

Web Survey on Consumer Electronics Technology MegaTrends

Stuart Lipoff
 Applied Value Company
 Lexington, Ma 02412
 tel +1.781.778.1800
 mailto:s.lipoff@ieee.org

In the IEEE Consumer Electronics Society February 2002 Newsletter I introduced the idea of a technology megatrend. By analogy to John Naisbitt's definition of megatrends I consider a trend, or technology theme, to be a candidate for my list if bringing the technology into the market has the potential to be disruptive to business as usual-- something much more than just evolutionary improvement. By disruptive I mean it can change the rules of the game by negating the competitive advantage of the industry leaders, by changing the basic economics of the business, and/or by creating new opportunities that never existed before.

The figure 1 list of candidate megatrends in the February newsletter was based on my own personal viewpoint and I was curious about two points: 1) Would other CE industry participants agree with my choice of megatrend candidates and 2) Did I miss some important key trends.

In order to get member feedback in an efficient manner, I designed the figure 2 simple web survey and invited the CE membership to respond by both rating my list of megatrend candidates as well as provide the opportunity for WRITE Ins to pickup candidates I missed.

There were a total of 62 votes submitted via the website at <http://www.comminfotech.com>. The 62 participants were a broad cross section of the industry as follows: 36 consumer electronics manufacturers, 5 component manufacturers, 3 other, 16 retailers, 2 telecommunications/cable service providers. There were no university/academic votes. I have not performed a separate analysis on the differences between the groups as the sample size of the subgroups is small.

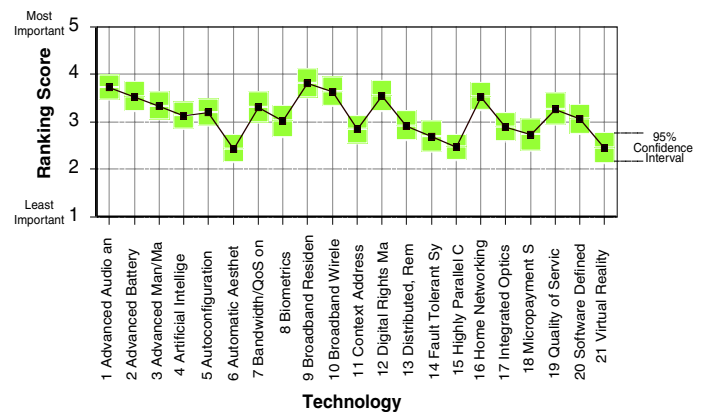
The submissions from the website were imported into The Minitab® statistical analysis program and some analysis was performed to gain insights. A summary of the analysis is presented in table 1 and graphed in figure 3.

Table 1
Summary Statistical Analysis
Web Poll Voting Results
Technology MegaTrend Candidates

Technology	MEAN	STDEV	SE MEAN	Low 95CI	High 95CI
1 Advanced Audio and Video Compression	3.726	1.043	0.132	3.461	3.991
2 Advanced Battery & Micro Fuel Cells	3.532	1.238	0.157	3.218	3.847
3 Advanced Man/Machine Interfaces & I/O	3.359	1.173	0.149	3.041	3.637
4 Artificial Intelligence Expert & Agent Systems	3.129	1.138	0.144	2.84	3.418
5 Autoconfiguration and Self Discovery Algorithms	3.194	1.128	0.143	2.907	3.48
6 Automatic Aesthetic Driven Media Conversion	2.435	1.196	0.152	2.132	2.739
7 Bandwidth/QoS on Demand Resource Allocator	3.306	1.262	0.16	2.986	3.627
8 Biometrics	3.016	1.349	0.171	2.674	3.359
9 Broadband Residential Multimedia	3.823	1.208	0.153	3.516	4.129
10 Broadband Wireless Packet	3.629	1.204	0.153	3.323	3.935
11 Context Addressable Storage	2.839	1.148	0.146	2.547	3.13
12 Digital Rights Management	3.548	1.327	0.168	3.211	3.885
13 Distributed, Remote, & Peer-to-Peer Computing	2.919	1.232	0.156	2.606	3.232
14 Fault Tolerant Systems	2.694	1.262	0.16	2.373	3.014
15 Highly Parallel Computing Architectures	2.468	1.082	0.137	2.193	2.743
16 Home Networking	3.532	1.183	0.15	3.232	3.833
17 Integrated Optics and All Optical Networks	2.887	1.216	0.154	2.578	3.196
18 Micropayment Systems	2.726	1.333	0.169	2.387	3.064
19 Quality of Service over IP Networks	3.274	1.345	0.171	2.933	3.616
20 Software Defined Products	3.065	1.253	0.159	2.746	3.383
21 Virtual Reality	2.452	1.263	0.16	2.131	2.773

Figure 3 shows both the mean ranking as well as the 95% confidence interval.

Figure 3
Web Poll Voting Results on Relative Importance of
Technology MegaTrend Candidates



From the statistical analysis I observe the following:

- All of the 21 MegaTrends had a respectable showing, which given that they were pre-screened to be of interest this finding is not a surprise.
- The 95% confidence interval band is very narrow and about the same magnitude for all MegaTrends-- on the order of +/- 0.25 of a score division

Figure 1
Original List of Megatrend Candidates as Published in IEEE Feb 2002 CE Newsletter

Advanced Audio and Video Compression	Algorithms that not only approach near lossless coding but are also computationally aligned with the limited processing power of inexpensive, portable, battery powered devices. The algorithms should be low delay and insensitive to channel transmission impairments and errors.
Advanced Battery & Micro Fuel Cells	Next generation electrochemical devices including batteries and micro fuel cells (e.g. alcohol) that provide increased volumetric and gravimetric energy density, high degree of safety, rapid recharge rates, and long cycle life at low cost
Advanced Man/Machine Interfaces & I/O	As devices get physically smaller and more complex it will be vital to find innovative input/output technologies and displays that provide the resolution at low power drain and small size and weight (e.g. offscreen, projection, and virtual displays perhaps combined with pen input or voice I/O
Artificial Intelligence Expert & Agent Systems	We can build many more features into today's products and services than we can take the time to learn to use. To realize the visions of next generation products and services, we need to incorporate intelligence into the products that adapt to each unique user with a natural language interface and can use agent technology to anticipate and automate routine tasks.
Autoconfiguration and Self Discovery Algorithms	Today's products are moving rapidly toward being but one node in a network of public and private peer-to-peer devices and network access points which need to reconfigure as we move from home, to the street, to the automobile, to the office, and between other islands of connectivity. We need technology that can manage the security, privacy, and billing that supports this mobility.
Automatic Aesthetic Driven Media Conversion	Content providers invest as much or more in the production values of their content. Today's trend to repurposing this content between publications, audio, video, movies, computers, internet appliances, etc-- will be become even more intense as the variety of delivery systems and delivery platforms expand into the future. We need technology that can reformat and repurpose content adding navigation and finding aids that is low cost and automatic.
Bandwidth/QoS on Demand Resource Allocation	The benefits of connectionless packet switched networks for wired and wireless applications is clear, but these networks were not designed to support the quality of service needs of streaming and delay sensitive information such as video, music, and voice telephony. Also many wireless networks, and wired networks, are resource limited and only economic if bandwidth is allocated as needed. We need modulation, coding, and protocol technology that allows demand assignment of QoS and bandwidth with a compatible billing system.
Biometrics	As much of the valuable content and information migrates from physical to electronic form access control and conditional access systems will become critical technologies that give comfort to content owners and consumer users of personal information devices that their content and data are safely locked away with the key being the end user biometrics.
Broadband Residential Multimedia	We are already seeing cable operators offering multimedia bundles of video, internet, and telephony but still lack technologies that take advantage of the possible synergies in cost, performance, and features. Today's solutions suffer from limitations in reliability, difficulties in powering, and high maintenance and logistics costs. We need new architectures and technologies to deal with the limitations of today's solutions.
Broadband Wireless Packet	The promise of 3G wireless for anything, anywhere, anytime is still a promise and while consumers are excited about the vision; today's technology can not deliver the coverage, capacity, cost, convenience, or control that meets the minimum threshold for mass market acceptance.
Context Addressable Storage	While we have advanced technologies available to index, store, and retrieve text based electronically coded content we need parallel indexing and retrieval technologies for non-textual material such as music, video, pictures, voice, fax, and compound documents.
Digital Rights Management	To provide commercial support for electronic sale, distribution, and management of content we need systems that are secure and robust against piracy, renewable, low cost, simple to use, and flexible enough to work in a world of mixed physical, broadcast, and unicast content distribution. The technology must scale to work from content servers to personal and portable battery efficient multimedia devices.
Distributed, Remote, & Peer-to-Peer Computing	Already we see the emergence of networked computing with many consumers sharing databases and content between their PDA, home computer, and office systems. This technology will need to grow to accommodate wireless devices, internet appliances, and new applications.
Fault Tolerant Systems	The vision of a home server or home automation system is not aligned with today's computing devices which exhibit high degrees of hardware and software failures. We need both hardware and software architectures which are fault tolerant, self recovering/repairing, and support remote diagnostics.
Highly Parallel Computing Architectures	To support the demands of multimedia computing, artificial intelligence, agent technology, media conversion, and other nonlinear computing tasks, we need new computing architectures and applications development tools that automatically translate linear code into code suitable for these special highly parallel architectures
Home Networking	With many computers, printers, TV outlets, telephones, etc in the home there is already a need for multipurpose networks. As new home servers and broadband residential access services grow there will be a need for next generation networks which scale in cost and performance from low bit rate control signals up to HDTV rates.
Integrated Optics and All Optical Networks	All optical and passive optical networks offer the promise of very low cost and highly reliable infrastructure for supporting next generation residential multimedia services. Integrated optical devices serving as transceivers and mux/demux functions at the subscriber premises offer the promise of meeting the demands of high performance at low cost.
Micropayment Systems	As a large fraction of today's transactions are in cash and often small value, an efficient and secure micropayments system is needed to support ebusiness as well as point-of-sale transactions with electronic media
Quality of Service over IP Networks	Networks need fully compatible end to end control of quality to support the mix of streaming and non-streaming content
Software Defined Products	Given deregulation and intense competition along with uncertain consumer market requirements for new products and services it is necessary to launch and fine tune products after sale well into their life cycle. By having the product be defined by software, it can be adapted to support evolution of the products and services as well as create attractive recurring revenue streams for the seller
Virtual Reality	With the power of today's computing devices we can now render near photorealistic animated virtual worlds creation new and exciting opportunities for games, information services, and remote telepresence applications.

Figure 2 Megatrend Feedback Form from Website

**Member Feedback on
Consumer Electronics
Megatrends**

**Consumer
Electronics
Society**

Please refer to the January 2001 issue of The IEEE Consumer Electronics Society Newsletter or [click here](#) for a copy of the article by Stuart Lipoff of Applied Value on Consumer Electronics Megatrends

Instructions: Review the candidate list of technology megatrends and vote your perspective on how important each trend is likely to be to the consumer electronics industry over the ten year period starting in 2002. Use the writein space at the bottom to record any technology megatrends that may be missing from the list. Comments and remarks are also welcome.

Please provide your email address so we can avoid multiple counting. Your email address will not be used for any other purpose

Your Email Address:

Type of Your Company or Institution

	CE Product Manufacturer	Component Manufacturer	Service Provider	Academic or Research Institution	Other
please select only one best category>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

<Least Important Most Important>

Candidate Technology Megatrend	1	2	3	4	5
1 Advanced Audio and Video Compression	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2 Advanced Battery & Micro Fuel Cells	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3 Advanced Man/Machine Interfaces & I/O	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
4	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
WRITE INs					
22 <input style="width: 95%; height: 15px;" type="text"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
23 <input style="width: 95%; height: 15px;" type="text"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
24 <input style="width: 95%; height: 15px;" type="text"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
25 <input style="width: 95%; height: 15px;" type="text"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Enter any comments or remarks in the space below

[Click Here to record your vote](#)

(the scores range between 1 to 5).

- Considering that the confidence interval band is about +/- 0.25 there are three clear clusters in the MegaTrends votes:
 - 1) a consensus group of high scores above 3.5
 - 2) a middle group of scores between 3.5 and 2.7, and
 - 3) a lower scoring group at 2.7 or less

The high cluster included Advanced Audio and Video Compression, Advanced Battery Technology and Microfuelcells, Broadband Residential, Broadband Wireless, Digital Rights Management, and Home Networking. The low cluster included Automatic Aesthetic Driven Media Conversion, Highly Parallel Computing Architectures, and Virtual Reality

What surprised me from the cluster analysis was the lower cluster. I view these low scored trends to be at least as important as those in the middle cluster. It might be interesting to discover what is the basis for these low scores. Some possibilities could be a lack of understanding what was meant by the technology title, a falling from favor due past over promise for the technology, or a true belief that these technologies are not megatrends. Perhaps we can devote future articles in the CE Newsletter to a discussion on the pro versus con of these low scoring technologies.

To gain some insight on higher order statistics, I also generated histograms in figure 4 of the votes for each megatrend candidate so that the shape of the voting distribution can be observed. As you can see from the histograms, that while several of the MegaTrends have the same mean they have very different distributions. For example, in the case of Biometrics the votes were evenly spread while in the case of Software Defined Products there was a clear peak at about 3.0.

You will note the figure 2 web survey form also provided for write-in candidates. We did not get enough votes on any one write-in to allow a statistical analysis but we did get some interesting additions to the MegaTrend candidate list. The write-in candidates were:

- Software downloadable products
- MEMS based directional antennas
- MEMS acoustic array directional microphones
- Real-Time and Embedded Systems

- Conventional and Unconventional Optical Storage
- Miniaturization of Portable Devices
- Digital TV via Cable
- Unified conditional Access for video services
- Nanotechnology
- Disposal of all the products using the technologies mentioned above
- Software quality improvement
- Dynabook with recording (all kinds) capability
- Wireless data links
- Security
- Companies sourcing products instead of designing products
- Content analysis in audio/visual systems
- Communicating Embedded Systems
- Autonomous robots
- Content-based indexing and retrieval
- Multimedia database management system

While some of these write-in candidates arguably overlap with the original list, there are some interesting additions. I believe the MEMS and nanotechnology categories to be of particular interest.

While the opportunity for contribution to the statistical findings for this project are now closed, it is not too late to provide feedback and opinion. The results of this study will be used by your society to drive our conference topics and technical activities and hopefully will be useful to our members as they plan their R&D investments. Please email any comments to the attention of our newsletter editor, Jim Farmer.

About the Author

Stuart Lipoff is partner at Applied Value Corporation and provides consulting services to manufacturers and services providers in the consumer electronics, communications, and information technology industries. Prior to Applied Value he spent 25 years at Arthur D Little, Inc as VP Technology and Product Development. He is past president of The IEEE Consumer Electronics Society, an IEEE fellow, and a member of the ACM, SMPTE, and SCTE. Mr Lipoff holds B.S. degrees in Electrical Engineering and Engineering Physics, an MSEE, and an MBA. He is a registered professional engineer in Massachusetts.

Figure 4
Histogram of MegaTrend Votes

