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SUMMARY AND CONCLUSIONS

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Austrian Presidency of the Council of the European Union

European Commission

Federal Ministry
Republic of Austria
Education, Science and Research

ICRI 2018 Executive Summary

Science and research are great and indispensable tools for the advance of mankind. The human brain and its wonderful and powerful capability of bringing ideas to reality also needs tools. Research Infrastructures (RI) in their great variety are such tools which enhance our eyes and ears to the universe, the subatomic world and to society. They analyse social structures and expand our memory through huge data banks – in a nutshell: Research Infrastructures are at the heart of innovation.

To create more awareness about RIs' important role, the European Commission started a series of conferences in Europe, which rapidly extended into a global forum and audience.

The 4th International Conference for Research Infrastructures – ICRI 2018 took place during the Austrian EU Council Presidency in Vienna, from 12-14 September 2018. The Hofburg Vienna provided the appropriate setting to discuss current and future challenges for research infrastructures from all over the world. The conference opened with a keynote speech on the breakthrough discovery of gravitational waves presented by Fred Raab from LIGO and Livia Conti from INFN.

Interesting and knowledgeable speakers and participants of more than 50 countries from all over the globe- the European Commission, the OECD, national governments, large facilities, networks, researchers and administrators - met to discuss challenging and pending issues faced by RIs of different disciplines and nature alike.

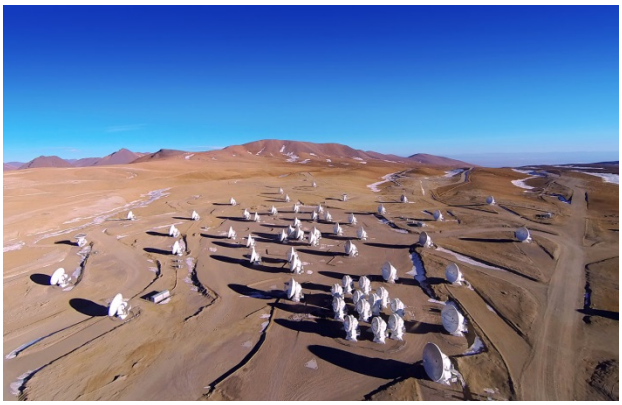
Most of the RIs are unique in their nature. They offer cutting edge facilities and services to researchers from national institutes and universities to conduct their research and progress humanities knowledge of the world. These facilities are complex organisations which require sound governance to ensure highest quality and sustainability of their services as well as contribute to economic competitiveness and innovation.

The aim of the conference was not only to discuss and debate a great variety of issues, but to focus on certain pressing issues and move the debate towards concrete conclusions and propose ways forward to secure effectiveness and functionality of RIs. In order to do this, the conference was organised around 3 Plenary Sessions and 5 Parallel Sessions which all highlighted individual aspects of RIs. While the 3 Plenary Sessions focused on strategies, long-term visions, and the final conclusions, the 5 Parallel Sessions looked at specific issues in more detail: internationalisation, human resources, fostering of diversity and overcoming of inequality, enhancing societal value, and data:

- **Internationalisation** of RIs results in various challenges as realising the most value from investment in RIs often means making them available to the widest possible pool of excellent researchers, wherever they are based.
- **Human resources** are key for RIs to offer unique services to the scientific community. They need to be highly skilled and flexible in order to meet emerging demands that go beyond purely scientific work and across disciplinary frontiers.
- RIs are also key actors in the advancement of knowledge but there is a need to **foster diversity and overcome inequality**. Due to differences in size, financial capacity, human resources not all countries and communities can contribute to their development and take advantage of their use, equally.
- RIs need methodologies and models to assess and **enhance societal value** as well as communicate it to various audiences and increase the involvement of citizens.
- While there have been significant advances in making ever larger volumes of increasingly complex **research data** available to researchers, ensuring the quality and reliability of this data is a major challenge for RIs.

Webpage: https://www.icri2018.at/ Speakers and presentations: https://www.icri2018.at/#slides

Day 1 - Plenary Session 1



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Sustainable RIs in the Global Arena – Policy Development, Lessons Learned, and Strategies

The first plenary session focused on policy, lessons learned and strategies. It provided an opportunity to see the complexity and the variety of RIs and experience first-hand the ever increasing need to engage both with societal issues and the regional level. The panel addressed a very broad spectrum of issues.

Phil Mjwara summarised the conclusions of the last ICRI conference on global RIs in Cape Town 2016, which are, despite progress made over the last two years, still valid. RIs are not only temples of excellence in science and facilitators of science based innovation, but very often, directly address issues of vital importance, and contribute to the solution of fundamental problems of mankind.

Karina Angelieva presented the main findings and recommendations from the Bulgarian Presidency Flagship Conference on Research Infrastructures. The regional impact of the RIs in the pan- European and international context was also discussed. In this context, links were also made to the role RIs play in the circulation of knowledge and the importance of data was stressed.

Sanja Damjanovič from Montenegro presented the first stages of a new RI concept currently in preparation for the Western Balkan in biomedicine. Again the regional or meta-regional impact and outreach was an important driver in these considerations.

Tony Donné addressed tasks important for long term sustainability of RIs. The need for a clear mission statement, long term planning and a strategy on impact were highlighted as a prerequisite for sustainable RI management. Close interaction with industry in setting research driven innovation targets is critical.

The regional and local impact of a global RI was nicely documented by Sean Dougherty for the ALMA Observatory in a remote environment of the Atacama Desert. Respecting regional settings and environmental and cultural specificities is vital for the successful construction and operation of an RI.

In this context, the EMBRC was presented by Ilaria Nardello who showed concrete examples of challenges on the way towards becoming an ERIC. The importance of a solid business approach was highlighted.

The complexity of considerations in the early stages of the RI-lifecycle was demonstrated by Luca Pezzati from ERIHS, which represented a project still in the preparatory phase.

Speakers	
Jean-David Malo (Moderator)	Director, DG Research & Innovation; Europ. Commission
Phil Mjwara	Director-General, Department of Science & Technology, South Africa
Karina Angelieva	Deputy Minister for Research & Structural Funds, Bulgaria
Sanja Damjanović	Minister of Science, Montenegro
Sean Dougherty	Director-General, Atacama Large Millimetre Array (ALMA)
Tony Donné	Chair, EIROforum
Illaria Nardello	Executive Director, European Marine Biological Resource Centre (EMBRC-ERIC)
Luca Pezzati	Scientific Coordinator, European Research Infrastructure for Heritage Science (E-RHI)
Jan Hrušák (Rapporteur)	Chair-elect, European Strategy Forum on Research Infrastructures (ESFRI)

Day 1 - Plenary Session 2

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Research Infrastructures in 30 Years' Time and How to get there

The second plenary session took a visionary look into the future and imagined how the landscape of RIs might look like in thirty years' time.

Plenary Session 2 reminded us that we have witnessed a technological and societal revolution over the past thirty years. The exciting science of the future will be the product of the RIs now under construction, and the international co-operation required to do this is a force for good in an uncertain world. Long-term planning will deliver a new generation of RIs supporting dynamic, high-resolution experiments that are highly networked and synergistic. RIs will respond to scientific needs but also increasingly to complex global challenges, which will require engagement with broader communities of interest.

We can expect the trend towards globalisation to continue and RIs to be drivers of open science. In the social sciences, the needs of researchers will be supported by long-term surveys and studies of change, and the data generated by these RIs will become even more valuable than it is today. New skills will be needed to keep up with the fast pace of developments in data and to ensure the sustainability of data repositories into the future, where data will be open by default. RIs will increasingly join forces to prepare for the challenges of the future and to maximise return on investments and this will require new, robust organisational structures and governance arrangements.

In conclusion, Plenary Session 2 found that we can expect long-term planning and international co-operation to deliver greater synergies between RIs and even greater societal impact.

RIs will still be both science driven and a driver for science, but they will take many forms, and for the social sciences, surveys will be an accepted form of RIs. How we get there will be an evolving process, but it will require new skills and the involvement of broader groups of interest and when we look back thirty years from today, we can expect the results to be just as revolutionary as the past thirty years.

Speakers	
Daniel Weselka (Moderator)	Head of Dept., Austrian Federal Ministry of Education, Science & Research
Yuri Balega	Vice-President, Russian Academy of Sciences, Russian Federation
Hongjun Gao	Director-General, Bureau of Frontier Sciences & Education, Chinese Academy of Sciences
Gabriele Fioni	Chairman of OECD Global Science Forum
Charlotte Warakaulle	Director for International Relations, CERN
Axel Börsch-Suppan	Managing Director, Survey of Health, Ageing & Retirement in Europe (SHARE-ERIC)
Tiziana Ferrari	Technical Director, EGI-Foundation
Helmut Dosch	Director, DESY, Chair League of European Accelerator-based Photon Sources (LEAPS)
Catherine Ewart (Rapporteur)	Associate Director, Stakeholder & International Relations, STFC

Day 2 - Opening Session

The second day of ICRI 2018 was opened by the Austrian Minister for Education, Science and Research **Heinz Faßmann** and the European Commissioner for Research, Science and Innovation **Carlos Moedas**. They discussed the links between RIs and science diplomacy and the benefits of RIs for society in general.

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Austrian Federal Minister of Education, Science & Research; Heinz Faßmann

"The European Social Survey….. bringing together and showing where and how different countries are thinking about different issues. This is not a benefit I can express in money, but which is a clear extension of our knowledge about the European society"

"If we don't invest in these research infrastructures then we will not have the solutions to transform cancer into chronic disease."
"We should invest more. That will make a difference not now but in ten years or in twenty years."

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European Commissioner for Research, Science & Innovation; Carlos Moedas

Day 2 - Parallel Session 1

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Internationalisation of Research Infrastructures

There is a growing interest in internationalising RIs so that they can better serve a wider range of researchers as they join forces to tackle global challenges such as climate change, food security, infectious disease, etc. This need for both trans-national access and the maximization of value through internationalisation results in various challenges for governments, funding agencies, institutions and researchers.

In developing international RIs, or expanding international access to existing ones, the key challenge is in identifying and stimulating broader stakeholder engagement. This involves dedicating resources to overcoming distance and cultural differences, reaching out to new partners, establishing communication lines, designing consultation processes, and determining priorities. This requires balancing out: the involvement of international stakeholders in defining the scale and scope of RIs that are located in, and under the responsibility of, a specific country; the interests of stakeholders in various sectors, disciplines and areas of research; the need for both competition and collaboration in the design and use of RIs.

Once the potential stakeholders of an international RI have been engaged, there is a need to foster cooperation between researchers, institutions and facilities, and to develop synergies between existing RIs and research capabilities. Unnecessary duplication of facilities and services needs to be avoided in order to maximize value. The role of decision makers and funders in calling for community to come together and develop a common vision should be further explored.

With the exception of a few very large-scale research facilities, almost all RIs are essentially national. Maximizing their use and value through international participation requires the development of both access regimes for foreign researchers and cross-border financing mechanisms. Such regimes could be based on excellence or on the research relation to national priorities, or the needs of industry and could also compensate host countries for the costs associated with non-national users or account for both initial capital costs and running costs. Another approach would be to move towards transnational research institutions.

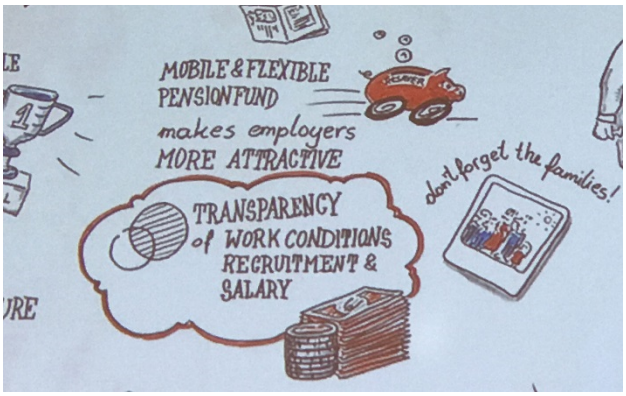
International collaboration amongst RIs can be stimulated through dedicated mechanisms. Voluntary approaches can be considered such as the Group of Senior Officials' Framework for global RIs. International mapping of RIs such as the one undertaken by the RISCAPE project, funded by the European Union's framework programme for Research and Innovation, can help foster international collaboration. Grassroots processes or more formal bi-/multilateral agreements are other possible ways forwards. International cooperation measures for RIs can also play a key role in science diplomacy.

Regardless of the adopted approach to international collaboration, the issue of definition and common terminology was seen as prerequisite to a successful match making between RIs.

Speakers

David Moorman (Moderator), Barbara Ryan, Kathleen Shearer, Pierrick Fillon, Horia Hangan, Beryl Morris, Maribeth Murray, Werner L. Kutsch, Henry W. Loescher, Maria Faury, William McDowell, Lise Sagdahl, Douglas Wallace, Matthew Hawkins, Sharon Cosgrove, Nigel Smith, Mikhail Rychev, Ari Asmi, Maud Evrard (Rapporteur)

Day 2 - Parallel session 2



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Staff mobility and skills development in research infrastructures

RIs require people with specific sets of skills during their lifecycle. Skills-needs and skills-gaps can be addressed through enhanced mobility of staff and specific training of new skills which evolve in specific domains.

State of the art infrastructures require highly skilled and flexible staff who can meet emerging demands that go beyond purely scientific work and across disciplinary frontiers. New professions such as research data managers and careers of a para-academic nature have emerged within the ecosystem of RIs. Some universities develop curricula to train these emerging para-academic skills to meet research demands; however, it is important that such skill sets are recognised, particularly within academic research facilities alike.

In addition to training future research data managers, skills-gaps can be addressed by enhanced mobility of staff between research infrastructures and disciplines, exchanges with universities and industry. In order to facilitate mobility, standardised competency frameworks and skills sets, transparent recruitment procedures, and publishing employment conditions including salary scales and comprehensive information on staff benefits are highly recommended to attract "the right people wherever they are". Mobile and flexible pension schemes such as the European Resaver pension scheme should be promoted to protect pension entitlements of mobile research infrastructure staff and fellows.

Speakers

Michael Ryan (Moderator), Catalin Miron, Jennifer Edmond, Veronica Cesco, Christoph Schwanda, Stijn Delauré, Silke Schumacher, Rahel Fidel, Irene Haslinger, Irina Kuklina, Sabine Hertgen (Rapporteur)

Day 2 - Parallel Session 3

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Fostering diversity and overcoming inequality in the development and use of RIs

One common goal of RIs, worldwide, is to promote and ensure scientific excellence. A second common goal is to fully maximise the scientific return for society on the massive public investments in infrastructures. To achieve these goals, research infrastructures should be open to all capable researchers, and countries should be able to contribute human and financial resources at levels that are appropriate and feasible.

It is to be understood and acknowledged that the shores on which the bridge between developed and developing regions must be built consist of scientific, cultural & political differences. This implies that not all differences can be bridged and that one needs to adapt to those differences in order to collaborate efficiently. However, one should not forget that political standpoints might limit diversity and researchers' access to RI or their mobility.

It was recognised that to reduce the gap between the emerging countries and the trendsetters, some dedicated grants could help in the initial funding to access RIs. It was also cautioned that a trendsetter region might lose its scientific edge due to loss of funding leading to closure of, or the inability to upgrade local RIs.

World Café

Paolo Budroni (Organiser of the World Café), Caterina Biscari (Moderator), Sarawut Sujitjorn and Lars Börjesson (speakers), Frédéric Le Pimpec (Rapporteur) and 25 active participants

1 Diversity has an impact regionally, scientifically and societally 2 Increasing diversity will increase knowledge creation
3 Excellence shall never be forgotten but must be weighted in regards of the goal of the RI

Day 2 - Parallel Session 4

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Enhancing the societal value of Research Infrastructures

There are various methods for assessing the societal value of RIs and the speakers presented the methodologies and models that they have developed or are developing for assessing the societal value of RIs. This assessment is complex as it covers subjective notions and involves intangible assets.

In the presentations, distinction was made between Key Performance Indicators (KPI) that are used to monitor the performance of an RI and its efficient use of resources, and Core Impact Indicators (CII) that provide a general picture of the socio-economic impact of RI. The necessity to include qualitative indicators was also raised as essential to have a complete picture of the impact of the RI. A flexible approach would be required for its implementation.

The panel agreed that the societal value of the RI depends on the objectives/core missions of RI and on the perspectives of stakeholders. Financial investment in RI has a direct impact on their societal value. However, a clear communication strategy should also be put in place and conceived from the onset of the RI to promote the contribution of the RI to society and maximise its impact. Enhancing societal value of RI requires the capacity from the RI to convey complex information to targeted stakeholders. It also requires the strengthening of the social trust (accountability to the public), through for instance a proactive involvement of the RI in activities for a better society. The panel stressed that the societal value of RI could also be enhanced by a greater integration of the RI into local ecosystem. Concrete examples and measures developed by RI for enhancing their societal value were presented by the speakers and included providing greater access to the public or fostering scientific literacy.

The presentations showed clearly that there was a general trend towards more communication done by RI to reach out to users, funders as well as the general public. Several speakers confirmed the necessity to engage with user communities in order to articulate the added value of the RI. Examples of the instruments of communication were presented, ranging from use cases and storytelling for the general public to portal for services and dedicated events for industry. Social media were offering in that context new ways of communication involving in particular the younger generations.

The conditions for a successful involvement of citizens in RI activities were described and relied mainly on the need to build trust between RI and the citizens, the necessity to bring down barriers of communication and recognise that local knowledge and ideas can be essential for the success of the RI. Speakers explained that trust could be achieved through an early involvement of citizens in the development process of the RI. The motivation and benefits of citizen's involvement were also discussed and entailed mainly an improvement of science literacy. Examples of citizen science were presented and included citizen's contribution in analysing data produced by RI (astronomy).

Speakers

Franciska de Jong (Moderator), Vincent Mangematin, Laura Hillier, Alasdair Reid, Anne Gauthier, Tom Keenan, Myeun Kwon, Xiaoming Jiang, Andrew Smith, Amy Bilton, Pierre Normand, Jeon Chan-Young, Guiseppe Cimo, Sara Iverson, Philippe Froissard/Frederic Sgard (Rapporteurs).

Day 2 - Parallel Session 5

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Research Infrastructures and Data

In today's digital world, research is increasingly data-driven and many RIs are becoming large-scale data factories, producing and managing ever larger volumes of increasingly complex data. While there have been significant advances in making research data available to researchers, ensuring the quality and reliability of this data is a major challenge. This parallel session focused on the central questions of how best to ensure data quality and reliability, how we can design and implement sustainable data management systems that can be trusted, and what will the impact be on both present and future research infrastructures and data producers.

RI, in many shapes and sizes, are a critical part of the research data ecosystem and have a leading role to play in promoting FAIR (findable, accessible, interoperable and reusable) data. The service orientation and concentration of technical skills in RIs mean that they are uniquely placed to fulfil this role. Research data has to be made available 'as open as possible and as closed as necessary'. The completeness of metadata is critical with regards to re-usability; data quality requirements depend on how it is to be used but key parameters should be clear from the metadata. Likewise data provenance is an important part of quality assurance and this requires the use of standardised unique and open identifiers. Interoperability and re-usability are the main challenges and they require not just the adoption of shared standards and processes but also openness of hardware and algorithms.

Cyber-infrastructure and specialised data repositories have an important role to play in linking with other RIs to provide the backbone of a trusted research data ecosystem enabling usage across different domains. Certification has a role to play in ensuring confidence in repositories (containers), software (tools) and data-sets (contents). Ultimately we need trusted data, trusted cyber-infrastructure and trusted connections.

There is a need to build a new workforce of data scientists and data stewards and there is a need for education and training that instils critical digital skills across the research community more broadly.

There is concern about the privatisation of data and scientific data-services as the major multi-national publishing and dotcom companies are rapidly expanding in the research data field. The increasing dependency of public research on a small number of commercial entities raises issues about dependency/autonomy, long-term stability and public trust. Funders and policy-makers play a critical role in setting the framework for trusted open data. Coordinated strategies that take into account the whole of the data life-cycle are required. Data sharing policies need to be harmonised internationally, whilst recognising that the benefits of fully open data will not necessarily be equitably distributed.

Speakers

Michelle Barker (Moderator), Simon Hodson, Darren Bell, Maggie Levenstein, Dale Peters, Erik Steinfelder, Francoise Genova, Ron Dekker, Devika Madalli, Silvana Muscella, Gabriele von Voigt, Andrew Treloar, Mohammad Nasser-Eddine, Fabrizio Gagliardi, Juan Bicarregui, Irina Kuklina, Jorge Tezon, William L. Miller, Federico Ruggieri, Cristina Martinez, Barbara Sánchez Solís/Carthage Smith (Rapporteurs)

Day 3 - Final Plenary Session

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***Wolfgang Burtscher**, European Commission; **Mikhail Romanovsky**, Ministry of Education and Science, Russian Federation; **Paul Dabbar**, DOE Under Secretary for Science, U.S. Department of Energy, United States; **Shumete Gizaw**, State Minister, Ministry of Science and Technology, Federal Democratic Republic of Ethiopia; **Roseann O'Reilly Runte**, President and CEO, Canada Foundation for Innovation, Canada; **Vinny Pillay**, South African Department of Science and Technology; **Barbara Weitgruber**, Director-General, Federal Ministry of Education, Science and Research, Austria*

In the final the discussions high-level speakers reiterated common themes of the conference. It was agreed that open science will bring many benefits and increase researchers ability to communicate with each other and know what is going on in their fields around the world. It was also agreed on that inclusiveness is important. Creativity plays an important role in research and it is often through interactions with many different types of actors that new ideas are born. Therefore it is important to bring people with different ideas to the table. In some cases it will be especially important to integrate people with experience of putting ideas in to practice as the application is equally as important as coming up with the idea. It is therefore important to better understand how to support creativity and inclusivity.

Ideas around application and impact played a role throughout the conference and it is clear that they will continue to do so in the future. Several examples of applications that have grown out of American super computers are a case in point. Super computing and the development of artificial intelligence algorithms are having an impact in many different areas of society including imagery and MRI scans but also energy management and running utility grids. In these two cases the artificial intelligence algorithms are more efficient and often better than their human counterparts.

These last examples prove that RIs have a considerable role to play in implementing the UN's Sustainable Development Goals and that their socio-economic value is tangible. However, it was pointed out that there is still much more to be done to understand better how to derive value from data and arrive at impact. RIs play a large role in making sure different disciplines come together and people and nations work together in an integrated way.

Finally, when asked what would help to encourage more international co-operation and how Horizon Europe can help, most speakers raised the necessity of good governance - whether this be on an inclusive level between the North and the South or through looking at overlaps and similarities between the United States and Europe. Governance can also be understood as the difference between top-down and bottom-up. Many scientific communities are developing new ways of interacting between themselves. However, on the other hand, the top-down level is equally important for talking about the best use of funds and for talking things forward together. Platforms such as ESFRI and the OECD Global Science Forum are very useful in this context. The European Union and Horizon Europe can support the RI community on many different levels, and all participants left the session with their notebooks full of ideas.

ICRI 2018

KEY MESSAGES

Best use of RIs is essential *across disciplines and countries. This requires frameworks for trans-national access and collaboration, data sharing, common and agreed skills sets, comparable work conditions and the right balance of cooperation and competition.*
RIs should promote their services at international level and reach out to new international members.

Societal impact *of RIs* ***is important*** *and can be fostered by better understanding of the complexity of societal value through adequate assessment and communication. The regional dimension and impact of RIs has to be considered as much as the international dimension of RIs.*

Understanding differences, building capacity and ***fostering diversity will benefit RIs and maximise scientific return for society.*** *All capable researchers should have the opportunity to contribute to scientific excellence at RIs and suitable cross-border-financing mechanisms in place.*

Trust in data and quality of data *through the data life-cycle are key requirements. Implementing the FAIR principles depends on trusted e-infrastructure. A* ***new workforce of data scientists and data stewards*** *needs to be built to manage and exploit FAIR data.*

Governance of RI is crucial *and requires robust organisational structures and governance arrangements along common standards and common visions for the eco-system of RIs.*

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