

December 2002

THE FUTURE OF THE WIRELESS APPLICATION PROTOCOL

Dennis Viehland
Massey University (New Zealand)

John Hughes
ANZ Bank (New Zealand)

Follow this and additional works at: <http://aisel.aisnet.org/amcis2002>

Recommended Citation

Viehland, Dennis and Hughes, John, "THE FUTURE OF THE WIRELESS APPLICATION PROTOCOL" (2002). *AMCIS 2002 Proceedings*. 260.
<http://aisel.aisnet.org/amcis2002/260>

This material is brought to you by the Americas Conference on Information Systems (AMCIS) at AIS Electronic Library (AISeL). It has been accepted for inclusion in AMCIS 2002 Proceedings by an authorized administrator of AIS Electronic Library (AISeL). For more information, please contact elibrary@aisnet.org.

THE FUTURE OF THE WIRELESS APPLICATION PROTOCOL

Dennis Viehland

Massey University (New Zealand)
d.viehland@massey.ac.nz

John Hughes

ANZ Bank (New Zealand)
hughesj@anz.com

Abstract

The purpose of this research was to assess the potential success of the Wireless Application Protocol (WAP) technology in the wireless communications arena. An extensive literature review identified 38 issues and trends related to the future development of WAP. The Delphi research methodology was used to consolidate these trends into 12 scenarios, which were then (a) ranked on their importance to the success of WAP and (b) rated on their likelihood of occurrence, by a panel of industry and academic experts in electronic commerce and wireless communications.

The key findings from the research are that:

- *Technology issues such as speed of access and infrastructure will be the greatest determinants of the success of WAP. The necessary infrastructure must be in place before WAP (and other mobile applications) can be successful.*
- *Business and market issues such as an expanding customer base, consumer-driven applications and market forces will play a critical, secondary, role in determining the success of WAP.*
- *Alternative technologies such as the development of personal digital assistant (PDA) devices will strongly encourage/limit the growth of WAP.*
- *The newer and more uncertain technologies are rated as least likely to happen.*

A more general finding from this study is that while WAP has achieved limited success at the start of m-commerce development, the long term outlook for WAP is very narrow, with further development limited to specialised, short transaction-oriented applications for WAP-enabled cell phones. Other, more open and global technologies are likely to advance ahead of WAP for most business and personal applications.

The findings are important for business because adoption of the wrong wireless technology early in m-commerce can lead to expensive and time-consuming re-work of the applications and infrastructure. Researchers will find value in this study as an illustrative study for the use of the Delphi method in projective technological forecasting.

Introduction

In the newspapers, magazines, books (e.g., Kalakota and Robinson 2002), and on the Web mobile commerce (m-commerce) is heralded as the next big thing, even “the successor of e-commerce” (Muller-Veerse 2001). This bold future seems possible given the broad definitions of mobile commerce,¹ the ubiquity of mobile telephones and other wireless devices (Cane 2000; Southward 2001) and range of business, entertainment, reference and personal applications being proposed. This seemingly inevitable future

¹For example: “The delivery of electronic commerce capabilities directly into the consumer’s hand, anywhere, via wireless technology” (Southward 2001. p. 25).

for m-commerce is summarised well by this observation: “Whether or not the breathless predictions come to pass, the wireless Web is slowly weaving itself into everyday life” (Alpert and Musser 2000, p. 28).

Beyond the hype, success in the m-commerce arena will be determined by the details – the business models, the applications, and the technologies that are adopted by the sellers and the buyers. The focus of this paper is to provide guidance to business people, vendors, industry observers, researchers, and others who are trying to determine the potential success of WAP, an early dominant wireless technology.

This is not idle research; there are important implications here. Many organizations are developing applications using WAP technology for the presentation and manipulation of data. If WAP technology stumbles, and another competing technology runs ahead, then much re-work, re-design and re-development will be required to convert the WAP-enabled application. The consequences for the organization are financial costs for the conversion and business losses as other competitors achieve first mover advantage and gain market share.

This paper begins with an overview of the wireless application protocol, essentially a highly condensed summary of the literature review that was conducted to initiate this research. The methodology section describes the Delphi research method as it was applied in this study. Then the results of the study are presented and discussed. The report concludes with some observations about the study and the results.

Wireless Application Protocol

WAP translates Web documents onto mobile devices, including mobile telephones, pagers, personal organisers and other handheld devices. The original intent, according to Southward, was “a single set of content and application standards to ensure product inter-operability” (2001, p. 37). However, it has since come close to a global de facto standard for the presentation of Web content on handheld wireless devices.

The Wireless Application Protocol was developed by Unwired Planet as part of an alliance with the major mobile telephone manufacturers – Ericsson, Motorola and Nokia. Facing the threat of a fragmented market due to the proliferation of multiple systems for mobile services, these companies agreed to form the WAP Forum, which produced the WAP 1.0 specification in April 1998. The WAP Forum was then opened to membership from other organizations and there are now over 200 members.

The goals of the WAP Forum are (WAP Forum 2000):

- To bring Internet content and advanced data services to wireless phones and other wireless terminals.
- To create a global wireless protocol specification that works across all wireless network technologies.
- To enable the creation of content and applications that scale across a wide range of wireless bearer networks and device types.
- To embrace and extend existing standards and technology wherever possible and appropriate.

A technical introduction to WAP and the WAP architecture is available from the WAP Forum’s Web site (Hubbard 1999).

WAP has been the subject of numerous articles over the last two years, many characterised by divergent views as to the success (Goldman 2001; Frederick 2000; Jackson 2000; Schwartz 2000; Shah 2000; Johnson 1999) or demise (Dooley 2000; Lewis 2000; Loken 2000; McGrath 2000; Sims 2000) of the protocol.

The WAP specification contains a number of technical deficiencies (Khare 1999; Saarinen 1999; Valdes 2000). For example, one analysis of protocol development found that a successful protocol contains a good technical design, is open to public commentary about its development and maintenance, includes little or no legal and financial restrictions on the use of the protocol and the specification is widely published and freely available. This study found WAP meets none of these criteria (Banan 2000). Other technical barriers are the limitations of the handsets (Banan 2000), the translation of HTML pages at the WAP gateway (Bannan 2000), lack of security (Sims 2000) and the incompatibility of WAP with other Internet standards (Khare 1999).

Practical trials have been difficult too. The most significant launch of WAP services to date in England in 2000 was not a success (Loken 2000). Some of the reasons were insufficient bandwidth that produced unacceptable response times, limited applications and service and insufficient quantities and poor reliability of the WAP-enabled handsets (Logan 2001).

The WAP Forum ignores these criticisms principally by outlining the achievements and market acceptance of WAP. The WAP Forum CEO (Goldman 2001) paints an impressive picture of success by citing:

- Nearly all handset manufacturers have a WAP browser on their phones.
- The WAP Forum membership continues to grow.
- The Internet site (www.wapforum.org) receives over one million hits per month.
- The 19 working groups of the WAP forum are very active, with numerous forum groups and five formal meetings per year.
- Over four million WAP pages are available on the Internet.
- WAP intends to increase WAP available content by migration to the eXtensible Hypertext Markup Language (XHTML).

More substantially, there have been some WAP success stories in freight tracking (Jackson 2000; Fisher 2000), taxi dispatch (Kamadolli 2000), sales workforce automation (Malcolm 2001), banking (Engen 2000), stock market alerts (Kamadolli 2000) and in delivery of location-based personal services such as theatre and cinema ticket booking, restaurant finders, weather forecasts, travel-related booking systems and even in-bookstore book reviews (Adam 2000).

The Delphi Method

There is no shortage of research studies that anticipate the future of mobile commerce. However studies from consulting firms (e.g., Ernst & Young, Gartner Group) or industry players (e.g., Nokia, WAP Forum) may carry some bias. In technology forecasting especially, writers who write about technology revolutions tend to stimulate that same revolution by emphasising the positive and minimising the negatives, leading to a type of bias labelled as “technological utopianism” (Dunlop and Kling 1991, p. 14). “Intent-to-buy” studies from organizations such as Forrester and IDC are rated poor-to-good for short and medium term forecasting and very poor for long-term forecasts (Chambers, Mullick, and Smith 1971).

Two forecasting techniques that reduce over-optimism and provide more rigour are extrapolative planning (i.e., seek determinates of past trends and use them to extrapolate future trends) and projective forecasting (i.e., use technology building blocks to forecast technological futures) (Schwartz 1969). Trend data in m-commerce tends to be very short term, severely limiting the use of extrapolative planning. Even when long-term trend data are available, this technique assumes what was will continue, albeit in a modified form (Maital 1993). Which leaves projective forecasting as the best method for achieving rigorous, non-bias research in technological forecasting. One of the most effective tools for projective forecasting is the Delphi method.

The Delphi method is a structured survey process of consolidating the opinions of a group of experts into a judgement on an issue, usually related to the future. Named after the future-telling Oracle of Delphi in ancient Greece, the Delphi method was first used shortly after World War II to achieve a consensus of expert military opinion about likely targets for a future war. Since then the method has been used extensively for technological forecasting in companies such as TRW, IBM, AT&T, Corning Glass, Goodyear and ICL (Bartol and Martin 1994).

As executed in this study, the Delphi method process is:

1. A panel of 16 experts from industry and academia in Australia, Hong Kong, New Zealand and the United States were selected based on their experience and knowledge of electronic commerce and wireless communications.
2. A coordinator assembled a set of 38 issues and trends in six broad categories – competition, leadership, human interface, network technology, market segments and technology progress – based on an extensive literature review. A pilot test was conducted to insure the issues and associated commentary were clearly stated.
3. In round one the panelists were asked to review and comment on this list for completeness and their agreement or otherwise on the validity of the item in relation to WAP.
4. The results of round one were collated by the coordinator and used to generate twelve scenarios and trends that were deemed significant to the success of WAP.
5. In round two the panel was asked to rank each item from 1 to 12 in terms of its “how important is this to the success of WAP”. Panelists were also asked to rate each item on a five-point Likert scale in terms of “likelihood of happening” (i.e.,

definitely happen, most likely happen, may or may not happen, unlikely to happen, definitely not happen) in the next two years. Finally, the experts provided comments about why they ranked and rated items in a certain manner.

6. The results of round two were tabulated by the coordinator, resulting in a ranked-and-rated list of issues and a list of comments about each item.
7. In round three this ranked-and-rated set of issues was returned to the panel with all (anonymous) comments. Each respondent was asked to consider their own ranking and rating and alter any of their scores if they wished. The purpose of this feedback and review was to seek a consensus of opinion, and for divergent views to be confirmed.
8. The results of round three revealed very little movement of opinion and general satisfaction among panel members with the results. If round two results had changed dramatically, additional rounds would have been required.

The panel consultation (steps 3-8) took place over 14 weeks in mid-2001. Sixteen panelists participated in round one, nine panelists contributed to round two and eight panelist returned results in round three.

The process was completed carefully to insure that the fundamental requirements of Delphi method were met (Linstone and Turoff 1975):

- Each round is completed in isolation to insure independent judgement of each panel member during the round.
- Each round includes anonymous feedback of the panel’s collective views from the previous round. Controlled feedback enables experts to refine their views on the questions at hand and anonymity avoids the introduction of bias.
- Each round gives members the opportunity to revise their views.

In summary, the Delphi method is a structured process for collecting and sharing expert knowledge in order to address an issue that is difficult to consider using other forecasting techniques.

Results

Table 1 shows the final ranking for the twelve items (1 = most important to WAP success; 12 = least important), the mean rating value (1 = most likely to happen; 5 = most unlikely to happen) and standard deviations of both values.

Table 1. Final Results of Delphi Survey on the Future of WAP

| Scenario/Trend | Mean Rank | Std Dev | Mean Rating | Std Dev |
|--|-----------|---------|-------------|---------|
| 1. Alternative technologies | 1.8 | 0.7 | 2.4 | 0.5 |
| 2. The interface changes | 4.9 | 3.6 | 1.8 | 1.0 |
| 2. Infrastructure for business success | 4.9 | 1.2 | 2.2 | 1.0 |
| 4. 3G delays and 2.5G reality | 5.0 | 3.8 | 2.9 | 1.3 |
| 5. m-Commerce hype and reality | 5.4 | 1.5 | 2.7 | 0.7 |
| 6. Market niches | 6.7 | 2.2 | 2.0 | 0.8 |
| 7. iMode domination | 7.2 | 3.8 | 3.2 | 1.0 |
| 7. Voice recognition is king | 7.2 | 3.9 | 3.4 | 0.9 |
| 9. Health and mobile networks | 7.4 | 3.6 | 2.8 | 1.4 |
| 10. Mobile customers increase | 7.8 | 2.4 | 2.7 | 1.3 |
| 11. Microsoft stings m-commerce | 8.4 | 3.6 | 3.1 | 1.3 |
| 12. WAP Forum membership | 9.9 | 1.9 | 2.7 | 0.7 |

Table 2 includes a description of the issue or trend and commentary by the authors about the results, based on the quantitative data presented in Table 1 and detailed panel results and comments (not included here).

Table 2. Twelve Scenarios/Trends to Determine the Future of WAP

| Scenario/Trend | Commentary |
|---|---|
| Alternative technologies: Other technologies (e.g., personal digital assistants (PDAs) with browsers; Blackberry, two-way pagers) provide easier access to m-commerce services and the Internet. | This item contributes the most to the success of WAP, by a large margin and high degree of consensus (SD=0.7). But some panelists felt alternative technologies would replace WAP, others felt they would promote the use of WAP. |
| The interface changes: The plethora of different mobile devices ensures the interface is sufficiently flexible for many different uses. The difference between PDAs and mobile phones becomes more blurred as different devices provide multiple functions (e.g., PDAs receive communications features). | The ranking (#2) is high but would have been much higher except for two experts who ranked it very low (11) (i.e., consensus (SD=3.6) was low). This item is rated as having the highest chance of happening (1.8) out of the twelve items. |
| Infrastructure for business success: Several infrastructure factors (e.g., 2.5G networks, improved handsets at lower cost, more applications, encryption in WAP 2.0) provide the impetus for a gradual increase in WAP usage and acceptance. | The mean ranking (4.9) equalled "interface changes" but with a higher level of consensus (SD=1.2). This item also has a high likelihood of happening. |
| 3G delays and 2.5G reality: The 3G networks experience significant implementation delays. Meanwhile, 2.5G networks roll out without promised access speeds, but succeed due to the "always-on" nature of the technology. | There are again some divergent views for this item (low consensus with SD=3.8), with mostly unfavourable comments about 3G. The likelihood ratings are also divergent. |
| m-Commerce hype and reality: The reality of m-commerce doesn't match the hype. Applications such as email services, information feeds and iMode-like entertainment services, not commerce, lead the way. | The consensus on the ranking (#5) of this item was high (SD=1.5). The "likelihood to happen" was near 50:50 (2.7) and also with a high consensus (SD=0.7). |
| Market niches: The different mobile market segments experience different growth patterns (i.e., infotainment = high growth; Internet access = limited growth; intranet/ extranet access = some growth; multimedia messaging = little growth). | The "mixed bag" nature of this item (4 market segments) probably put this item in the middle of the ranking (#6). Commentary showed experts had different views for different segments. This item is considered relatively likely to happening, because of conservative growth estimates. |
| iMode domination: With regional partners, NTT-DoCoMo rolls out the iMode protocol. The iMode business model, the partnerships, and broadband infrastructure produce a majority market share. WAP's specialist applications put it into a small market share. | There is considerable disagreement about the ranking of this item. The consensus (SD=3.8) was nearly the lowest and individual panelists ranked this item from #1 to #12. With a mean rating of 3.2 it is also one of two most unlikely to happen. |
| Voice recognition is king: Voice recognition technology in mobile devices provides added impetus to m-commerce. Mobile phones beat PDAs as voice-activated commands replace the clumsy phone keyboard. | With an SD=3.9, this item has the highest disagreement of ranking. It is also the item panelists feel is most unlikely to happen (3.4). This is not unexpected for an emerging, immature technology. |
| Health and mobile networks: The health issues surrounding mobile technology (e.g., more powerful handsets, positioning of base stations) spark further debate. This delays the growth of WAP-enabled systems. | The divergence in the rankings (SD=3.6) and ratings (SD=1.4, highest) probably reflects the lack of conclusive scientific research results in this area. |
| Mobile customers increase: A major driver for the interest in m-commerce is the large predicted increase of mobile subscribers. However, the increase does not eventuate as quickly as predicted. | The ranking of this item is relatively firm (SD=2.4). Comments from the panel suggest some geographical areas will grow fast, others slow, and this divergence is reflected in the low rating consensus (SD=1.3). |
| Microsoft stings m-commerce: The Microsoft Stinger starts slow, but gathers acceptance over the next two years. A WAP-enabled device, this provides added impetus to WAP in the short to medium term. | The panel members rank this item low, just two experts consider it to be important to WAP success. It is one of three items considered least likely to happen (rating = 3.1). |
| WAP Forum membership: WAP Forum membership increases over the next two years. This translates into new applications and a surge of market interest and demand. | This item is considered to have the least impact on the success of WAP, with a high consensus (SD=1.9). |

Discussion and Conclusions

The item-by-item discussion of the results in the previous section masks some important findings which are brought out in this section. This discussion combines the straightforward results presented in the previous section with interpretative comments by the authors of this paper. The paper concludes with some limitations of the study and general conclusions.

Rankings: Technology and Market Forces Dominate Success

In looking for common themes in the ranking results, the most obvious observation is the dominance of technology-rated items at the top (see Table 3). Three of the top four items (alternative technologies, infrastructure success, 3G delays and 2.5G reality) are technology-related issues. The #2 item (“the interface changes gradually”) has technological components, but is mostly a human-computer interface (HCI) issue. The only technology item not at the top is “Microsoft stings m-commerce”, perhaps because of the polarity of opinion that seems to characterize the debate on any Microsoft technology. We conclude, *for an emerging technology such as WAP, technological issues such as speed of access and infrastructure will be the primary determinant of its success.*

Table 3. How Important are These Scenarios/Trends to the Future of WAP?

| Scenario/Trend | Category | Mean Rank |
|-------------------------------------|--------------------------|-----------|
| Alternative technologies | Technology | 1.8 |
| The interface changes | Human-Computer Interface | 4.9 |
| Infrastructure for business success | Technology | 4.9 |
| 3G delays and 2.5G reality | Technology | 5.0 |
| m-Commerce hype and reality | Business/Market | 5.4 |
| Market niches | Business/Market | 6.7 |
| iMode domination | Business/Market | 7.2 |
| Voice recognition is king | Human-Computer Interface | 7.2 |
| Health and mobile networks | Social Consequences | 7.4 |
| Mobile customers increase | Business/Market | 7.8 |
| Microsoft stings m-commerce | Technology | 8.4 |
| WAP Forum membership | Business/Market | 9.9 |

Business and market items dominate the middle rankings (i.e., m-commerce hype and reality, market niches, iMode domination fall fifth, sixth and seventh), which we interpret to mean that *an expanding customer base, consumer-driven applications and market forces will play a critical, but secondary, role in determining the success of WAP.*

Why then is “mobile customers increase” ranked 10 out of 12? As noted earlier, panel members commented that some markets will grow very, very fast while others will grow much more slowly. So mixed expert opinion comes from mixed interpretation of the item. “WAP Forum membership” is ranked last, but perhaps “insignificant” is a better word to describe the panel’s viewpoint of this item.

The other HCI item (voice recognition is king) is ranked eighth and the only social consequences issue (health and mobile networks) is ranked ninth. While these will have some influence, they will not be major determinants of WAP success.

Ratings: The Older the Technology, the More Likely it Will Happen

To assess contribution of the item to WAP success is important, but will the scenario represented by this item actually happen? This is the question addressed in the ratings column.

The categorisation that was helpful in interpreting the rankings is far less useful now. Business/market items dominate the middle (equally likely or unlikely to happen) with other items falling up and down in close symmetry.

Table 4. How Likely is This Scenario/Trend Likely to Happen?

| Scenario/Trend | Category | Mean Rating |
|-------------------------------------|--------------------------|-------------|
| The interface changes | Human-Computer Interface | 1.8 |
| Market niches | Business/Market | 2.0 |
| Infrastructure for business success | Technology | 2.2 |
| Alternative technologies | Technology | 2.4 |
| m-Commerce hype and reality | Business/Market | 2.7 |
| Mobile customers increase | Business/Market | 2.7 |
| WAP Forum membership | Business/Market | 2.7 |
| Health and mobile networks | Social Consequences | 2.8 |
| 3G delays and 2.5G reality | Technology | 2.9 |
| Microsoft stings m-commerce | Technology | 3.1 |
| iMode domination | Business/Market | 3.2 |
| Voice recognition is king | Human-Computer Interface | 3.4 |

The determining factor in this table seems to be the “newness” or “uncertainty” of the technology at the time of this study (mid-2001). So PDA’s (interface changes, alternative technologies), mobile Internet access (market niches) and 2.5G networks (infrastructure) were already happening, thus “most likely to happen”. On the other hand, Microsoft’s Stinger and voice recognition were emerging, even futuristic technologies, thus “most unlikely to happen”. The iMode item falls low because the strength of the business model, not the technology, is being measured in this item. So, it may seem like stating the obvious, but we conclude that *the more new or uncertain the technology or business model, the less likely it is to happen*.

A final observation is that the mean rating tends to mask the diverge views of the individual panel members. All means are between 1.8 and 3.4, but panel members provided a number of 1’s and 5’s. This is evident in the rather large standard deviations shown in Table 1.

Mixed Success in Reaching Consensus

To what degree do the experts agree about the results reported here? The short answer is, “not much”. Despite the desirable goal of the Delphi method to reach a consensus on important issues, this didn’t happen here. In the third round there were only fractional changes in panelist’s rankings and ratings and few comments. There is no reason to believe a fourth round would have moved the panel closer to consensus.

In a few items the lack of consensus may be attributed to the bunching of issues and trends after round one. For example, market niches consolidated four market trends together. One panelist commented, “the multiple bullet points in this scenario makes ranking and rating difficult”.

Limitations of the Study

The limitations of this study pertain both to the subject at hand and the execution of the study as a Delphi research study.

- WAP is a dynamic technology that is changing almost weekly. Any report on its future can only represent a snapshot of a fast-moving train. Time will determine to what extent this snapshot is indicative of where this technology is going.
- WAP is a relatively recent development with few trendlines and no significant historical perspective in which to cast the trends, scenarios and issues.

- Although the results are presented in a quantitative manner, this is essentially a qualitative study based on the subjective viewpoints of a group of experts in the topic.
- Over simplification of the issues is a common fault in studies such as this. Although there are a multitude of issues and trends that have a bearing on the success of WAP, some simplification must be done to get a manageable core number of issues.
- A relatively small number of panelists (8 out of the original 16) contributed to round three. However, the diverse range of people involved has produced a range of views on the topic.

Where To from Here for WAP?

The expert opinion of the panelists is very much divided on this question. One commented “WAP is a dead duck” while another held a far more optimistic view: “a market will develop to enable the migration of proprietary technologies to WAP, as WAP matures”.

Our opinion, based on all that we have heard and read and seen is that WAP does have a future, but a future that is largely limited to specialist transactional applications that can be performed on a WAP phone. While WAP has achieved limited success at the start of m-commerce development, the long-term outlook for WAP is very narrow, with further development limited to specialised, short transaction-oriented applications for WAP-enabled cell phones. Other, more open and global technologies are likely to advance ahead of WAP for most business and personal applications.

Another observation is that any new technology must avoid the technological utopianism that is prevalent in technological forecasting. A realistic and objective assessment of new technologies is required to avoid the ‘over-hype’ during the development period of the technology. A solid methodological-based study such as this one can bring a good dose of reality to this utopianism.

References

- Adam, J. “Internet Everywhere,” *Technology Review*, September/October 2000, pp. 86-93.
- Alpert, M. and Musser, G. “The Wireless Web,” *Scientific American*, October 2000, pp. 28-45.
- Banan, M. *The WAP Trap: An Exposé of the Wireless Application Protocol*,
<http://www.freeprotocols.org/LEAP/Manifesto/article/TheWAPTrap/split/main.html>, 26 May 2000. [6 March 2002]
- Bannan, K. J. “The Promise and Perils of WAP,” *Scientific American*, October 2000, pp. 36-38.
- Bartol, K. M. and Martin, D. C. *Management* (International edition), McGraw-Hill, New York, 1994.
- Cane, A. “More Than Mobile,” *Financial Times* <http://www.ft.com/specials/sp9686.htm>, 14 June 2000. [5 April 2001]
- Chambers, J. C., Mullick, S. K. and Smith, D. D. “How to Choose the Right Forecasting Technique,” *Harvard Business Review*, July-August 1971, pp. 45-74.
- Dooley, B. “WAP’s Cred Gap,” *Computerworld NZ*, 4 September 2000, pp. 23-28.
- Dunlop, C. and Kling, R. “The Dreams of Technological Utopianism,” in *Computerisation and Controversy: Value Conflicts and Social Choices*, C. Dunlop and R. Kline (eds.), Academic Press, London, 1991, pp. 14-30.
- Engen, J. R. “Banking on the Run,” *Banking Strategies*, July/August 2000, pp. 16-25.
- Fisher, M. G. “Wired Executive: Trends and Successes in e-Business: Wireless - on the Road Again,” *Sales and Marketing Management* (152:12), 2000, pp. 31-34.
- Frederick, H. “Doo WAP,” *Unlimited*, August 2000, pp. 80-82.
- Goldman, S. “WAP on the Attack,” *Telecommunications* (35:3), 2001, pp. 104-106.
- Hubbard, T. *WAP Architecture: Introduction and Overview*, <http://www1.wapforum.org/member/developers/slides/WAP-Architecture/sld001.htm>, 3 February 1999. [6 March 2002]
- Jackson, R. “A WAPing Future,” *CIO*, October 2000, pp. 16-24.
- Johnson, A. H. “Quick Study: WAP,” *Computerworld*, 8 November 1999
<http://www.computerworld.com/home/features.nsf/all/991101qs>. [5 April 2000]
- Kalakota, R. and Robinson, M. *M-Business: The Race to Mobility*, McGraw-Hill, New York, 2002.
- Kamadolli, S. “The Yap about WAP,” *Telecommunications* (34:12), 2000, pp. 90-92.
- Khare, R. *W*Effect Considered Harmful*, <http://www.4k-associates.com/IEEE-L7-WAP-BIG.html>, 9 April 1999. [5 March 2002]
- Lewis, T. “Why WAP May Never Get off the Ground,” *IEEE Computer* (33:8), 2000, pp. 110-112.

- Linstone, H. A. and Turoff, M. "Introduction," in *The Delphi Method: Techniques and Applications*, H. A. Linstone and M. Turoff (eds.), Addison-Wesley, Reading, Mass., 1975, pp. 3-12.
- Logan, B. personal communication to the author on March 9, 2001.
- Loken, S. B. *WAP Dead in 6 months?*, <http://www.wap.com/share/osas/cache/artid200229.html>. [21 September 2000].
- Maital, S. "Caution: Oracles at Work," *Across the Board* (30:5), 1993, pp. 52-53.
- Malcolm, A. "Lion Gives Wireless a Go," *Computerworld NZ*, 29 February 2000, p. 5.
- McGrath, P. "Plenty Wrong with WAP," *Newsweek* (136:25), 18 December 2000, p. 82.
- Muller-Veerse, F., "m-Commerce: How to Make it Reality." *Business Briefing: Wireless Technology 2001*, <http://www.technology-briefing.com/businessbriefing/pdf/mcommerce2001/reference/StrategicOverview7.pdf>, 2001. [6 March 2002]
- Saarinen, M-J. *Attacks Against the WAP WTLS Protocol*, <http://www.cc.jyu.fi/~mjos/wtls.pdf>, 1999. [6 March 2002]
- Schwartz, E. *WAP: The Technology Everyone Loves to Hate*, <http://iwsun4.infoworld.com/articles/op/xml/00/06/26/000626opwireless.xml>, 26 June 2000. [5 April 2001]
- Schwartz, L. E. "Another Perspective," in *Technological Forecasting*, R. V. Arnfield (ed.), Edinburgh University Press, Edinburgh, 1969, pp. 71-82.
- Shah, R. *Wireless Application Protocol Set to Take Over: WAP Addresses the Shortcomings of Other Protocols*, <http://www.sunworld.com/sunworldonline/swol-01-2000/swol-01-connectivity.html>, 27 January 2000. [5 April 2001].
- Sims, D. *WAP Takes a Pounding*, <http://www.oreillynet.com/pub/a/network/2000/05/26/magazine/wap.html>, 26 May 2000. [6 March 2002]
- Southward, I. "Dial M for Mobile," *Financial World*, January 2001, pp.19-49.
- Valdez, R. "Waiting on WAP," *Web Techniques*, November 2000, pp. 84-87.
- WAP Forum, *Wireless Application Protocol: White Paper*, http://www.wapforum.com/what/WAP_white_pages.pdf, June 2000. [6 March 2002].