

IMPLEMENTATION PLAN FOR THE VIRTUAL LABORATORY

(Submitted by Anthony Mostek/NOAA/National Weather Service)

Summary and purpose of document

To inform CGMS Members on the status of activities within the CGMS Virtual Laboratory for Training in Satellite Meteorology

ACTION PROPOSED

- (1) CGMS Members to note the report and make comments, as appropriate;
- (2) CGMS Members to indicate activities towards completion of the actions and timetable described in the Implementation Plan in Appendix B.
- (3) CGMS Members to support, as appropriate, the third session of the CGMS VL Focus Group to be held in 2006.

Appendices: A. Structure and Goals for the VL Focus Group
B. Implementation plan for the VL

DISCUSSION

Background

1. CGMS-XXVIII
 - a. CGMS-XXVIII was informed of WMO discussions concerning a Virtual Laboratory (VL) for Training in Satellite Meteorology. WMO noted the importance of the coordination and overseeing needed for the VL and thus suggested that CGMS, in partnership with WMO, form an "International Satellite Data Utilisation and Training Focus Group".
 - b. CGMS-XXVII places ACTION 28.14 on WMO and the CGMS Secretariat initiate the establishment of a focus group on satellite data utilisation and training within the Virtual Laboratory Framework that reported back to CGMS XXIX on its findings and need for future activities in this area.

2. CGMS-XXIX
 - a. CGMS XXIX reviewed and confirmed the Terms of Reference, proposed structure and goals for the CGMS Virtual Laboratory Focus Group. The structure and goals, and implementation plan are included as Appendices A and B, respectively for completeness.
 - b. The Virtual Laboratory for Satellite Data Utilization was formally adopted by CGMS XXIX, with continued reporting through the Virtual Lab focus group.

3. CGMS-XXX
 - a. CGMS-XXX noted that a number of important activities and milestones that were established by the VL focus group were being addressed and met.
 - b. CGMS-XXX was pleased to be informed of the successful application of the Virtual Laboratory for Satellite Data Utilization for the Asia Pacific Satellite Application Training Seminar (APSATS) workshop that was co-sponsored by WMO, Japan Meteorological Agency and the Bureau of Meteorology.
 - c. CGMS-XXX requested that the VL focus group convene before CGMS-XXXI and report back on activities and status with regard to the implementation plan.
 - d. Second session of the CGMS Virtual Laboratory Focus Group Rescheduled for December 2003

4. The CGMS-XXX had requested that the VL Focus Group convene before CGMS-XXXI and report back on activities and status with regard to the implementation plan. Schedule and funding constraints required the VL focus group meeting to be postponed until December 2003, to coincide with the WMO Satellite training program scheduled for Barbados from December 2-13, 2003. Thus the second session took place in Barbados during the week immediately following the WMO training event. As instructed by CGMS, the second session of the Focus Group conducted an initial assessment of the VL, report back to CGMS-XXXII on activities and status with regard to the implementation plan (this report), on the following items: the resource library, its role, how it is structured, how it is "peer reviewed," and other pertinent matters; VISITview, its role the Virtual Laboratory construct, etc.; expectations for the RMTCs that are participating in the Virtual Laboratory especially in the area of a review of the questionnaire to help focus their training, and as an input to WMO; coordination of training activities that could lead to a schedule of "classes" for each year; Virtual Laboratory participant roles and responsibilities; archiving of training class presentations as a future training resource; development of a web-based training resource available to WMO and others, how it is managed, and what is the corresponding role of the "centre of excellence". The third session should occur in five years (2006) and conduct a comprehensive review of the VL.

Activity within the Virtual Laboratory (VL) since CGMS XXXI

?? All centres of excellence completed a survey covering how they were using the VL and importantly, details on their connection speeds. The survey showed that all centres were using the VL but some a lot more than others due to slow communications lines. These slow lines were a major problem for Nanjing, Nairobi and Niamey with it taking considerable time to load even the simplest pages. Barbados and Costa Rica were experiencing some problems but not as acute as the African centres. All centres are using the VL, mainly for lecturer information rather than class room, this was at least partially due to slow line speed

?? The VL is directly accessible through the WMO's Satellite Activities Home Page under the heading "CGMS Virtual Laboratory for Education and Training in Satellite Matters" at the following link: <http://www.wmo.ch/hinsman/vl.htm>

?? All satellite operators have a server online and connected to the VL
VL servers are online and connected to the NESDIS (CIRA), EUMETSAT, NSMC and JMA

?? Some "centres of excellence" have a server online and connected to the VL
VL servers online at BOM (Australia) and EAMAC (Niamey, Niger)

?? Resource libraries are available online for the VL at NESDIS (CIRA), EUMETSAT, JMA, NSMC and WMO

?? VISITview was available via the VL web site at CIRA to all participants
Courses on MSG were organized at the centres of excellence at EAMAC in Niamey, with help of EUMETSAT, and the RMTC in Nairobi. During that period, VISITview was successfully used with participation between those centres of excellence and the centre of excellence at Australia's BOM.

?? Four action items from the VL-1 Implementation Plan had been completed while some "additional specific action items" for the 0 to 1 year and 1 to 2 year timeframes had only been partially completed. In particular, only the BMTC "centre of excellence" had evaluated the content, and what could be maintained on its server in the 0 to 1 year timeframe and the BMTC, Niamey and Nanjing "centres of excellence" had placed a server online and connected to the VL. Virtual Resource Library (VRL) improvement in general was still pending in the 1 to 2 year timeframe since VL-1.

?? The second session was informed of the Rapporteur's report to CGMS-XXXI concerning the status and progress of the VL. The report pointed out that a number of important activities and milestones that were established by the VL FG were being addressed and met. All "centres of excellence" were connected to Internet, some with more bandwidth than others; all centres were using the VL, mainly for lecturer information rather than class room, this was at least partially due to poor line speed in some cases; servers were in place at all operators and by some "centres of excellence"; and, the VL was available for WMO Members with a rich variety of resources. CGMS was informed that the WMO Congress at its fourteenth session (Cg-XVI) had noted the positive impact of the VL and that it had made a tremendous impact throughout WMO Regions through its six "centres of excellence".

?? The resources listed below are available from various VL servers:

Satellite Imagery	Satellite Products	Tutorials
Training Tools	Software	Digital Satellite Imagery
Live Training Events	Online Courses and Quiz's	Search

Centres of Excellence resource sites and sponsors' resource libraries are available from:

Centres of Excellence at five WMO Regional Meteorological Training Centres at San Jose, Costa Rica , Bridgetown, Barbados , Niamey, Niger , Nairobi, Kenya, and Nanjing, China plus the Australian Bureau of Meteorology Training Center (ABOMTC)
Resource libraries at NESDIS (CIRA), EUMETSAT, JMA, NSMC and WMO

Supporting Science Groups have links into the VL, and each science group has agreed to support the needs of the VL

International TOVS Working Group (ITWG)
International Winds Working Group (IWWG)
International Precipitation Working Group (IPWG)

The second session was pleased to note that the new WMO Space Programme included as one of its major elements "additional and continuing emphasis on education and training". Finally, the second session noted that the WMO Space Programme Office was developing an associated Implementation Plan reviewed by the fourth session of the WMO Consultative Meetings on High-level Policy on Satellite Matters held in Geneva, 26-27 January 2004. The Implementation Plan contains appropriate description of the resources required to provide for the "additional and continuing emphasis on education and training".

REVIEW LESSONS LEARNED FROM VIRTUAL LABORATORY TRAINING EVENTS

Under this agenda item, the session reviewed lessons learned at Nanjing 2000, APSATS-2002, EAMAC 2003 and Barbados 2003.

APSATS 2002

The second session was informed that the VL was at the core of the very successful APSATS 2002 event training. The organisers of APSATS 2002 used the VL framework to engage face-to-face presenters, VISITview presentations, and, resources in the form of CD and paper materials. VL tools such as SATAID, RAMSDIS online and VISITview were extensively used. NASA supported the workshop by presenting several sessions on the application and use of MODIS data. Participants took home SATAID based case study material relevant to their region that had been worked on during the workshop. More than 20 CDs of resource material were generated for and during the workshop.

Based on the experiences learned at APSATS 2002, the following were strongly recommended:

- ?? create a Learning and Action Guide for each course to assist in course planning for local organisers (setting course and session objectives), presenters (focussing session presentations and noting key learning points and references), and participants noting down the key points as they see them and forming action plans for what to do on return to their own countries;
- ?? create a email list for follow up discussion between the group and, with the benefit of hindsight, some consolidation of course material using VISITview;
- ?? collect presentation material early to make the process of providing the resource material to the participants a lot more effective (highlighted in the outcomes from the Nanjing workshop in 2000); and

- ?? where possible, utilize case studies the participants have nominated to get more engagement with the course presentations and workshops; and, use both written and oral feedback as part of the evaluation process at the end of the course with further follow up evaluation sometime later.

Nanjing 2000 Training Event

The second session noted the importance of proper baseline facilities for the training event held in Nanjing in December 2000. The baseline facilities were prepared in advance by the Nanjing Institute of Meteorology (NIM) under the support of the China Meteorological Administration (CMA). A special purpose lab with 20 microcomputers was set up for the training seminar. All computers were linked to the Internet with a bandwidth of 100Mbps. Each participant could use a computer and have access to satellite data at the designated web sites. Communications and linking with other satellite centres and RMTCs were quick. RMTC Nanjing was of the opinion that it was most important to be aware of participants' level of experience with satellite data prior to the workshop.

Barbados 2003

The session was informed of lessons learned during the recent Regional Training Event for RA III and IV held in Barbados, 2-12 December 2003. CIMH stressed the need for advance preparation. Sufficient lead-time to identify the participants in advance was a necessary prerequisite in order to tailor the lecture content. Additionally, advanced knowledge of the participant's level of experience would be very helpful. Language was also a challenge to be overcome especially with those whose mother tongue was not that being used for the course. One positive experience was the presentations made by the participants and this should be continued. VISITview also had a very positive impact and its potential was realized and should be further exploited.

EAMAC

EAMAC informed the second session of a dedicated distance training session during the EUMETSAT Satellite Data Applications Courses (ESAC-IIIIF) co-organized by EUMETSAT and ASECNA at the EAMAC Training Centre over the period 12-25 July 2003. The dedicated distance training session had made use of a live connection to Mr Jeff Wilson, from the Bureau of Meteorology (BOM) in Melbourne. The concept of distance training was a new and important element of this particular course.

The distance training session contained the following elements:

- ?? introduction to collaboration and the training on-line;
- ?? presentation on the Bureau of Meteorology and its training activities;
- ?? components of distance training;
- ?? the VISITview Project: history, goal and perspectives;
- ?? explanation of the client/server concept of VISITview;
- ?? VISITview terminology: lesson, page, framework, client/server, etc.

The main purpose of the distance training session was to demonstrate to course participants and lecturers at EAMAC the potential for using tools such as VISITview to provide both distance learning opportunities and real time collaboration between geographically remote training centres. Whilst tools such as VISITview have been available for some time, it was only the recent improvement of Internet bandwidth at the EAMAC centre that made the demonstration realistically possible.

REVIEW INITIAL ASSESSMENT OF THE Virtual Laboratory (VL)

The session reviewed an initial assessment of the VL that was requested by CGMS-XXX and CGMS-XXXI.

The Co-Chairmen were of the opinion that the VL had achieved much in the first 30 months of its existence and were proud to have been Co-Chairmen during this period. In order to maintain the same rate of achievement in the next three years, there would be a need for sustained or even accelerated:

- ?? commitment (commitment to put effort and resources into the VL);
- ?? cooperation (by asking each other for help and sharing material); and
- ?? collaboration (agreeing to work on joint projects or priorities)

between all parties within the VL, particularly the “centres of excellence”. Many of the achievements in the initial 30 month period had been concerned with the technical challenges of placing servers online, sharing data and applications etc. For the next 3-year period, the challenge will be to utilize the physical infrastructure to deliver training remotely and improve the effectiveness of face-to-face training events. Technical challenges in the next 3-year period will include improvement of VRL content and increase Internet bandwidth to centres such as Nairobi, Barbados and Costa Rica.

The second session, in response to the request from CGMS-XXXI, reviewed an initial assessment of the VL presented by the Co Chairmen and updated it to represent the view of the VL FG as contained in Annex IV.

Bureau of Meteorology Training Centre (BMTc) in Australia

BMTc provided input to improve the effectiveness of the VL as summarised in the following points:

- ?? Commitment (to be visibly committed to being a VL “centre of excellence”);
- ?? Cooperation (to be more active in engaging the other “centres” and satellite operators); and
- ?? Collaboration (to demonstrate that the VL’s potential by working on some agreed upon, high priority joint projects).

BMTc proposed two high-priority areas where the VL members could demonstrate their commitment, cooperation and collaboration:

- ?? improved VL confidence in using satellite imagery and data at the meso -scale; and
- ?? increased knowledge and use of near-IR data to assist services in areas such as aviation, fire and severe weather forecasting.

BMTc further suggested that for “improved confidence in using satellite imagery and data” a list of meso-scale features (and their attendant processes and interrelationships) be circulated amongst members, and agreement be made to collect examples of these features in each region using VISITview lessons by the end of March 2004. After March 2004, VL FG members could meet via VISITview with audio service to discuss the examples (clarification and quality control) and then post the lessons on the VRL. The VL FG would then continue to do this at 3 monthly intervals to build up a library of material (on a global basis) and the confidence at each centre to use the data at the meso-scale level. At the end of 12 months each “centre of excellence” could then advertise a series of VISITview sessions to their neighbouring NHMSs on the use of satellite data in the meso-scale.

BMTC suggested “increased knowledge and use of near-IR data” be approached in a similar fashion where the CIRA 3.9 micron tutorial would be utilized while concentrating on the application of 3.9 micron data for particular areas, such as aviation, fire, severe weather, etc. By the end of March 2005, each “centre of excellence” would be able to offer a series of tailored lessons for the NHMSs within its region.

RMTC Costa Rica

The second session was informed of suggestions from the RMTC Costa Rica to increase VL effectiveness as follows:

- ?? Resources in the VL were attractive to teachers, students and other users. Each resource in the VL should strive to make the job of the trainer more effective. e.g. images, products, data, information, links. The number of books in the library should be increased;
- ?? Use the VL in training whenever possible, as done in APSATS 2002, Barbados 2003, in the classroom at the RMTC, etc;
- ?? For training materials that were accessible only by request, a short description should be prepared that would encourage potential users to access the resource;
- ?? Presentations and notes for WMO satellite training seminars should be in the VRL for immediate consultation;
- ?? Multilingual material should be made available;
- ?? A collection of case studies should be prepared;
- ?? Focus on people in the early stages of education;
- ?? The search engine was very important.

EUMETSAT

EUMETSAT informed the second session of its current Training Programme, activities since VL-1 and ongoing projects and activities.

With regard to improving VL effectiveness, EUMETSAT made the following suggestions:

- ?? EUMETSAT should mirror the software of the prototype VRL currently hosted on its server to the EAMAC and IMTR (Kenya) servers as soon as feasible. IMTR and EAMAC should consider themselves as owners of this facility, maintain it and update the software as required, including protection against threats of viruses and misuse;
- ?? IMTR and EAMAC senior management should be fully committed to further develop and promote the concept of the VL at their institutes;
- ?? A “What’s New” bulletin should be developed centrally to keep the “centres of excellence” and other trainers and organizations aware of new developments and new training material;
- ?? To be eligible for the role of “centres of excellence”, a minimum set of requirements should be agreed. These would give management of these centres guidelines for further development of the infrastructure. For example, current access to the Internet at IMTR was inadequate to support VL activity. IMTR should set a goal of achieving a minimum speed of 1 Mb/s as soon as possible;
- ?? Further training in the use of tools such as VISITView, SATAID, RAMSDIS, EumetCAL, etc., should be arranged locally on a regular basis;
- ?? Actively promote the concept and use of the VL at conferences, seminars and courses;

- ?? Investigate the feasibility of disseminating training material by operational meteorological dissemination services such as EUMETCast. This would match the requirement set at VL -1 to directly insert data acquired at a ground receiving station into the VL servers;
- ?? Encourage the use of “distance-learning” techniques at training events held at “centres of excellence”. These presentations should serve two objectives:
 - ~~///~~ To demonstrate the potential of distance learning,
 - ~~///~~ To increase knowledge of satellite meteorology,
- ?? As soon as feasible, organise a “remote conference” meeting with the “centres of excellence” to build up experience in these techniques; Goal:2005
- ?? Too few CAL development groups were currently trained. A Working Panel should address this need.
- ?? Investigate the feasibility of making near real-time data available to the VL from sources such as archives, the Internet and via direct broadcast or alternate dissemination system.

IMTR Kenya

IMTR informed the second session of its activities since VL -1 including the current status. With regard to improve effectiveness and efficiency of the IMTR’s education and training programmes, it suggested this could be achieved through the utilization of the e-learning approach and that the Institute should have good Internet connectivity although at the moment the bandwidth was 64 kbps. In this regard, the second session was informed that IMTR, under the auspices of Kenya Meteorological Department (KMD), had installed a VSAT with a proposed bandwidth of 512 Kb/s or more. Although there exists some restrictive policies concerning the connection of a VSAT to the backbone, IMTR was optimistic that the government of Kenya would exempt KMD and provide the authorization immediately after the commissioning.

Through the current Meteorological Transition in Africa Project (MTAP) initiative, IMTR was in the process of establishing a “Meteosat Second Generation (MSG) Laboratory” fully installed with 12-networked PCs, a web server, and satellite receiving equipment early next year. IMTR would, therefore, have capabilities to receive near realtime data (satellite and conventional data) for training purposes. The Laboratory would be connected to the Global Telecommunications System (GTS) Regional Telecommunication Hub (RTH) through the LAN. These facilities should enhance the learning environment and VL activities. Additionally, IMTR has plans to create a new computer laboratory specifically for VL activities.

JMA

JMA informed the second session of its activities since VL-1 including its co-sponsorship of APSATS 2002 and SATAID. JMA suggested the following to increase the efficiency and effectiveness of the VL:

- ?? Easy access to proper materials on the VRL. There were already many materials on VRL. However, it was sometimes difficult to find the proper material. The inventory, key words, and the VRL at EUMETSAT represented a possible methodology for a more sophisticated system to reach the resource that a user required.
- ?? Distribution of near real-time data. Most of the SATAID users have queried how they could use SATAID with the satellites available in their area. Access to near real-time data was a high priority. The imagery server project undertaken by BOM and JMA was an example of an attempt to meet such a requirement.
- ?? JMA could consider a more systematic and sustainable manner to maintain the VRL and development of SATAID.

RMTC BARBADOS

The second session was informed of suggestions from the RMTC Barbados and noted that all points were contained in the recommendations by the other “centres of excellence”.

APPENDIX A

**STRUCTURE AND GOALS
FOR THE
CGMS VIRTUAL LABORATORY FOCUS GROUP**

Management structure

Co-chaired by one satellite operator and one representative from the “centres of excellence”. Served by the WMO Satellite Activities Office as the Secretariat. Membership should include:

- ?? representatives of science teams as appropriate;
- ?? remaining satellite operators and “centres of excellence”;
- ?? other interested parties as appropriate.

VL Strategic Goals

- (1) To provide high quality and up-to-date training resources on current and future meteorological and other environmental satellite systems, data, products and applications;
- (2) To enable the “centres of excellence” to facilitate and foster research and the development of socio-economic applications at the local level by the NMHS through the provision of effective training and links to relevant science groups.

VL Immediate Goal

- (1) To implement a baseline VL and to foster its logical growth.

VL Connectivity Goal

- (1) To assure links between the 6 “centres of excellence” (and supporting satellite operators) with a **minimum** data rate of 56 kbs, to support communication (email, voice), the exchange of software and limited image data sets (e.g., case studies and some near real-time data sets);
- (2) “Centres of excellence” to consider means to increase link capacity to a minimum of T-1 within 5 years;
- (3) A preferred method in the short-term would be the direct insertion of data from a ground receiving station into the Virtual Laboratory servers. As an alternative, the Internet can be used to route data and products to the VL servers.

VIRTUAL RESOURCE LIBRARY (VRL) GOALS

- (1) To establish a list of usable training resources (includes image data sets, s/w, tools);
- (2) To implement a structure for the depository of training resources which will allow easy access by the “centres of excellence” trainers;
- (3) To populate this structure with a core set of material from the training resources list;
- (4) To consider a more general access to the resource library by students (forecasters);
- (5) To consider the provision of additional (enhanced) material from the resource library to all 6 “centres of excellence”.

VL UTILIZATION GOALS

- (1) To establish a VL user tracking and feed-back mechanism, from the outset, (for analysis, refinement, reporting to VL management, and to assess overall usefulness);
- (2) To keep abreast of user requirements for the VL (baseline being WMO Pub No. 258). Assume: analysis of user responses focused on education and training to questionnaires within their region and other user feed-back is carried out by "centres of excellence" and results are reported to VL management;
- (3) To train meteorological students to an operational level of expertise as well as to allow daily weather discussions during training events, near real-time data and products are a strong requirement. Near real-time data are needed to train forecasters on the effective use of new satellite reception and processing systems. Depending on the application, the need for near real-time data availability may not be as stringent.

Long-Term Evaluation of the VL

- (1) After five years, conduct a comprehensive review of the VL.

Typical activities to be undertaken to meet the goals

- ?? Consolidate documentation of the range of skills/competencies for operational meteorologists and specialists;
- ?? Examine which online (Web-based learning), Computer Aided Learning. CDs and hard copy learning materials are currently available for use in the Virtual Laboratory. This activity will include contacting groups such as ASMET, COMET, CIRA, EuroMET, BMTC and CIMSS who have complementary projects under way and relevant science groups (such as the EUMETSAT SAFs, the TOVS Working Group, the Winds Working Group and the proposed quantitative precipitation working group);
- ?? Negotiate with the copyright holders of the training material rights to either link to their material and/or to acquire the rights to use their material at the designated centres of satellite training expertise (this includes the centres making the material available to on- and off-site users);
- ?? Working with groups such as ASMET, COMET or EuroMET, design and test possible user interfaces, educational approaches for delivering the material, and examine methods for online tracking of student participation;
- ?? On a trial basis, evaluate the proposed Virtual Laboratory material in conjunction with one of the WMO satellite training workshops for more user feedback;
- ?? Incorporate user feedback into the educational approach and review the content of the Virtual Laboratory;
- ?? Move to a wider implementation of the material;
- ?? Undertake a periodic review of the Virtual Laboratory sites in conjunction with reviews of the skills and competencies of the operational meteorologists and specialists;
- ?? Prepare sample data sets for the various data streams now being provided or planned for in the near future. The data sets would be used within the VL concept;
- ?? Provide for continuous monitoring of user requirements for Education and Training as well as the effectiveness of the Virtual Laboratory

APPENDIX B**IMPLEMENTATION PLAN****Action items:**

Prepare an inventory of which training resources and materials are presently available for the core VRL by the end of July 2001 and provide response to J. Wilson (Wilson and all VL participants).

?? Done

Each satellite operator should identify which data and products could be linked into the core VRL by the end of July 2001 and provide information to R. Francis (Francis and satellite operators)

?? Selected imagery is available through the CIRA VL web site, the WMO Satellite Activities web page 's Imagery link to "Online Satellite Imagery Sites," and EUMETSAT's VL web page

CIRA to establish a web server for an initial set near real time data and products by the end of November 2001 and report to the VL list-server (Purdom).

?? Done

EUMETSAT to establish a server for an initial site for training resources and materials by the end of July 2001 and report to the VL list-server (Francis)

?? Done

Additional specific actions and timetable:**0 to 1 year**

?? During the next 6 months, all "centres of excellence" to evaluate content, and how and what can be maintained on a server at the "centre";

?? Content revision is an ongoing activity.

?? Content was reviewed and updated for APSATS 2002.

?? Train satellite operators and "centres of excellence" on the use of RAMSDIS using VISITview;

?? Either RAMSDIS machines or code have been provided to all operators and centers of excellence.

?? VISITview has been made available via the VL web site at CIRA to all participants

?? Training has been provided by NESDIS for EUMETSAT, Costa Rica, Barbados, BOM, and Nanjing

?? EUMETSAT to provide training for Nairobi and Niamey

?? Increase training event effectiveness through the use of VISITview;

?? VISITview effectively used for APSATS 2002

?? Add the SATAID training resource to the VRL and utilize VISITview on the use of that tool.

1 to 2 years

?? Within 1 ½ years, all satellite operators to strive to have a server online and connected to the VL;

?? Servers on line at NESDIS (CIRA), EUMETSAT and JMA

?? Each "centre of excellence" will strive to have a server online and connected to the VL;

?? Server online at BOM

?? To establish a voice channel capability within VISITview;

?? To evaluate and ways to improve the VRL;

?? To evaluate the quality of submitted materials by the “centres of excellence”, completeness (e.g., speaker notes), appropriate deletion dates, compatibility issues, and virus protection.

5 years

?? Conduct comprehensive review