1 Excellence

Research infrastructures are the cradle of world-class science, which is in turn the foundation of tomorrow's technologies, jobs, and well-being. These statements are particularly true for radio astronomy, where innovations in communication and ICT technology open new windows on the universe. Through the diverse programmes that the European nations funded in the past, Europe's radio astronomers can work with an impressively wide range of radio telescopes, covering a range of wavelengths spanning five decades, from metre to sub-millimetres waves. Radio astronomy is a perfect example of a field in which national infrastructure providers have joined their efforts to establish and maintain world-class research facilities to develop, attract and retain research talents. From this, a vibrant community, spread out over even more nations, has developed. This community fosters scientific and technological innovations and contributes not only to the field of astronomy but also to interdisciplinary areas (like geodesy, fundamental physics, computing science) and the competitiveness of Europe at large.

Since 2000, the European Commission has supported an infrastructure cooperation network in radio astronomy. It started under the 5th Framework Programme (FP5) as a collaboration of partners from Europe, Australia and Canada. This collaboration continued successfully during FP6 (RadioNet) and FP7 (RadioNet2 and RadioNet3). The number of partners increased from 11 to 27, including global partners. Through this coordinated effort, Europe has successfully integrated a unique array of capabilities and made fantastic progress in radio astronomy. A world-leading position has resulted from this integration, which is for example demonstrated by the high proposal pressure for European time on the global ALMA telescope in Chile. Moreover, the ESFRI-listed SKA telescope is being developed as a global research infrastructure under European leadership. In order to make use of this advantage at a pivotal time in the development of radio astronomy, the RadioNet activities remain crucial.

The EC project contributions have allowed access for European scientists to a very complete range of radio astronomy infrastructures. At the same time, world-class technical development was initiated; European teams produced state of the art receivers for sub-millimetre telescopes, mastered the art of low frequency data processing, researched the use of aperture array receivers and implemented unique VLBI capabilities on the EVN. Nothing like this would have been possible without the formal collaborations that were initiated through the RadioNet projects. A small contribution (<10% of the operating cost of RadioNet infrastructures), has proven to be essential for bundling the efforts in European radio astronomy at all levels. This ensures that the required capacity building continues, which will be in high demand because of the astronomy facilities on the ESFRI roadmap. It is also a crucial ingredient for involving more countries in radio astronomy. Moreover the developments for SKA and other ESFRI facilities offer synergetic opportunities to boost the science return of the past national investments in radio astronomy.

The proposed RadioNet work programme is structured into three types of activities: 3 Networking Activities (NA), 7 Trans-national access Activities (TA) and 3 Joint Research Activities (JRA). These activities are the outcome of a competitive selection process. The entire radio astronomy community was invited to submit applications, which were selected by independent experts based on excellence, implementation and impact criteria. Notably, an important criterion was that all selected activities would be measurable, realistic and achievable.

also new is the amount of data to be transported and handled. Maybe better say: "mastered the art of low frequency wide field calibration and massive data transport and processing."

1.1 Objectives

Describe the specific objectives for the project, which should be clear, measurable, realistic and achievable within the duration of the project. Objectives should be consistent with the expected exploitation and impact of the project.

Against the backdrop of the development of the SKA and the operations of ALMA as global radio telescopes, we will focus on activities that maintain a strong European radio astronomy community, both scientifically and technically. There has been noticeable progress with the European-scale governance of radio astronomy through the establishment of JIVE-ERIC and the commitment to continue the existing collaborations. However, strong leadership of the RadioNet collaboration is much needed, with the following objectives:

1. to provide a governance structure for the collaboration of European radio astronomy institutes
2. to facilitate access to a complete set of key research infrastructures in Europe for advanced radio astronomy – open and free of charge,
3. to attract users of the wider astronomy community by providing an integrated, professional and consistent level of user support,
4. to equip scientists and engineers with the essential skills to take charge of existing and future radio astronomical infrastructures,
5. to provide a joint channel for the dissemination of scientific and technical achievements resulting from the collaboration,
6. to facilitate scientific and technical interaction among the radio astronomy community and with all partners , including industry and other stakeholders,
7. to develop state-of-the-art hardware and software necessary for the existing radio infrastructures and relevant for access to the future ESFRI ,
8. to ensure that the joint technical development programme makes an impact on a European scale and connects with industry, reinforcing the H2020 mission,
9. to work towards establishing a long-term, self-supporting RadioNet structure, identifying the resources that will secure this collaboration on many levels
10. to contribute substantially to the implementation of the vision developed in the *ASTRONET Strategic Plan for European Astronomy* by providing key facilities and fostering a sustainable radio astronomical research community with world leading qualifications.

It is a strong point that this RadioNet proposal builds on its precursors and will continue to organize European radio astronomy. In some key places the RadioNet programme will make provisions to address the most important current issues. The user community will recognize the continuous commitment to provide a complete, innovative and accessible set of research facilities. In addition, RadioNet will continue to be the body representing the interest in radio astronomy in the context of European science and national initiatives (*OBJECTIVE 1*).

Most importantly, RadioNet provides European astrophysicists with the most sensitive telescopes (*OBJECTIVE 2*) like the single dishes of APEX, Effelsberg 100m, and IRAM-PV, and unique interferometers probing high angular resolution such as e-MERLIN, EVN, IRAM-NOEMA, LOFAR, and WSRT. A so-called “open skies” policy is offered by all these radio telescopes, even though they are constructed and operated by national agencies, local institutes or limited collaborations. The European access is an essential ingredient for promoting the use of these facilities on a larger scale. In radio astronomy we proudly note that there has been substantial progress towards establishing an exchange of researchers as envisioned in the European Research Area (ERA). While traditionally the field was dominated by local specialists, an effective transition has been made by employing dedicated support staff at the telescopes. The nature of radio astronomy experiments are such that an adaptive level of assistance is key for allowing astronomers with a different background to make effective use of the radio astronomy infrastructures (*OBJECTIVE 3*).

A particular challenge in this respect is that radio astronomy rapidly adapts new technologies, producing ever more voluminous and considerably more complex data. At the same time there is a demand from an increasing community of researchers to use the radio astronomy data. RadioNet is important for organising joint training events to attract new users, to provide scientist with the essential tools to take full advantage of existing and future radio astronomical infrastructures. (Use of the archive will be included) The programme not only targets scientists, but also an international pool of engineers, who can update their skills and knowledge in exchange programmes. *(OBJECTIVE* 4). Dissemination of technical and scientific results will also benefit from a joint approach in order to maximise their impact. RadioNet will use the appropriate dissemination channels to promote the scientific and technical output of the project activities (e.g. publications, oral presentations at scientific conferences and workshops – *OBJECTIVE* 5). The audience will certainly not be restricted to radio astronomers, but it will include the broader scientific community, policy makers and industry. RadioNet will establish links with other EU projects (Europlanet, ASTERICS, AHEAD, OPTICON) and serve as an important point of contact for policy activities (ASTRONET, ESFRI initiatives). New links with industry will be explored by attending the specialised events, e.g. IEEE, communication meetings (*OBJECTIVE* 6).

Radio astronomy is big science with local, earth-bound telescopes. This continues to provide fantastic opportunities for innovation, as is demonstrated by the way our pioneering R&D activities have upgraded RadioNet facilities. The European partners will work on software that deploys modern parallel computing techniques, high in demand for instruments such as e-MERLIN, LOFAR, Apertif and the EVN. New digital equipment will allow radio astronomers to make more sensitive observations with the existing telescopes by increasing the observing bandwidth or the field of view. This possibility to design innovative receivers comes at a time when the increased data rates can be handled by new digital components. This particular programme has a direct link with the SKA; if these big data issues are not addressed for the upgraded RadioNet facilities, they will become a serious bottleneck for scientific progress. We envision that the developments will push the current norm for data processing and establish a new standard for radio astronomy performance (*OBJECTIVE* 7).

The topic of big data is a good example of the way radio astronomers are learning to mobilize the expertise that is available in industry. This interest has proven to be mutual, because the large data volumes and associated real-time analysis operations provide an interesting challenge for industry. All the JRAs proposed in the program have been selected to provide possibilities to combine our astronomical objectives with industrial partnerships (*OBJECTIVE 8*)

Concerning sustainability, RadioNet must make progress beyond current standards in terms of integration and services, technical development, expanding trans-national access and securing long-term services. In order to achieve this, we have to identify the core resources necessary to support the fundamental mission of European radio astronomy and secure this independently of EC funding (*OBJECTIVE* 9).

There is already a RadioNet vision on how the European radio astronomy community should formally organise itself in the coming decade (ASTRONET- ERTRC[1] Report & RadioNet3 White Paper). This vision now requires a sustainability plan for RadioNet beyond the grant lifecycle. Future R&D developments require a critical mass that can only be found on a European scale with respect to the needed resources (*OBJECTIVE* 10).

For all of European astronomy ASTRONET (an FP7 ERANet) has evaluated the strategic priorities for the next 5-25 years. The outcome of this exercise was reported in two documents: a Science Vision outlining the opportunities and priorities for European astronomy, and a Roadmap translating that Vision into a plan for establishing the required large-scale facilities. The proposed RadioNet contributes substantially to the implementation of the *Strategic Plan for European Astronomy (OBJECTIVE 10)*:

1 *European Radio Astronomy Review Committee*

This conclusion is of paramount importance for consideration on the sustainability of coordinated approach to European radio astronomy.

RadioNet joins together 24 partners, amongst which are institutions operating world-class radio telescopes as well as organisations performing cutting-edge research, education and development in a wide range of technology fields that are important for radio astronomy. The consortium will establish strong links to complementary European initiatives by appointment of representatives in its Advisory Group. The consortium board will consider members from ESFRI initiatives (e.g. SKA), related scientific projects (e.g. ASTERICS, AHEAD, EUROPLANET), and key industries.

RadioNet dedicates a significant amount (42%) of the EC funding to support the Trans-national and Virtual access to the set of key radio astronomy facilities for researchers from European and Third Countries.

All selected TA facilities offer access based only on scientific excellence, using in almost all cases a common electronic application system (NorthStar, developed under RadioNet). The close cooperation established between the RadioNet facilities is an excellent starting point for TA leaders to identify the areas for further harmonisation and optimisation of the access procedures and interfaces. Collecting, calibrating and interpreting radio astronomical data is a challenging activity. On the one hand, a certain number of black-belt users are crucial for pushing the radio telescopes to their limits, and for exploring new instruments and new techniques. On the other hand transparent and streamlined access for non-specialised users to the radio telescopes and their data will increase the range and impact of the science that is delivered. The projected full range of science capabilities drives the technological developments. (Arguments for including/offering Apertif Long-Term Archive under virtual access will be included)

Therefore, RadioNet dedicates a substantial budget (41%) to Joint Research Activities. These projects will develop equipment and software to improve the quality and variety of the services of our radio astronomy research infrastructures. The implementation of the delivered technology will reduce the observing time, improve the bandwidth and quality of the data, simplify the use and maintenance, and reduce the operating cost and therefore increase the scientific productivity.

Thanks to RadioNet, the European radio astronomy community is now better connected than for example the US community, despite dealing with national and language barriers. In particular, effective platforms have been established for the interaction between European radio astronomers, engineers and the facility operators. For example, the European radio astronomers speak with one voice to keep the radio sky free from man-made interferences. The European radio astronomy engineers meet regularly in order to define new common standards and goals. As a consequence, duplication of effort is avoided and the technical developments are pushed forward effectively.

Previously, Networking Activities focused on specific audiences (scientist, engineers, policy makers), successfully addressing their particular needs. However, this autonomy of the Networking Activities was not designed to optimally support mutual interaction between the activities and their respective communities.

Now, RadioNet networking activities are proposed to be combined into three work packages with over-arching goals of dissemination, training and sustainability. This will be a significant improvement compared to previous incarnations of RadioNet. Each of these three topics involves the entire radio astronomy community; this facilitates interaction and synergy between researchers from the scientific community or industry, engineers, technicians, policy makers, and other stakeholders. This way RadioNet will contribute to an efficient and attractive European Research Area.

RadioNet will organise the efficient curation, preservation and provision of access to the data collected or produced under the project. For this purpose, the repository of the Max Planck Society (MPG) will be used to establish a long-term archive for the preservation of results obtained by JRAs and NAs: software source-codes, technical design plans, publications, tutorials and oral presentations.

STRATEGY FOR KNOWLEDGE MANAGEMENT AND PROTECTION

*Outline the **strategy for knowledge management and protection**. Include measures to provide **open access** (free on-line access, such as the 'green' or 'gold' model) to peer- reviewed scientific publications which might result from the project. (Open access must be granted to all scientific publications resulting from Horizon 2020 actions. This obligation does not apply to trans-national access users.)*

Open Access will be ensured for all scientific publications from the RadioNet project. Papers resulting from TA projects would be encouraged but not required to become available open access.

RadioNet partners will be encouraged to adopt the 'gold' model by publishing in dedicated open access journals or by selecting open access options if applicable. We expect the RadioNet results to be published as articles in radio astronomical and multidisciplinary journals (A&A, ApJ, Nature, Science etc.) or in form of conference proceedings (several possibilities). In particular, the JRA results will often be published by IEEE. Today, article processing charges for these publishers range from $5200 (Nature Communications, http://www.nature.com/openresearch/publishing-with-npg/nature-journals/) to $1750 (selected IEEE journals, http://open.ieee.org/) and RadioNet will reserve allocated budget for this purpose at the WP1-Management.

However, the potential target audience of the publications will have high priority when selecting the appropriate journal and we expect that not all publishers will offer a 'gold' open access option at time of article submission. In these cases, the conditions of 'green' open access will be investigated by checking the individual author contract and consulting the openAIRE help desk if necessary.

RadioNet will deposit an electronic copy of the published version (e.g. the final peer-reviewed manuscript) of all scientific publications into MPG.PuRe (http://pubman.mpdl.mpg.de). This publication repository contains bibliographic description and numerous fulltexts of the publications of Max Planck researchers and associated projects. The repository is based on eSciDoc.PubMan, a software suite developed by the Max Planck Digital Library. MPG.PuRe is OpenAIRE compliant and therefore can be harvested by the OpenAIRE repository. Additionally the MPG.PuRe is open for several search engines, e.g. the MPG.PuRe records are indexed by Google and Google Scholar. Additionally the PuRe records are indexed by scientific search engine ‚Base', operated by University of Bielefeld (DE). 'Base' is one of the world's most voluminous search engines especially for academic open access web resources (https://www.base-search.net/). BASE is a registered Open Archive Initiative (OAI) service provider and contributed to the European project "Digital Repository Infrastructure Vision for European Research" (DRIVER).

b) Communication activities

Describe the proposed communication measures for promoting the project and its findings during the period of the grant. Measures should be proportionate to the scale of the project, with clear objectives. They should be tailored to the needs of different target audiences, including groups beyond the project's own community. Where relevant, include measures for public/societal engagement on issues related to the project.

In a complex and transnational project like RadioNet, efficient communication is required i) within each WP and between the WPs (including Management), ii) between the RadioNet consortium and the rest of the scientific and technical community, iii) with industry, iv) with policy makers (such as national and international authorities, e.g. the ones that determine frequency allocations), v) complementary projects (such as ASTRONET, ESFRI related initiatives), and finally vi) with a general public.

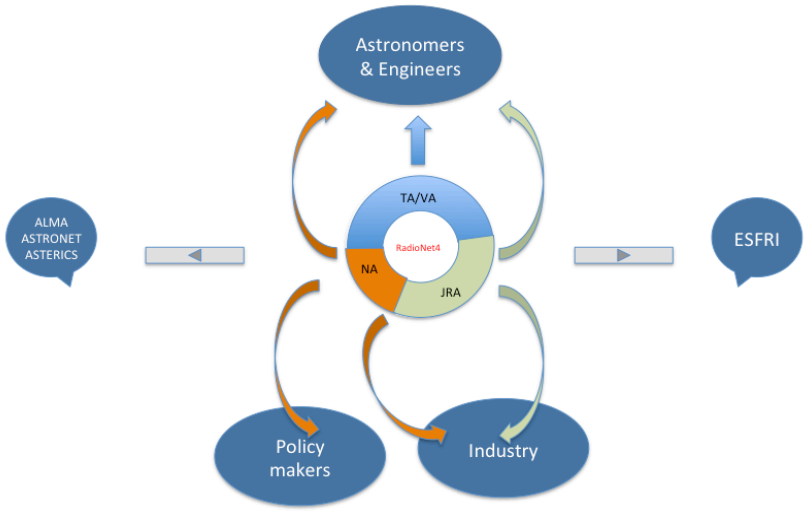
stakeholders? audiences?

Fig. 2.2b.1 depicts the main recipients of RadioNet. Communication always means in both directions: obtaining feedback forms is an integral part of the communication tasks of RadioNet. All official communication in RadioNet will be in English. The RadioNet project foresees internal communication between the different activities (MGT, NA, JRA, TA/VA) as well as between the consortium partners and bodies (Board, Exec). Priority is an effective information chain. Furthermore, each RadioNet activity will address the potential stakeholders. Primary, the TA, JRA

do not quite understand this statement

and NA activities will concentrate on the astronomers and engineers. Secondly, the NA will address the policy makers and industry, the JRAs the industry. The RadioNet project as a whole is in a constant dialog with ~~the~~ current (ALMA, ASTRONET) and future (SKA, Europlanet, OPTICON) astronomy organisations.

Each of them requires different communication channels described below individually.



FIGURES. 2.2b.1 The audiences for which communication is foreseen. In all cases communication will be in both directions.

COMMUNICATION WITHIN THE RADIONET CONSORTIUM

OBJECTIVES: Communication within the RadioNet consortium aims at providing transparent guidelines, foster the exchange of information to achieve scientific and technical goals, reaching consensus about decisions to be made, documenting progress, in order to create synergy and to facilitate a common identity.

METHODS: All Entire information relevant for RadioNet will be made available on web and wiki pages maintained by the Management and the WP leaders. The Wiki is the administrative platform for the executive of the project. The access is in general open, however some of the information (contractual documents, budget, minutes etc.) is restricted to RadioNet beneficiaries only. The project Wiki contains guidelines (e.g. in form of a Management Manual, to be prepared by Management), procedures, templates, minutes of meetings, information on imminent events and opportunities. Each WP maintains ~~their~~ its own Wiki, to allow internal discussions, finding solutions to common problems, to store documents, define procedures. Management will provide guidelines and hands-on support how to set up Wikis for each WP. Communication exchange within the individual WPs will also be facilitated by face-to-face meetings and emails. Management will maintain an email distribution list in order to ensure an efficient spread of news.

Communication at the management level will be by regular executive bodies (Board, Exec) meeting, either by teleconference or face to face. The results of the Board and Exec meetings will be made available by email and stored at the project Wiki.

IMPACT: An effective communication within the project will assure that each project partner is always up-to date; there is no loss of information. All documents are centrally stored and available at any time to all project partners. This communication structure assures the full traceability of all project steps (decision, documents, meetings etc).

COMMUNICATION BETWEEN THE RADIONET AND OTHER SCIENTIFIC AND TECHNICAL COMMUNITIES.

OBJECTIVES: The communication with the astronomy scientific and technical communities aims at informing this group of the RadioNet actions such as TA and NA, but also advertising JRAs. RadioNet will also provide a forum to announce events and opportunities at the individual partners. The feedback on TA and NA from these communities will be in particular used to improve TA and NA actions.

METHODS: Management will set up a web page where all relevant ~~information~~ openings of RadioNet actions and opportunities can be located, such as events or job ~~offers~~. There will be clear directions how to contact Management and the other WPs. At regular intervals there will be an email digest of news (newsletter) and call for opportunities for support/organisation of scientific and technical events. A possibility to join the RadioNet mailing list will be offered at the registration page for each event supported by the project, also to TA users.

Management will also ask web content managers at the RadioNet partners to post this information on the institute websites. Events will be also announced by posters, and social media such as Twitter and Facebook. RadioNet will be represented at large national and international events by posters and talks. The feedback from the community to RadioNet will be via email and personal contact. In order to provide a RadioNet identity, a logo and a mission statement will be created and advertised at the supported events.

IMPACT: An effective communication between the RadioNet project and other scientific and technical communities will assure the execution of the planned scientific and engineering events. This will foster cross-fertilisation and attract other communities. At the same time RadioNet results are disseminated to a broader community and the RadioNet brand is promoted. This is also a good opportunity for gaining new users for RadioNet facilities and creating new vibrant science.

COMMUNICATION WITH INDUSTRY

OBJECTIVES: Communication with industry serves to optimize the synergy necessary to develop state-of-the-art equipment and techniques and to optimize the fabrication phase of the developed instruments and methods.

METHODS: RadioNet representatives will make use of existing contacts and visit relevant fairs and conferences (e.g. IEEE, SPIE) in order to broaden and intensify such contacts. The industry experts relevant for RadioNet communities will be invited to technical events; also Short Training Missions will strengthen the ability of RadioNet to develop future collaborations with industry. The JRA partners will maintain close contact with respective industries to assure the marketing of the developed products. Industry representatives will be present in the RadioNet Scientific Advisory Board. RadioNet spectrum managers will exchange with industry the astronomy interests in relevant meetings (WRC-World Radio communication Conferences, ITU-International Telecommunication Union meetings, CEPT-European Conference of Postal and Telecommunications Administrations). RadioNet will develop policies in line with the contractual obligations for addressing intellectual property rights on the potential outcomes and future utilisations from the individual JRAs.

IMPACT: An effective communication between the RadioNet project and industry will assure the promotion of the results, their exploitation within astronomy and beyond, and when applicable a further development of the results. It will strengthen the position of the European technical developments. Particularly the industry will be made aware of the importance of the radio spectrum protection for the scientific use, and the RadioNet spectrum managers uphold the community interest.

COMMUNICATION WITH POLICY MAKERS AND COMPLEMENTARY PROJECTS

OBJECTIVES: Feedback to the European Commission and national policy makers is necessary in order to ensure the correct implementation of RadioNet and its transition toward a self-sustained action. RadioNet is playing an important role in the allocation of protected frequency ranges in order to minimize radio interference to scientific observations. In order to maximize the impact, to avoid duplication of efforts, and to provide a common, interdisciplinary vision, RadioNet will maintain contacts with complementary projects and organisations on European and international level, such as EVN, ASTRONET, AERAP, Europlanet, or ESFRI relevant initiatives such as SKA.

METHODS: Interaction with EC will be between the RadioNet Coordinator and the project officer in person or by email. RadioNet will support a synchronized strategy in CRAF issues. The RadioNet spectrum managers (CRAF) together with telecommunication administrations and industry will provide guidelines to the European Telecommunications Standards Institute (ETSI) for developing engineering standards. RadioNet will explore with the Board and other relevant bodies (EVN, SKA, ASTRONET) across Europe the best way forward into the next decade for European Radio Astronomy including the need to arrive at a sustained approach for European collaboration. This will be done in form of meetings and the development of policy documents. RadioNet will contribute to the development of policies for AERAP and Europlanet too. This will be realised in the form of meetings, organisation of joint conferences, development of material and policy documents. Individuals from complementary actions will be invited to become members of the RadioNet Advisory Board

IMPACT: An effective communication between the RadioNet project and policy makers will assure a successful execution of the project and will lead to a self-standing RadioNet astronomy organisation. In the same time the radio frequencies are protected for scientific purposes. Africa will have as strong radio astronomy community and facilities enlarging the scientific and technical radio astronomy landscape. Additionally the RadioNet community will extent its ability exploring collaboration with planetary science community (Europlanet).

COMMUNICATION WITH A GENERAL PUBLIC

OBJECTIVES: Public outreach is already highly developed in the partner institutions. To assure the highest impact it is mostly done by outreach offices in the local language(s), e.g. making use of visitor centres. Complementary actions exist at European and international level (e.g. by UNAWE and IAU). RadioNet will not duplicate these efforts, however it will support all those initiatives at any requested level. RadioNet will concentrate on efforts that maximize the impact of research resulting from TA, NA and JRA achievements of the project as a whole.

METHODS: A close connection to the RadioNet infrastructure public offices will be established by the Management in order to document and communicate the scientific discoveries resulting from TA use and the achievements of the project as a whole. RadioNet will outreach to a broader community via the project webpage, newsletter, the HORIZON2020 press office, and social networks. The project will support local efforts by preparing fact sheets on the actions and performance of RadioNet.

target its

IMPACT: An effective communication between the RadioNet project and general public through the professional local outreach officers and dedicated initiatives will avoid the duplication of work. At the same time RadioNet assures a wider dissemination of the results.

and it will encourage the involvement of industrial associations in consortia or in advisory bodies.

In order to ensure the highest impact on the scientific and engineering communities, a Call for Events to be supported by the RadioNet WP2 will be released every 8 months, with the goal to collect all the requests at the same time and proceed with a comparable evaluation. A broad distribution of the Call will be ensured thanks to a detailed and exhaustive mailing list addressing the astronomical scientific and engineering communities at large, and use of other providers. The requests will be evaluated on the basis of the scientific or technical relevance, and of the impact they will have on the community at large. The evaluation will be made by a steering committee, to be appointed by the RadioNet Board.

done/carried out

All the activities of this WP play a major role in the radio astronomical community. Some of them are organised regularly, in particular the YERAC, the EVN Symposia and TWS. To avoid the duplication of work and to ensure their continuity a basic guidelines concerning the purpose and organization of those events will be developed together with the organisers. The guides will be made publicly available on a dedicated web site and will be updated regularly as an interactive document.

represent the composition of the protosolar nebula, a still unidentified process has caused 15N-enrichment in the solids. APEX observations of nearby protostars revealed 15N-enrichment in two of three sources, consistent with the chemical fractionation scenario,

- Groenewegen (A&A 561, L11, 2014) used APEX and IRAM to study mass loss from evolved stars. For stars with masses below about one solar mass, most of the mass loss occurs early during their giant phase. Five such “red giant branch” stars were observed in two rotational CO lines, and for one the first such detection ever was made, raising new questions about the mass loss mechanism and paving the way for future studies with ALMA.

The demand for observing time on APEX Swedish time is high, with an oversubscription ratio (between requested and observed time) of 1.5–2.2. The annual number of proposals for Swedish APEX time increased almost 40% in the last 4 years. More than half of them had only non-Swedish authors. During the same years, the number of unique international PI and co/PI of Swedish APEX time increased from 164 to 233 per year. Recently there are ~~in~~ on average 65 publications per year based on APEX data. This includes all entire APEX observing time.

DESCRIPTION OF WORK

MODALITY OF ACCESS UNDER THIS PROPOSAL

Outline how a user, or user group, will be given access to the infrastructure or to its services (e.g. type of equipment/service used, expected output/deliverables, etc.). For trans-national access indicate the typical location and duration of work (estimated number of days spent at the infrastructure), and, where relevant, how the users will be integrated into the scheduling of the infrastructure and the degree of independence they will experience with respect to the normal research activity of the infrastructure. Define clearly, for each installation, the unit of access being offered and indicate what is covered and included (e.g. preparatory work, specific training courses) in one unit. This is essential for monitoring the access provided under this project, but also to justify the corresponding costs (see section 3.4b of this document). Indicate for each installation which modality will be used to declare access costs (on the basis of unit cost, as actual cost, or as a combination of the two) and justify your choice.

Access to APEX is carried out through a proposal and peer review process (see below). The Call for Proposals is widely advertised. The observations at APEX are complicated by the high altitude of the telescope, 5100 m, which prevents the use of a regular visiting-astronomers scheme. APEX observations are therefore made in semi-service mode through a scheme where the APEX staff and selected visiting astronomers carry out the observations. All observers must pass a high-altitude physical test. The observed data is validated by the APEX staff before it is archived. Swedish APEX data is archived in the ESO archive (http://archive.eso.org/). The proprietary time is one year, after which the data becomes freely available.

The unit of access is telescope observing hour, including time for pointing and calibration checks made for the particular project additionally to the observing time. Access costs will be declared on the basis of unit cost, since the access cost (per telescope hour) is similar for all users.

SUPPORT OFFERED UNDER THIS PROPOSAL

Describe the scientific, technical and, for trans-national access, logistic support that would be offered to the users. Where relevant, emphasise the quality of the scientific environment in which the users will be working and explain how this might stimulate their research. Explain to what extent such support is already routinely provided to external users.

The observations are carried out in semi-service mode as described above. TA-eligible users may, if they wish and pass the physical test, act as visiting astronomers at the expense of OSO. TA users will then get practical experience of using a world-class sub-mm telescope and will interact with other astronomers and telescope experts. TA users not visiting APEX will get experience in planning sub-mm observations, reducing and analysing the data. OSO offers help, via its APEX project scientist, both during the proposal phase and the data reduction phase, to those who need it. This type of support has worked successfully for many years.

WP14 – ALTA

WORK PACKAGE NUMBER	14	LEAD BENEFICIARY – ASTRON
WORK PACKAGE TITLE	VA - ALTA	
PARTICIPANT NUMBER		
SHORT NAME OF PARTICIPANT	ASTRON	
PERSON/MONTHS PER PARTICIPANT	0	
	START – END MONTH	14 – 48

OBJECTIVES	PROVISION OF ACCESS TO
	DESCRIPTION OF THE INFRASTRUCTURE
NAME	Westerbork Apertif Long Term Archive (ALTA)
LOCATION	Westerbork (NL)
WEB SITE ADDRESS	www.astron.nl
ANNUAL OPERATING COSTS	€

DESCRIPTION OF THE INFRASTRUCTURE *Give a brief general description of the infrastructure to which access is offered. Illustrate, in particular, its state-of-the-art equipment and services offered to users that make it rare or unique in Europe. Outline the areas of research normally supported by the infrastructure, as well as new areas opening to users, if any. If the infrastructure is composed of several installations, describe these including their specific features. If parts of the infrastructure are still under construction, specify the starting date of construction and indicate the date when access can realistically be made available.*

The Westerbork Apertif Long Term Archive (ALTA) is a brand new facility offering to the world-wide astronomical community free virtual access to data and scientific products produced from all sky surveys of the Northern sky that will be conducted with the Apertif frontend of the WSRT, as well as services to query, further exploit and perform in-depth data mining of these products adaptable to diverse research goals.

The ALTA is a complete Centre of Expertise. It creates a scientific research environment in which varied astronomical research programs can be conducted by offering a complete set of Services and extensive User Support, to exploit the central information system whose main goal is to allow transparent and distributed access, to Apertif data and processed data products in its long-term storage.

The data collection (surveying) strategy that will populate the ALTA has specific strengths for a number of science areas, including: the use of imaging of *resolved* or faint HI structures to study the role of gas (dynamics, interactions, accretion) in galaxy evolution and investigate the properties of the smallest gas-rich galaxies in the local Universe, the study of magnetic fields in galaxies and of the large-scale structures in which they are embedded, the study the role of cold gas, feedback activity, star formation in bright and faint AGN. Furthermore, the surveys will also detect, characterize and localize fast radio bursts (FRBs) over the Northern sky (in a much larger volume than hitherto available surveys), perform a census of intermittent and normal pulsars along the Galactic Plane as well as study afterglows of Gamma Ray Bursts and Tidal Disruption Events.

The ALTA addresses its products, services and the associated user support (documentation, personal help, analysis algorithms) to both specialists and non-experts in radio interferometry. In a quantum leap from the paradigm of supplying only observations, it takes the onus of performing data analysis on their own from the majority of the users. Offering a range of high quality science-ready products and tools to perform intensive and in-depth data mining on them, the ALTA will enable astronomers not only to reach the wide range of scientific goals set by the design of the surveys, but also to engage in more sophisticated multi-wavelength and multi-instrument studies, availing themselves of appropriate combinations of data from large scale facilities, to explore novel cutting-edge science.

The ALTA will be populated with data in regular public releases, growing by a rate of 2 Petabyte/year