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Emerging Technology & Applications
Year 2000 Edition
A Report to the IHO CHRIS 12
By the
Technology Assessment Working Group (TAWG)

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0. Introduction

The Objective of the CHRIS Technology Assessment Working Group is:

> *"To assess the potential of present and developing information technology with respect to applications within the scope of CHRIS, and advise CHRIS accordingly."*

TAWG made an initial report in 1998. That report defined the methodology for technology assessment and used it to define the top ten technology trend for the IHO to monitor in 1998/99. This report is a revision, bringing new issues forward (e.g. e-Commerce) and pushing certain technologies further into the future (e.g. LEO telecommunications satellites).

1. Assessment of Emerging Technology

As discussed in the 1998 TAWG Report, in the most part technology advances incrementally with widely spaced intervals between significant breakthroughs. A good example of this incremental change phenomenon can bee seen in **Moore's Law** which states that computer power will double every 18 months. And so it has for nearly two decades. In the 1998 report it was suggested that by the Fall of 2000 **1 GHz PC's** would be shipping - and so they are.

This kind of sequential advance has become so ingrained in our cultural mindset that most buyers of high technology devices today expect this kind of learning curve growth in power and rapidly declining pricing. In fact we now count on it. We have come to expect breakthrough technologies to be followed by a period of steady incremental advances.

Often the breakthrough technologies are so fundamental that they cause a shift in people's behavior or thinking. These are the paradigm shifts, described by Thomas Kuhn **in *The Structure of Scientific Revolutions*** in 1962. Naturally, paradigm shifts are a concern for planning any distance into the future. This is one of the reasons for having a group concerned with emerging technologies, particularly those which lie outside one's normal sphere of contact. Paradigm shifts are frequently led from outside this sphere.

Sometimes two or more emerging technologies can combine to have paradigm shifting effects. Typically this requires some form of technology that acts as an enabling infrastructure upon which other integrated technologies can be built. The marriage of **DGPS** and **GIS** has re-created the charting world as we know it. The **Internet** is the major paradigm shifter of our age and we are still at the beginning of that shift.

This is progress as seen from a technology viewpoint. There is another viewpoint, one more concerned with the unmet needs of a potential user. Technology by itself is of no value until it is married to an application, and a useful one at that. It takes two forces, one, the push of technology and the other, the pull of applications to make the most significant advancements.

Given this, one might expect to see a programmatic approach to technology diffusion. If only that were true. Unfortunately history shows people have a hopeless record in predicting the impact of emerging technology. More typically we rationalize what has occurred after the fact. For some reason planning for changes in technology is chaotic. The sudden removal of **Selective Availability (SA)** from GPS was unexpected event that we will have to react to.

"The Tipping Point" by Malcolm Gladwell gives an explanation for how trends, including technology trends, can catch hold of people's imagination and be taken up in huge numbers with little or no warning. New technologies can spread like a virus if they are pushed by a network of committed and influential people, if those technologies have a stickiness that makes them attractive and if the world is ready for a new idea. Nevertheless predicting what will be accepted is still a chancy affair. For example, the world is looking for a cheap, easy to use portable, global communications system. Clearly **Iridium** was not what the market was looking for, despite the ease of use and universal coverage it offered. It was judged too expensive and too slow to deliver the digital data stream clients want. We will have to wait for the Internet in the sky that the market now wants.

One of the major new needs to have emerged since the last report was in the area now referred to as **e-Commerce**. The shipping industry is quickly comprehending the enormous advantages the Internet can bring to the table. After all the cost cutting is done, it is the creative use of new technology that will differentiate competitors. The use of **Interbox** to manage empty containers is changing the nature of the container business. Companies like **OneSea.com** are making inroads into marine procurement as shippers continue to look for ideas that help create a transportation system that operates with pipeline simplicity and efficiency. Companies like **Inmarsat** and **Teledesic** are investing millions to provide the satellite based infrastructure for electronic marine highways to run on. **Logistics** remain a rich area for improvement and companies like **Descartes** help to improve capacity utilization through improved networking of shippers and carriers. HOs and their agents, will have to fit into this new networked world.

A second initiative is the field now popularly known by the term **Wireless**. Although this term also applies to wireless LANs and alphanumeric pagers, the new thrust is in the area of the wireless Internet or, more appropriately, mobile Internet. **IDC**, the worlds largest IT consultancy, forecasts that mobile Internet users will exceed web-based Internet users within 2 years. The applications

expected are in mobile commerce and financial transaction capabilities, navigation and location specific applications, instant messaging and infotainment (e.g., news, sports, weather). Rather than "surf the web" mobile users want information quickly with transparent access to the network. **Handheld Devices** such as Palm Pilot and their Windows CE-based kin are starting to take advantage of wireless networking for custom applications.

A third initiative is in the field of **open standards**. **Linux** is just one manifestation of this new trend towards open source software. However, it is in the field of data standards that more will be gained. Consider the case of **EDI** – a data interchange system that has been in place for decades but underutilized used because of its expense. However **XML**, a language like HTML that can be read on any computer over the Internet can get suppliers and users together. This will help spur more vertical portals (or **vortals**) to provide tools for improving shipping efficiency and reduce costs.

2. Emerging Needs and Emerging Technologies

2.1 Emerging Needs

Table 1 gives a listing of emerging needs as expressed either by HOs, associated stakeholders or HO clients. This list is not meant to be exhaustive but it does contain many of the major concerns expressed today. These represent ***Problems Looking For Solutions***.

Table 1: Emerging Needs

Increased Navigation Efficiency
Pilot Carry-on ECDIS
Electronic Docking Aids
Forecasting real-time under-keel clearance
Vessel Traffic Systems (VTS) and AIS
3D- ENC data.
Real-time data (water level, ice, weather, …)
Short term forecasting of water levels
Modeling currents
Back-up Navigation Systems
Real-time chart functions
Increased HO Efficiencies
Real Time Kinematic positioning
Computer Assisted Compilation
Print on Demand (POD)
Improving Chart Accuracy
Technology for fast/cheap surveys
Ocean Mapping tools
Digital Sailing Directions
GPS vertical control
Archival Compression
Improved Product Distribution
Encryption Standards
Virtual RENC
e-Commerce
Authenticating Electronic Data

In order to add some quantitative measure to each of these Emerging Needs a weighting is determined for each according to its level of importance and urgency in meeting the needs of HOs and their clients.

Table 2: Emerging Needs And Level Of Importance

Emerging Needs	Importance	HO Urgency	Client Urgency
Encryption Standards	9	6	4
Electronic Docking Aids	7		6
Pilot Carry-on ECDIS	7		6
Tools for faster/cheaper surveys	7	4	
Print on Demand (POD)	8	10	
Forecasting real-time under-keel clearance	5		6
Real-time chart functions	5	4	6
Authenticating Electronic Data	9	6	4
Computer Assisted Compilation	7	10	
Real-time data (water level, ice, weather	7		4
Vessel Traffic Systems (VTS) and AIS	7		10
Back-up Navigation Systems	5		10
Improving Chart Accuracy	7	6	10
Short term forecasting of water levels	5		10
Real Time Kinematic positioning	5		4
Modeling currents etc	5	6	1
e-Commerce	7	6	6
Virtual RENC Tools	5	6	
Ocean Mapping Tools	5	6	
Digital Sailing Directions	7	10	6
GPS vertical control	5	5	3
Archival Compression	3	3	
3D- ENC data.	3		1

Urgency	Rating
Immediate	10
Next 2 years	6
Next 5 years	4
Long term	1

2.2 Emerging Technologies

Table 3 includes the major technologies now in ascendance. Some of these technologies are developing in an environment focused on a problem area. Some, however, are simply ***Technologies Looking For Problems To Solve***. It is not so much that any one technology will bring about a revolution but more the confluence of several technologies that fuse together. GPS, high resolution remote sensing, cheap storage, wireless, Internet, telecomm LEOS and open standards all collaborate to help create what US VP Al Gore calls a “Digital World”. **Pervasive GPS chip integration** might help push this vision to fruition.

Table 3: Emerging Technologies

Acoustics
Side-scan sonars
Acoustic Seafloor Classification
Synthetic aperture sonar
Multibeam echosounder
Precise 3D Positioning
GPS Attitude & squat
On-The-Fly DGPS
Motion sensors
INS integration with GPS
GPS/Glonass integration
Pervasive GPS chip integration
Remote Sensing
Satellite radar imagery
Laser hydrography
High resolution satellite imagery
SPOT bathymetry & bottom type
Data Communications
Internet
High Band Width data links to ships
LEOS Communication
Wireless
Ultrawideband pulse (UWB)
Displays
Flat screen
Low cost Image engines
Low cost large scale plotters
Wearable heads-up displays
Visualization
Handheld devices
Informatics
Low cost GHz CPUs
64 bit OS
Data warehousing
Spatial Data Base
Encryption
High Density Storage
Machine Voice recognition
Open Standards

2.3 Technology Readiness

A significant element in estimating the impact of emerging technologies is the state-of-readiness of the technology. A great idea ahead of its time remains that, ahead of its time. Each technology was evaluated according to its state-of-readiness. A weight of 10 was given to well developed technology available commercially to a wide market whereas a weight of 1 signifies a technology at the proof-of-concept stage.

Table 4: Emerging Technologies & State of Readiness

Emerging Technologies	Tech. Readiness
Acoustics	
Side-scan sonars	10
Acoustic Seafloor Classification	6
Synthetic aperture sonar	1
Multibeam echosounder	10
Precise 3D Positioning	
GPS Attitude & squat	6
On-The-Fly DGPS	6
Motion sensors	10
INS integration with GPS	4
GPS/Glonass integration	2
Pervasive GPS chip integration	6
Remote Sensing	
Satellite radar imagery	6
Laser hydrography	10
High resolution satellite imagery	6
SPOT bathymetry & bottom type	1
Data Communications	
Internet	10
High Band Width data links to ships	4
LEOS Communication	4
Wireless	4
Ultrawideband pulse (UWB)	3
Displays	
Flat screen	6
Low cost Image engines	6
Low cost large scale plotters	10
Wearable heads-up displays	1
Visualization	6
Handheld devices	6
Informatics	
Low cost GHz CPUs	10
64 bit OS	10
Data warehousing	6
Spatial Data Base	6
Encryption	10
High Density Storage	6
Machine Voice recognition	1
Open Standards	4

2.4 Summary Matrix

The Emerging Technologies, and Emerging Needs were combined into a 33X23 matrix. A score was applied as to the goodness-of-fit between each row/column pair in the matrix. This is the Technology-to-Need correlation. Scores of zero were given for pairings with no obvious direct connection. Weighted scores were then computed according to the state-of-readiness, level-of-importance, Client Urgency, HO Urgency and strategic importance. Finally, the matrix was ranked by score to find the most important emerging technology trends to follow.

$S_j = P_j * In_j$
Where S_j is the Score of need j
P_j is the technology Potential
In_j is the Influence score

And where
$In_j = MAX(H_j * C_j) * I_j$
Where H_j is the Hydrographic urgency
C_j is the Client urgency
And I_j is the Importance

And where
$P_j = SUM(TN_{ij} * E_I)$ $i = 1, \ldots, n$
$E_i = SUM(TN_{ij}) * R_i$ $j = 1, \ldots, m$
Where TN_{ij} is the correlation Matrix between Technology and Need
E_i is the technology Effectiveness
And R_j is the technology Readiness

2.5 Top Ten Technology Trends

Table 5 Top Ten Emerging Technology Trends – Year 2000

Print On Demand (POD)
Electronic Docking Aids
Data Encryption/Authentication
Pilot Carry-on ECDIS
e-Commerce
Computer Assisted Compilation
Under-keel Clearance Prediction
VTS
Tools for Improving Chart Accuracy
Tools For Faster/Cheaper Surveys

This table can be cross-referenced to the table from the 1998 report

Top Ten Emerging Technology Trends – 1998

Encryption Standards
Electronic Docking Aids
Pilot Carry-On ECDIS
Technology For Fast/Cheap Surveys
Print On Demand
Forecasting Real-Time Under-Keel Clearance
Real-Time Chart Functions

Authenticating Electronic Data
Computer Assisted Compilation
Real-time data (water level, ice, weather, …)

The most notable difference being the combination of Encryption and Data Authentication, the leap of POD from 5th to first and the addition of e-Commerce tools, VTS and Tools for Improving Chart Accuracy. This is explained by using a slightly more complex method for scoring which differentiates between Importance, HO Urgency and Client Urgency and by the addition of the the new technologies: e-Commerce, Wireless, GPS on-a-chip, Ultrawideband pulse (UWB), Handheld devices and Open Standards.

2.6 Notes On The Modeling Process:

As stated in the previous report the weights and scores are subjective, as are the initial lists. It is presumed that ten different people doing a similar exercise will arrive at ten different rankings. Nevertheless there is some degree of logic prevailing and subjective scores are often the realization of a neural coding based on many years of experience. That being the case, despite differences among the values individuals might use to score the matrix elements, the results will not be so different as to make the results appear totally random. Many of the applications support more efficient shipping, something we know our major clients are always looking for. HOs are always on the hunt for better ways of doing surveys and compiling charts faster and cheaper. Grinding down multibeam data into a usable product quickly is in much better shape this year as opposed to two years ago but still a big concern calling for more automated compilation tools. e-Commerce is either a part of the way we do business now or it soon will be. And encryption and data authentication are clearly in the minds of many HOs today, as they were two years ago. So the list is not wildly out of reality.

3. Recommendations:

Top Ten Emerging Technology Trends	Recommendations
Print On Demand (POD)	Form User Group to cooperate on evolving best practices
Electronic Docking Aids	Monitor progress in technology and report on feedback from special purpose Electronic Docking Charts (EDCs)
Data Encryption/Authentication	Continue implementation trials
Pilot Carry-on ECDIS	Monitor Feedback from Sea Trials
e-Commerce	Form User Group to cooperate on evolving best practices
Computer Assisted Compilation	No action needed
Under-keel Clearance Prediction	Monitor trials
VTS	Monitor trials
Tools for Improving Chart Accuracy	No action needed
Tools For Faster/Cheaper Surveys	No action needed

4. Appendix 1: An Update on Encryption Technology

ENC Security and Protection Issues
Report to WEND 2000
The Encryption Project Group (EPG)

The issue of ENC protection has been raised at previous WEND and CHRIS meetings. At the last CHRIS meeting the issue was discussed at length. The minutes of the meeting contain the following instructions for further action:

> *"The Chairman summarized:*
> - *If encryption is introduced, it should be as standardized as possible.*
> - *IHO will eventually need to establish a position on this matter.*
> - *A policy should be established before technical details can be decided upon.…."*

The current situation can be summarized as follows: For those HO's and RENCs that wish to implement some form of protection there are three general applications
1) Data Authentication (a.k.a. Digital Signature)
2) Copy Protection
3) Access Control

These applications can be taken in turn or as a complete integrated system depending upon the degree of security the HO or RENC wishes to implement. One solution is the PRIMAR Security system. It performs all three applications. Nevertheless there are ways to do each separately. For example there are many ways to do access control that does not involve encryption. One can implement Data Authentication without implementing encryption.

The following design considerations for a Protection System should be kept in mind:
1) the candidate solutions must be based on an established standard
2) use an algorithm in the Public Domain
3) offer maximum transparency to the end user
4) be comparatively easy to implement and manage
5) not break any nation's export restrictions
6) the candidate solutions should not imply a specific business model

Consideration 1) is evolving rapidly with a big push from federal agencies looking to push e-government and also from e-commerce.
Consideration 2) is straightforward and do-able right now;
Considerations 3), 4) and 6) are implementation issues;
and Consideration 5) is becoming easier to solve and perhaps is now off the table. See

http://www.epic.org/crypto/export_controls/regs_1_00.html

The technical problem lies in implementation, not so much with the algorithm chosen. The PRIMAR implementation is openly described but not immediately transferable as in a "plug-and-play" sense. Therefore for another RENC to implement exactly the same thing would be difficult since it is deeply embedded within their operational system. Implementation of a similar approach at another RENC would have to ensure that the end product is fully compatible. RENCs should contact PRIMAR directly for further information. A project is underway in Canada to assess the degree of difficulty to implement the system at a RENC.

The world of e-commerce is rapidly advancing and fast changing. The US has a plan to develop a new encryption standard called Advanced Encryption Standard (AES) The algorithms are open, source code available and carry no copyright. This selection process represents one of the leading efforts to establish a standard algorithm. Many countries are likely to adopt this approach once it is established. For a summary of the AES project and its status see

http://csrc.nist.gov/encryption/aes/round2/conf3/aes3conf.htm

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