IVOA Strategic Plan

V2005.01.04

P.Quinn

1.0 Introduction

The mission of IVOA is *to facilitate the international coordination and collaboration necessary for the development and deployment of the tools, systems and organizational structures necessary to enable the international utilization of astronomical archives as an integrated and interoperating virtual observatory*. To achieve this mission, IVOA is currently producing internationally agreed standards definitions for the fundamental infrastructure of the VO as outlined by the IVOA-supported VO Architecture. IVOA needs a strategic plan that will maximize its chance of success. IVOA needs to anticipate the evolution of its work and role in the community to the point where its mission is successfully concluded or it moves into a new role with a different mission and associated community. Today, IVOA has already adopted several elements of a strategic plan. The formation of working groups, the publication of a roadmap, the promotion of project-level demonstrations and the building of bridges to international bodies (GGF, IAU, OECD) are all initiatives taken to ensure the success of IVOA. These initiatives, and new ones to come, collectively represent the IVOA Strategic Plan. Just as we are looking closely at the VO architecture map to search for missing elements, so we should also look at a strategic plan to see if we have all the elements we need for success on the timescale of a fully enabled VO. This document seeks to outline the elements of an initial IVOA Strategic Plan that must be a living document that evolves with the IVOA. It will define the major pieces of the plan and raise a number of issues that need to be addressed at the level of the IVOA Exec.

2.0 IVOA Today

2.1 IVOA structure and governance

The IVOA is an alliance of established VO projects. By January 2005, the IVOA has grown to include 15 funded VO projects from Australia, Canada, China, Europe (United Kingdom, Germany, Italy, France, Hungary, Spain, ESO, ESA), India, Japan, Korea, Russia and the United States of America (http://www.ivoa.net). The alliance seeks to fulfil the IVOA mission statement:

To facilitate the international coordination and collaboration necessary for the development and deployment of the tools, systems and organizational structures necessary to enable the international utilization of astronomical archives as an integrated and interoperating virtual observatory.

Each project is represented by at least one member on the IVOA Executive Board. The chairperson of the Executive Board is identified by consensus from the members of the Board and servers a one-year term. The chairperson is supported by a deputy chair (also identified by consensus from the Board) who also servers for one year. The deputy chair replaces the chair at the end of his/her term. The chair and deputy chair are supported by three officers (a technical lead, a secretary and a document coordinator) who are nominated by the chair and serve for a three-year term. The IVOA Executive Board meets face-to-face twice a year (in January and June/July) and via telephone conference as needs require. All meetings of the Board are minuted and publish on the IVOA website.

VO projects seeking to join the IVOA can apply at any time to the chair of the Board. Guidelines for participation are posted on the IVOA website (http://www.ivoa.net/pub/info/index.html#statement).

2.2 IVOA links

The IVOA has sort to form links to other communities, projects and governing bodies in order to share technological approaches, gather scientific and technical requirements and to promote the importance of adequate funding for the scientific exploitation of data from new and existing facilities. In particular, the IVOA has initiated the formation of an astronomical Grid community Research Group within the Global Grid Forum, has encourage IAU Commission 5 to form a VO Group to facilitate IAU oversight and endorsement of IVOA recommendations, has made presentations to specific large project meetings (ALMA, LSST and IAU Joint Discussions) and has actively participated in the OECD Global Science Forum workshops on Future Large-Scale Projects and Programmes in Astronomy and Astrophysics (April 2004).

2.3 The role of working groups and interest groups

The IVOA Executive Board creates working groups and interest groups to pursue the discussion and definition of IVOA standards and mechanisms

(http://www.ivoa.net/twiki/bin/view/IVOA/WebHome). Each working group has a chairperson nominated by the Executive who will produce reports on the actions of the working group to the Board twice a year. To facilitate the global advancement of working group activities, the IVOA organizes Interoperability Workshops twice a year (Spring and Autumn) at which all working groups will discuss progress and work towards final definitions of standards. Interest groups have no specific mandate to produce draft standards but rather to identify needs and requirements that may precipitate working group activities. The operation of working groups and interest groups is supported through a collaborative environment maintained on the IVOA website with oversight by the IVOA document coordinator.

The process of defining standards within the working groups is described by a standards process (http://www.ivoa.net/Documents/REC/DocStandard) modelled on the W3C process.

2.4 The role of coordinated demonstrations

All partner projects of the IVOA are encouraged to demonstrate their development efforts on an annual basis to their national or international supporting communities. These demonstrations can coincide with national astronomical meetings or be part of a regular series of meetings with science steering groups. Several projects have chosen to undertake these demonstrations each January.

Demonstrations of capabilities and developments provide IVOA member projects and the IVOA with several major benefits:
- They provide a forum to engage the scientific community in order to
  - highlight new and emerging capabilities – show the astronomical community IVOA projects are actually doing something!
  - allow scientific requirements to be identified
  - allow open astronomical comment and criticism of priorities, directions and results
  - showcase scientific results obtained by VO projects with new tools and standards
- They provide a major, regular and predictable milestone for development projects to meet deadlines and provide operational code
- They allow IVOA to assess progress on standards development and implementation and to set priorities for standards roll-out in a coordinated way

3.0 Strengths, Weaknesses, Opportunities and Threats

Most organizations conduct a periodic SWOT analysis to checkpoint their strategic plans. This can happen on the timescale of months in the ICT arena. A SWOT study of IVOA would form an important backdrop to the evolution of the IVOA Roadmap and would identify strategic choices for development priorities within the VO architecture.

3.1 Strengths

- [S1] The VO concept is **well regarded internationally at the level of governments and funding agencies** as effectively addressing a well defined need for access to data, for maximizing scientific return on public investment and as an important ICT activity
- [S2] The IVOA is an **effective international collaboration** including large and small projects from large and small countries. This builds link within and across astronomical communities that may not have existed before and which will result in the advancement of astronomy
- [S3] The VO concept is appealing as **a method of empowerment** for research communities without access to major facilities and as a means of connecting research with educational needs.
- [S4] In the past several years, there has been **significant unity of purpose** amongst a large enough group of international astronomers in Europe, the US and elsewhere to make IVOA possible.

3.2 Weaknesses

- [W1] The IVOA is not a funded project and has no resources other than those committed to its mission that are under the control of member projects. This means the IVOA will only succeed and advance by **achieving and maintaining a strong consensus** on all actions while allowing the success and autonomy of each member project
- [W2] The success of the IVOA depends on the **uptake of its products by data centres and service providers** that will form the VO. These centres are maintained and funded by organizations that may not share similar views, interests or resources with the agencies that are funding the IVOA projects.
- [W3] The IVOA developments must precipitate new scientific results that must then be widely recognized by astronomers and others as having being enabled by the VO. Without effective seeding of projects and promotion of results, there will be no incentive for uptake by data centres, development projects or research teams – "publish or perish". **Finding "killer VO problems" has not been easy** to date.

3.3 Opportunities

- [O1] Funding agencies are **still willing to provide funds** for ICT developments following the "grid paradigm"

- [O2] ***Large international astronomy projects are in start-up*** (ALMA, LOFAR, ELT, SKA) and there is a window of opportunity for VO concepts to be planted in the fundamental design of these facilities
- [O3] The ***concept of data heritage and curation in archives is spreading*** and, in some cases, being imposed by government funding agencies to ensure public access
- [O4] A ***multi-wavelength strategy to solving problems is widely regarded*** by the astrophysics community
- [O5] ***Future large projects, by their sheer scale, will need to be international*** and therefore will have to deal with distributed data, resources and teams.

3.4 Threats

- [T1] The VO concept is still regarded with ***considerable scepticism by some (maybe a majority) of the astronomical community***, based either on the failure of "similar" efforts in the past or a misunderstanding of the basic VO mission. These individuals at least consider VO a threat to the funding of instruments and telescopes. A few loud voices and/or a relatively minor slip-up by the IVOA effort could have very serious consequences with respect to acceptance by the broader astronomical community.
- [T2] Unless ***network infrastructures are improved*** in a large number of international communities, the true potential of the VO will not be realised and fractions of the community will be cut off from the benefits.
- [T3] ***Too close an association with "the grid"*** may be a treat if it fails to deliver on its promises

3.0 Strategic Choices, Objectives and Developments

The SWOT analysis provides a backdrop to review the current status of IVOA's methodological approach to achieving its mission and highlights a number of strategic choices, resulting objectives and the developments necessary to achieve those objectives.

3.1 IVOA Work Program

The initial work program of IVOA is focused on
- producing standards documents that cover all aspects of the VO infrastructure and interoperation mechanisms
- formulating a roadmap for the role-out of these standards based on assessments of short term need, their strategic significance and cross-project consensus
- promoting the international adoption of IVOA standards, VO enable science and inter-project collaboration through sponsorship of conferences, workshops and the maintenance of a website

The current work program is progressing successfully **[S1][S2]**. We have achieved agreement on a number of major pieces of the VO infrastructure. Given this, the current process of recommendations, working group composition and function and IVOA Executive governance does not need any major modifications.

3.1.1 Building, Releasing and Maintaining Standards

We have chosen the initial work program because of our mutually agreed sense of an overall VO development path that first produces the standards, then enables/promotes the take-up of the standards by data providers and finally layers on the tools that astronomers use to do science on the VO-exposed data and services. Therefore, we have implicitly defined an evolution in the IVOA work program that implies transition timescales and meshing of objectives. Right now, we are rolling out standards. These standards must be taken up by data providers **[W2]**. We need to choose when and how we roll out the standards and how we will facilitate the take-up.

> **Work Program Objective 1[WPO1]**
> IVOA wants to see the extensive taken up of its standards by international projects, archive centres and service providers. In order for this to happen, the standards must:
> - have broad visibility and acceptance in the VO community
> - be well documented
> - be configuration controlled and maintained
> - be stable on a timescale that allows developers to make manpower investments and development choices for long term projects
> - be updated in a consistent and coordinated manner which anticipates the needs of developers and long-term operators of data centres

Work Program Development 1 [WPD1]

IVOA does not have any guidelines for standards roll-out. Possible guidelines would be:

- The initial introduction of a new standard is timed to allow development projects to incorporate it into the next available demonstration. This would normally mean standards come out mid-year for beginning of year demonstrations – a six month lead time
- Once introduced, a new standard is not updated and reissued within the first year. This will allow sufficient time for market penetration and developments. The standards may be evolved within the working groups on a shorter timescale.
- The first reissue of a standard should not result in major functional changes. Major changes should occur (if necessary) on alternate releases.
- Since we are dealing with standards and not code, changes to standards can, in principle, be significant, involve major concept changes and not be entirely "backward compatible" conceptually. This is necessary if we are to put acceptable standards in place early (e.g. VOTable) and refine them (perhaps significantly) at a later date.

3.1.2 Promoting Take-up

In order for the new standards to broadly visible and to promote take-up, the IVOA needs to decide when and how this should occur. Following the May 2004 Interoperability meeting in Boston, there was a broad consensus that 2005 was the year to actively begin the process of promoting take-up of the basic set of interoperability standards as demonstrated in January 2004 and 2005.

WPO2

The IVOA will begin in 2005 the process of promoting and encouraging the take-up of VO standards and technologies by international data providers.

WPD2

IVOA should:

- Agree on what the appropriate minimal set of standards to be promoted in 2005 should be
- Identify dates and locations for international workshops/tutorials/summer schools at which developers and staff from data providers will be invited to come and learn the basic IVOA standards necessary for them to start making their content VO-visible.
- Develop some mechanism to measure VO take-up (a take-up metric)

> **WPD3**
> If standards are to be well documented and configuration controlled, then they become a long-term product and commitment from IVOA. This opens up a number of important strategic choices and possible developments, some of which will be discussed in section 3.2 on the IVOA mission, members and community. Practically:
> - IVOA should develop and maintain reference implementations of standards

3.1.3 What About Tools?

The final step in the VO becoming an operational reality is to enable new science through astronomers using tools that *access and utilize* VO-exposed data and services. Unless astronomers see new science coming from the VO (using the new tools) and unless they have the tools in the first place, the VO will fail **[W3][T1].** The role of IVOA has been to create the standards that will be employed by the tools. Individual VO projects have identified their own interests in tool building that are guided by scientific requirements from their home communities. What then should be the role, if any, of the IVOA in the process of making sure astronomers have the tools they need to use the VO content and services? There are two broad issues here. First, the IVOA should not prejudge or assume the scientific priorities of individual communities. I believe these priorities are best set by the communities and acted upon by community funding projects to build VO tools. IVOA can create a forum in which applications and application developers experiences are shared, e.g. the applications working group. Furthermore, IVOA can promote and organize international meetings (and/or be present at those meetings) to enable scientists to discus their scientific requirement, results and future needs that impact VO developments and capabilities, e.g. IAU General Assembly and Symposia. The second major issue for tools is the distinction (which may be fuzzy) between tools that enable *access* and tools that *utilize* the resources that are exposed. A lot of the VO infrastructural development has been focused on data access. Clearly, there needs to be tools and systems (new and old) that can use the access to ask and answer complex queries. There is already a growing movement in the community asking what the future of data analysis packages like IRAF and MIDAS will be in the era of data intensive astronomy and the VO. What role should IVOA play in defining the interface between the developers of new analysis environments and the development of the VO infrastructure? This is partially addressed in section 3.2 on the evolving IVOA community role. Again, individual VO projects may have roles in both access enabling and utilization aspects of the VO.

> **WPO3**
> The IVOA will promote the development and deployment of VO-enabled tools that are developed within the individual VO projects and communities to the specific requirements of those communities.

> **WPD4**
> The IVOA will support
> - Working groups in application areas
> - Workshops and scientific meetings that showcase VO-enabled science.

3.2 IVOA mission, members and community

The mission of the IVOA states that it wished to "*facilitate the international coordination and collaboration necessary for ….*". We have been successful in the business of facilitating international collaboration and coordination and we have been recognized for this effort and success by the OECD and others. Is there a logical end-point to this mission and should IVOA modify its mission in anticipation of evolving roles and needs? More generally, what role, if any, should IVOA play in the operational era of a VO with international reach? Should IVOA promote the existence of an IVO or should there only be a web of data and service providers that constitute a dynamic and multi-treated research environment? The answers to these questions will drive our strategic development with respect to membership, community, resources and long-term role in the community (if any).

3.2.1 Mission

The effective take-up, utilization and long-term usefulness of standards requires those standards to be maintained and controlled **[WPD3].** This goes beyond the initial mission statement of the IVOA which implies a logical end to the IVOA mission once the VO becomes operationally viable. There is a close analogy here between the mission/Work Program of the IVOA and the W3C. The WWW remains an operational and interoperating entity because there is a body (the W3C) with the mission and long-term support to maintain and evolve the necessary standards. Should IVOA follow a similar path? I believe the answer is yes. The only alternative I can see would be the creation of a VO working group within the IAU following a similar model as the FITS working group. I do not believe this would be as effective as an evolutionary outgrowth of the IVOA.

Mission, Members, Community Objective1 [MMCO1]
The mission of the IVOA should evolve to identify a long-term role for IVOA as a standards maintenance organization.

MMCD1
The IVOA Executive should
- Identify a timescale for the transition of the IVOA mission. This would logically be consistent with the timescale for 2nd round funding for current VO projects ending around 2008/9
- Propose mechanisms by which a long-term role for the IVOA can be supported financially. Possible mechanisms could include subscriptions from data centres, observatories, national astronomical agencies and international funding agencies **[O3].**

The global issue of the existence of an IVO is an interesting one. The Web exists. No one is proposing that there are multiple WWWs and the simplicity of a single WWW lends strength and appeal to it as a unifying and desirable global resources. The WC3 supports the mechanism by which an operationally seamless WWW is possible. But the WC3 does not run the WWW. There is no global authority to control the WWW (maybe some

governments would like this to be the case). In my opinion, we should adopt a similar stance. There is a VO which has a global reach and capability that will change with time. The capabilities and funding for the capabilities, will vary on a national basis. What we should be most concerned about is the preservation and promotion of the capability and we should not promote some overarching control of the utilization of this capability. That control, like the control of access to observational resources, will happen on a national basis via appropriate scientific and funding review bodies.

MMCD2
The future mission of the IVOA should focus on the long term preservation of a global VO capability and not the creation of a controlled global IVO entity.

3.2.2 Members

Currently the IVOA membership consists of funded VO projects that are willing to contribute to the work of the IVOA. This alliance is working and successful **[S1][S2][S4].** We should not damage that success by prematurely modifying the membership model **[W1].** As we seek to encourage take-up by data providers **[W2]**, IVOA needs to have effective communication with data centres and observatories. This communication is within the scope of work of some of the IVOA member projects. However, it is probably useful to consider if data providers should have some channel directly into the IVOA. Clearly the data providers will be an important source of requirements and feedbacks on the evolution of the IVOA standards. Following the analogy of the WC3, national astronomical agencies and astronomical facility providers (e.g. ESO, ESA, NASA, NOAO, NRAO) could be represented in the management structure of an evolved IVOA and/or could post representative to the existing IVOA through a dedicated interest group.

MMCO2
As the role of IVOA changes and the work program evolves, IVOA must adopt an effective membership structure that will not prematurely damage the ability of the alliance to form a constructive consensus, but will recognize the need to effectively engage data providers, funding agencies and new communities.

3.2.3 Communities

The international astronomical community is actively considering (and building) large-scale, new facilities on the ground and in space with data flow rates and volumes that will challenging existing data management/archiving infrastructures **[O2][O3][O5]**. The funding agencies for these projects are promoting, and insisting on, an open-access and availability policy of scientific data. Furthermore, these projects are global and involve new astronomical community links. This set of circumstances represents any ideal environment in which the capabilities enabled by the VO infrastructure can directly impact on the scientific success of new projects. The importance of the VO capability to

these efforts was clearly highlighted in the IVOA paper to the OECD on astronomical data management challenges in the 21st century (http://www.ivoa.net/pub/info/#documents). It is therefore vital that the IVOA actively engage new large-scale projects so that VO concepts and appropriate data archiving strategies can be inserted into project planning at an early stage. Conversely, IVOA needs to anticipate the new for new and evolving standards in the light of new astronomical facilities.

MMCD3

The IVOA needs to identify mechanisms for outreach to new astronomical facility projects such as "project delegates" within working groups.

One powerful aspect of the VO capability is its potential to empower research communities that do not have ready access to front-line astronomical instrumentation **[S3]**. The IVOA is making a positive effort now to promote the VO within astronomical communities that are facing significant research funding difficulties (e.g. Russia, China) through financial support and the promotion of regional meetings. What else should the IVOA be doing in this area? Our long-term ability here will be limited by the lack of specific IVOA funds **[W1].** The IVOA should certainly continue to promote collaborations between exiting member projects and emerging projects or communities that may not be able to significant contribute to the IVOA work program.

MMCD4

The IVOA should consider mechanism of membership that will allow effective involvement of VO projects from communities who cannot contribute significant resources to the IVOA work program. Furthermore, IVOA should encourage full member projects to cultivate collaborations with emerging community projects and organizations.

As international astronomy becomes increasingly multi-wavelength **[O4]**, it is vital that IVOA consider the particular needs of new "wavelength communities". Some VO projects already include Solar Astronomy and High Energy Astrophysics. We again need to ensure that these community groups are encouraged to participate in, or form, VO projects that are represented in the IVOA.

MMCD5

The IVOA should encourage member projects to seek participation from new "wavelength communities"

3.2.4 How can we measure our success?

Measuring success must have a lot to do (at the IVOA level) with the number of data providers that use the IVOA standards **[WPD2].** Success at the VO level has to do with

the amount of science enabled. Measuring the enabled science is not easy. Maybe IVOA should be talking to journals about how to do this is in an internationally consistent manner?

MMCO3
The IVOA should define and promote mechanisms that measure the scientific return from VO-exposed resources.