scanning sequence are applied to the hyperspace pattern library.

The images must be stored in raw bit pattern format, such as separate red-green-blue fields (up to 16bit/color). As the compression algorithm is "visually lossless," the images can be compressed and expanded indefinitely without reduction in the image quality. The encoding algorithm encodes the images into 16bit codes, which are stuffed into universal 64bit codes. The 64bit codes can be randomly mixed with other data, including live video, sound, text, or random bit files for universal communications. The retrieval algorithm then retrieves the output image tiles from the 16bit codes, using a duplicate hyperspace library and the reverse hardware-independent spiral scanning sequence. The output image tiles are then pasted into the output image buffer. Special 16bit control or command codes are embedded into the code stream. A hyperspace library is grown prior to transmissions. It contains many thousands of the most common image "patterns" stored in a hyperspace mode. The library does not change during the image compression process. A generic library is part of the compression software to be used for open communications. Special encryption libraries may be grown for secure, encrypted communications. Both the transmitter and the receiver must have an identical copy of the hyperspace library. Useful image retrieval is virtually impossible without a matching library.

**TRANSMISSION OF RANDOM BIT FILES FROM LEGACY DATA FORMATS**

According to the Autosophy information theory, files such as totally random bit files, encrypted files, or previously compressed data files, cannot be further compressed without the risk of data expansion (negative compression). Data compression should therefore not even be attempted for random bit files or files of unknown data format.

Compressed and encrypted still image files are encoded into all 16bit codes, which are transmitted like random bit files. In an Internet teleconferencing session, for example, it should be possible to mix and insert up to 64 separate random bit files into the sound and video code stream for transmission in the Internet's intermittent packet stream.

A universal 64bit code packet is used for all random bit files or files of unknown origin. Each code contains a 48bit payload, an 8bit index, and a 6bit type code. The index and the type code are combined to allow the simultaneous transmission of up to 64 different data files, which are mixed in the same channel on the Internet. The index is required because data packets may be delivered out of order on the Internet. The current Internet TCP/IP protocol provides error retransmission and sorting of packets, but this cannot be relied upon in a universal protocol. The 64 data type codes may be assigned for generic files, such as still images, Microsoft compatible files, or control register arrays.

**ERROR-PROOF AND SECURE POST TCP/IP COMMUNICATIONS PROTOCOL**

A next generation of the Internet could include revolutionary improvements to the TCP/IP protocol. This would provide error-free communications with virtually impenetrable security for all mixed multimedia communications.

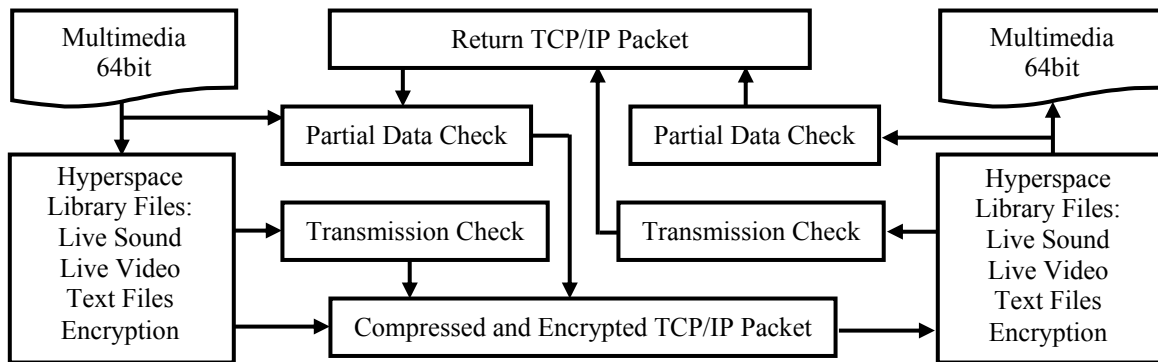


Figure 12. Secure and error-proof communications protocol

The next generation communication protocol may use a universal 64bit data format that may be forwarded from media to media (wire to radio, to satellites, through the Internet) without needing to be reformatted. Each communication terminal would use one or many pre-grown hyperspace libraries. Open, non-encrypted, communications would use "generic" libraries that are supplied to anyone in the communications software packages. Encrypted communications would use hyperspace libraries that are grown by software from data samples. The libraries may be downloaded in encrypted format to all authorized communication partners via the Internet.

Each packet would generate two communication check characters. The TRANSMISSION CHECK character is a checksum of all the transmitted codes in a packet. It confirms that a data stream was transmitted without errors. The DATA-CHECK character is a checksum code that is generated from the data retrieved from the hyperspace library. Both check characters are returned to the transmitter as in the TCP/IP protocol. If both check characters match then the packet transmission was successful without errors. If both check characters don't match then a normal communications error has been detected. The data packet is ignored and repaired by a normal TCP/IP packet retransmission. If the TRANSMISSION CHECK character matches and the DATA-CHECK character is incorrect, then an attempted break-in or deception is detected. Only a receiver in possession of the correct encryption library could generate the correct DATA-CHECK code. This both confirms correct data reception by the receiver, and that the receiver is authorized to receive the data. Instant detection of break-in or deception would allow for instant countermeasures, such as ignoring the transmissions or tracing the transmission through the Internet to its source (its telephone number).

### IMPROVEMENTS TO NETWORK-CENTRIC SYSTEMS

Converting conventional platform-centric communication systems to modern network-centric systems requires a holistic approach that may solve most communication problems at the same time. Piecemeal solutions to specific problems, or improvements to the old Shannon based communications, will not be sufficient. The future Internet would provide data compatibility for all communications in any media. Knowledge files may be merged so that only new knowledge needs to be transmitted. The new data formats may provide virtual immunity to the Internet's Quality of Service problems and additional high data compression and encryption.

**A shift from hardware-based to content-based communication:** Bit rate or bandwidth requirements in conventional (Shannon) communications are tied to the data volume or the communications hardware. For example, whenever television evolves towards larger screens and better image quality, then a new standard protocol is required that will be incompatible with all the previous standards. Communication networks are caught in an endless cycle of introducing new data standards and upgrading old documents that have become incompatible. In Autosophy communication, in contrast, the bit rates are dependent only on the data "content" (meaning), which is universal and hardware independent and which will not change with future evolution in the hardware. Converting old communication methods or files from legacy protocols or operating systems to the new 64bit format can be done by simple software patches or by small chipsets for real time data such as live video. This would provide a paradigm shift in communications and data archiving that may revolutionize all communications and the Internet. The new standards may be introduced slowly without interference with existing Internet communications.

**High data and video compression and resistance to transmission errors:** For the next generation communication systems, data and video compression is no longer a choice but a necessity. Though higher bandwidth channels may become available in the future, a need for higher and higher bandwidth will also increase. There is simply not enough bandwidth in digital radio, satellite links, or the Internet, to satisfy demand. If compression is "lossless", then data compression will be much less expensive than building higher bandwidth channels. Both conventional "lossy" and Autosophy "lossless" compression can be used in the future. In conventional lossy image compression (JPEG, MPEG-2, DCT, Wavelets, Fractals) compression is achieved only by sacrificing image quality. The more the video images are compressed, the worse the image quality becomes. Image distortions include blurring, blocking, jagged motion, and introduced image artifacts, which may resemble objects not actually in the input images.

Error sensitivity is a severe problem in conventional video compression (JPEG, MPEG-2, MPEG-4, Wavelets, Fractals). A single wrong bit or gaps in the transmission can cause the video images to break up into random (snow) noise. This makes conventional video extremely sensitive to noisy radio transmissions or intentional jamming. The problem is especially severe in Spread Spectrum Transmission, which is inherently very noisy. Autosophy video in contrast is extremely resistant to transmission errors. Incorrect bits or missing portions in the transmission will only cause tiny spots on the video screen to freeze when they were supposed to change. The video quality will therefore remain excellent even in very noisy or jammed transmissions.

**Providing secure network-centric multimedia communications between all nations and operating systems:** Universally compatible multimedia communication requires that all data standards must remain compatible regardless of operating systems or future evolution in the communications infrastructure. Compatibility must include all data types including live video with synchronized live sound, text, still images, and unknown file formats from legacy devices. The new data formats should be compatible with current platform-centric or Internet communication methods, for a gradual shift towards the new Autosophy communications. Legacy data formats should be converted to the new 64bit universal format by software patches or chipsets for real-time data. Encryption is required to authenticate a communication and to prevent interception of data by unauthorized users. Conventional data formats require additional hardware or software for encryption, including firewalls and access controls. Autosophy communication, in contrast, offers unbreakable "codebook" encryption by growing separate encryption libraries for each user. This provides positive authentication and virtually unbreakable barriers to data interception. Data being misdirected by the server will be useless to the unauthorized receiver. Only a receiver with the correct library will be able to retrieve useful information. Encryption libraries may be downloaded via the Internet, in encrypted format, to change the encryption keys in each terminal. Attempts of deception can be detected immediately to initiate appropriate countermeasures, such as simply ignoring the packets or to trace the packets back through the Internet to its sender. Autosophy would allow a user to carve his own private Internet from the public Internet using private encryption libraries.

**Reliability profiles: platform-centric vs. network-centric systems.** In conventional platform-centric systems a single hardware or software failure can cause a total communications blackout. The reliability profile resembles a very long chain in which a break in any link will cause a total failure. The longer the chain becomes, the higher the probability of a failure. The Mean-Time-Between-Failures (MTBF) is calculated from the number of components in the system and the failure probability of each component. The larger a platform-centric system becomes the higher the probability of a failure. Network-centric systems, in contrast, have a living tree-like reliability. Cutting a few leaves or branches from a tree may not lead to failures. A tree will not only continue functioning, but will eventually repair itself by re-growth of the still functioning branches. In network-centric systems, likewise, a terminal failure will only cause a localized failure in communications. The terminal may be replaced or the terminal may use alternate media, such as cellular phones, satellites, radio, or wireless Internets. The new network-centric systems may cause orders of magnitude increases in communications reliability.

## CONCLUSIONS

Conventional platform-centric systems were developed as the only available option at the dawning of the computer age. A large mainframe computer was used to connect all communications media, sensors, and terminals. Communication was concerned mainly with squeezing as many signals or bits as possible through very noisy transmission channels. Information was defined by the Shannon information theory, as binary "quantities" measured in bits and bytes, transmitted in meaningless bit streams. This outdated theory is still taught at our universities, even though there is no evidence of any living creature actually communicating in this way. These early systems are now being replaced by modern network-centric packet-switching systems, such as the Internet, the Global Information Grid, or the future Information Superhighway. Unfortunately, technological developments have greatly outpaced theoretical understanding and information theories. Most experts are still trying to solve the many problems on the Internet using Shannon's solutions, i.e., more bandwidth, lossy data compression, and better protocols. This cannot be successful. The new network-centric systems will require a new information theory. This new information theory will be able to solve virtually all the Internet's problems and open the way to a next generation Internet. There is no doubt that the Autosophy paradigm will replace all Shannon based applications in the very near future.

When a radically new theory replaces an older, well-established theory then new and unexpected applications will appear opening the way to entirely new industries. Autosophy-based machines will shortly replace virtually all Shannon-based technologies, essentially our entire communication infrastructure. It will also replace the programmed data processing computer with brain-like self-learning and failure-proof autosopher. Self-learning machines may greatly exceed human intelligence and open the way to self-organizing intelligent robots. This may eventually evolve into true Artificial Intelligence. The new machines may even have learning modes that are not available in our own brains. The following applications may be imminent:

**Wireless network-centric systems** will overcome most problems caused by the outdated Shannon methods. It may provide virtual immunity to the Internet's Quality of Service problems, and add high lossless data compression with impenetrable security.

**Universal Internet Multimedia** will allow the mixing of all data types, such as video with synchronized sound, still images, text, and random bit data. All data types are randomly mixed in the Internet's intermittent packet stream while avoiding the Quality of Service problems. No data transmission or data file will ever become incompatible because of changes in the hardware or in the operating systems.

**HDTV Internet television** will become possible because of the very high video and sound compression. All video transmissions will be compatible regardless of screen size, color resolution, frame rates, or image formats.

**Error-proof memories** may provide enormous storage capacities at low cost and small size. The memories are self-organizing, self-checking, self-healing, self-repairing, and even self-cloning and self-rejuvenating.

**Self-learning robots** will require no programming. They may never fail or produce wrong information even after suffering severe physical damage.

**Artificial intelligence** may provide unlimited learning capacity combined with virtually absolute reliability. They may have virtually unlimited intelligence and learning modes that are not possible in our own brains.

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