

# Accessing and contributing to global research: the problem of the last kilometre

Ensuring good IT infrastructure helps higher education to fully benefit from investments in infrastructure, journals, books and data

Research is a global enterprise that needs everyone, no matter where they are working, to be able to access and contribute to the dialogue. As well as the individual skills of researchers, academics and students, this requires strong enabling institutions, reliable infrastructure, and affordable journals, books and data. It also requires skilled library and ICT professionals.

Organizations such as the World Bank and the European Union's GÉANT initiative have made considerable investment and progress in getting the technology and content in place in the Global South, but many people working for research and higher education (R&HE) still struggle to exchange data, information, knowledge and ideas.

## What is the problem?

Picture this. A kilometre from your desk there is a warehouse where the world's most relevant, timely and credible data and knowledge are instantly available... but you can only access or contribute to it one page at a time. To add to your difficulties, each page has to be



Delegates at a UbuntuNet conference in 2015

carried along a long, meandering path, and the path is poorly signposted, badly maintained and crowded with other people. There are no rules and, even if there were, there are not enough people to enforce them. When you do eventually transport a page, you have to do the whole journey again for the next one.

It is a tortuous process that wastes time, money and opportunities for you and for those who could benefit from your work. And for many people this is a frustrating daily reality.

Years of effort and investment mean that the books, journals, databases, cables, servers, software, laptops and mobiles are largely in place, ready to go. Researchers, academics and students are ready too. But things grind to a halt in the kilometre between the backbone and the desktop if campus networks are not properly configured and managed.

## How did we try to solve it?

In 2013, the UbuntuNet Alliance including the Network Startup Resource Centre (NSRC) and AfricaConnect—and INASP identified a shared interest in the issue, and agreed to work with National Research and Education Networks (NRENs) to try and find a sustainable solution through a pilot project.







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UbuntuNet meetings brought together NRENs to work on the shared challenge of enabling good campus networks

The pilot project recognized that much of the hardware, software and content was already in place, and so potential solutions were first and foremost about people the need for enough people with the knowledge, skills and attitudes needed to tackle this 'lastkilometre' problem on three levels:

- The long-term need for support to R&HE institutions so that they can meet changing ICT needs/ demands and take advantage of digital opportunities.
- The medium-term need for R&HE institutions to monitor, manage and secure their campus networks on an ongoing basis.
- The immediate need to improve the speed, reliability and reach of R&HE campus networks.

NRENs are well placed to help meet these goals. They are independent, trusted, noncommercial organizations with established relationships with R&HE communities. As well as collectively bargaining for more reliable bandwidth at a lower cost, they have the potential to innovate and customize services for their members, convene key actors and decision makers, offer policy advice to national government and development partners, and collaborate on international ICT and networking efforts.

For the pilot, TERNET (Tanzania), RENU (Uganda) and ZAMREN (Zambia) were identified as wellestablished and effective NREN partners who were ready to take this work forwards.

The immediate need to improve campus networks could only be met by first addressing the medium- and long-term needs, and so the first two years of the pilot focused on three cascading strands of work:

- Advanced network engineering and management workshops: training a pool of 18 NRENassociated trainers.
- Network engineering and management workshops: applying the learning from the first activity, NREN engineers trained over 100 campus engineers.
- Direct Engineering Assistance (DEA): applying the learning

from the other two activities via hands-on work to improve the networks on four campuses in Tanzania and eight in Uganda.

In the last year of the pilot, the NRENs were awarded modest grants (up to \$25,000) to enable them to meet their own strategic goals and further the pilot's aims. The work they identified was:

- RENU: deliver three network engineering and management workshops; nine DEA missions; a symposium for ICT directors, librarians and directors of research; a workshop for librarians in charge of technology.
- TERNET: pay four interns for a year in order to strengthen NREN systems/revenue collection and deliver at least six network audits; at least four DEA missions; four training workshops; and support to members.
- ZAMREN: deliver two campus network training events with at least 20 participants at each; four DEA missions; and five needs-assessment missions.

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An engineer at Gulu University in Uganda

The outputs and outcomes of these activities are reported in detail in a previous Learning, Reflections and Innovation article [1].

## What changed?

#### The building blocks

The pilot saw changes in the capacities of network engineers and the NRENs that train and support them, and in the campus networks.

For the NREN and campus engineers, **training and network engineering knowledge and skills were built** and, importantly, put into practice. Within the pilot, the NREN engineers used their newly improved training skills to run workshops for campus engineers so that "in a short spell of time we have a huge pool of network engineers" who "can manage their own campus networks"[2]. The pool of trained trainers then enabled the NRENs to run over 40 training events on their own initiative.

The pilot also resulted in changes in approach, with **increased** confidence, collaboration and peer support between NRENs in different countries, between the NRENs and the campuses, and between the campus engineers themselves. The outcomes of these changes include increased skill sharing and problem solving, meaning that "no one individual needs to know everything because they can tackle most network issues as a community". Another effect of this increased sense of community was that "people used to make decisions based on how they would benefit, but now the sense of community means they are looking at what is in the best interests of the institution" [3].

As well as developing the capacity of network engineers and the NRENs, the pilot led directly to improvements in campus networks. In many cases the DEAs and targeted donations of network equipment by NSRC enabled campuses to immediately maximize the performance of their networks with "very **significant network speed improvement"** [4] and the capacity to handle more network traffic. In other cases the DEAs identified gaps in the existing hardware/software and so supported a **strategic approach to investments** in improving the campus network.

### Accessing and contributing to research

Whilst the above are valuable and necessary building blocks for the running and sustainability of campus ICT networks, they are not the ultimate goal of the pilot project. This project aimed to improve the exchange of data, information, knowledge and ideas. So, how did we do?

Firstly, we'll consider the flow of data, information and knowledge from the world to researchers, academics, staff and students in Tanzania, Uganda and Zambia.

One campus librarian notes, "Our campus network has tremendously improved in terms of speed; availability [of Wi-Fi access] is more reliable and provides us with stable public IPs which ensure stable access with the publishers. E-journal articles and e-books are downloaded faster but apparently, as the network has improved, so has the number of users. The peak hours tend to get the downloads slower but with a better band rate than previously." [1].









Direct Engineering Assistance at work in Gulu University in Uganda

Secondly, what about the other direction? Has the improved link from the desktop to the backbone meant that researchers are more able to share their work and to collaborate? Although much of this progress will take time to unfold, there is already evidence that it is happening. For example, in Zambia PhD student Lydia Chabala has saved significant time and money on her soil-environmental modelling project [5]; another researcher has been able to carry out large computations of geophysical data [1]; and groups of natural resources, forestry and physics researchers are sharing and comparing data to allow them to better interpret their own results[6].

It will be valuable to continue to track these impacts in order to better understand if and how they strengthen R&HE output and use across the coming month and years.

# What helped the changes to happen?

One of the main influences on the pilot's success was identifying and supporting the correct personnel to participate in the training and DEAs. The project paid a great deal of attention to this and the partners' in-depth knowledge and close ties to the field were an important resource. Partners noted that there was unusually strong continuity of people through the pilot, and that this was helped by the fact that everyone mixed well and worked together as equals, and that people's commitment to the work and to their community grew across the project.

Another critical aspect of the project was the **partnership work** between INASP, the NSRC, the NRENs and the UbuntuNet Alliance that "leveraged the talents and resources"[7] of all those involved. This was helped by the fact that each of the partners was good at their core business, had overlapping objectives, worked together collegially, and contributed complementary skills, contacts, methods and resources. All of the partners agreed that they were able to achieve more together than they could have done separately.

The design of the pilot, with sequenced activities that built and then applied knowledge and skills, helped to overcome one of the key issues with training-that once people get back to their normal role they don't have the chance to apply their learning—and provided immediate, practical outcomes for participating institutions. The fact that institutions quickly benefitted from the project increased confidence and commitment amongst those participating, and could encourage further institutional investment in the work. Finally, the model involves the exchange of technical staff so the NRENs get a chance to learn

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from their neighbour networks and enrich their human networks in the process of helping each other.

The project was also helped by arriving at **the right time** for the partners with, for example, the NRENs at a point where they were seeking to expand their work. One comment was that INASP "jumped on a bus that was driving and filled the empty spaces" [8] by identifying and sponsoring new people to join UbuntuNet and NSRC's ongoing work.

This coordination of work with existing initiatives (e.g. NSRC's training and DEA activities) and events (e.g. AfNOG 2016 and the UbuntuNet Alliance conference) also helped the project to provide value for money. Alongside the input of all of the partners' and staff time and expertise, NSRC provided training materials and hardware plus targeted donations of network equipment, and INASP managed a budget of £155,000 across the three years (with £60,000 of that total devolved to the NRENs).

The cost per participant at the training workshops was £265. As well as strengthening outreach, it is possible that hosting even more of the training events outside the main cities could lower these costs even further. The average cost of a DEA—i.e. the average cost of assessing, redesigning and, in most cases, implementing the changes needed to improve the speed and reach of an entire campus network—was £950.

It is striking that this relatively small expenditure on improving human capacity has unlocked existing (and significant) investments in e-resources and ICT infrastructure.



Campus engineers in Uganda apply lessons from the project

## Are the changes sustainable?

The sustainability [9] of the work will depend on the changes continuing on an individual, institutional and national level.

On an individual level the project partners report that there are now more skilled network engineers, and that the pilot's "benefits are embedded in the people". It was also noted that many of those trained are young with potentially long careers in engineering that would, in time, allow them to influence policy and decision making.

At the institutional level, NRENs are at the heart of sustaining this work. Offering training and DEA services means they have increased their usefulness, profile and value to existing members, and so attracted new members. For example, RENU reports that its membership rose from nine to 60 members across the three years and that this rise was "catalysed by the capacity building"[2]. The additional members bring in new revenue and so strengthen the NRENs' sustainability. The training of network engineers also supports NREN sustainability as campus ICT staff become increasingly able to manage their own networks and so free the NRENs to support new campuses/members. Finally, sustainability is supported by successful NRENs that are now able to support and mentor fellow NRENs and "take our brothers with us"[1].

As the NRENs' capacity increases, they can reach more people and offer more services such as data sharing and storage, authentication and data passporting. In Uganda, for example, RENU has built a data storage facility for Ugandan researchers, and has developed secure data passport services, to enable Uganda virologists to collaborate more effectively with US and European partners.





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#### Working together at a UbuntuNet Connect meeting

Increased capacity will also support the NRENs to respond to and take advantage of new technological developments.

The NRENs noted that it would be important to look strategically at what else they can offer members; improvements in price and services offered by NRENs "cement buy-in and allows people to say 'no' to commercial providers"[1]. Services, in particular, were felt to be important because commercial providers may be able to match on price within two or three years.

On an institutional and national level, the practical improvements to campus networks and the unlocking of existing investments in e-resources and ICT infrastructure could act as important arguments for continued institutional support and investment in the work started within the pilot.

## What issues are there?

As well as allowing us to learn what works, the pilot helped to identify areas that could be improved.

Firstly, the pilot identified a need for **more intensive follow-up support** for the campus engineers than was initially planned. Although there are benefits in this

extra support-it has built strong bonds between NREN and campus tech teams—it limits the number of DEAs that can be managed whilst maintaining the quality of the work. With current NREN capacity, a realistic number is thought to be between three and five DEAs and follow-up per year [2]. Given the demand created by the success of the DEAs and the increased membership of the NRENs, how can members needs be prioritized and met? Of particular concern is how rural and more remote campuses can best be supported.

Secondly, some campuses are still not within reach of the fibre backbone and some DEAs identified the need for investment in network hardware or software. It is not clear who is in a position to fund these purchases in the short term, and how the case will be made to institutional decision makers to include such investments in the budget in the medium and long term. It was felt that it is important to emphasize that this is an investment in research and teaching, rather than technology.

Thirdly, there were concerns around **staff retention**. One of

"The NSRC has worked in 120 countries since its founding in the early 1990's. I've worked with the NSRC in some way, or another, since 1997. During this time I'd say that this coordinated pilot programme was one of the most successful I've seen. Working closely with engineers and staff at TERNET (Tanzania), ZAMREN (Zambia) and RENU (Uganda), we have seen significant growth, outreach and improvements in human capacity over the three-year period of the programme." [6]

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the NRENs does not currently have full-time staff and was unable to maintain the employment of interns at the end of the pilot. At the campus level too there is always a risk that, as their skills and experience increase, engineers move to better paid work in other sectors.

Fourthly, there were some issues in the pilot design and sustainability. Some of the partners thought that it might be more effective to focus on DEAs, with 'on the job' learning rather than training workshops for campus engineers. It was also noted that it would have been useful to include a strand of work to specifically **support** cooperation between NRENs, rather than this happening in an ad hoc way. A key part of the success of the pilot was **the identification** and engagement with the 'right' people and institutions, and it is not clear how knowledge and time needed would be replicated if the pilot is rolled out elsewhere.

Finally, although many of their strategic objectives overlapped, there were some **differences between the partners**' priority institutions and countries in reporting needs and sometimes approach.

#### INASP Team

Peter Burnett, former Programme Manager for Library Curricula & Network Management

Jon Harle, Senior Programme Manager, Research Access and Higher Education

Fran Deans, Monitoring & Evaluation Officer

Sara Gwynn, INASP Associate



- 1 Improving IT infrastructure to ensure better access to research, Learning, Reflections and Innovation @ INASP, March 2015 www.inasp.info/en/publications/ details/162
- 2 Interview with Bonny Khunga, Director of ZAMREN 01/03/17
- 3 Interview with Isaac Kasana, Director RENU 23/02/17
- 4 Email from Isaac Kasana, Director of RENU 09/03/17
- 5 From an end user's mouth: Zambian PhD student explains how she benefited from a

research and education network, NUANCE newsletter, Ubuntunet, May 2016, www.ubuntunet.net/ may2016#article3

- 6 Interview with Bonny Khunga, Director of ZAMREN 18/08/16
- 7 Email from Hervey Allen, Assistant Director of the NSRC 126/03/17
- 8 Interview with Cathrin Stover, Chief Collaboration Officer at GÉANT 23/02/17
- 9 For more in INASP's approach and progress on sustainability see www.inasp.info/en/publications/ details/255

#### Conclusion

The pilot project produced useful, practical outcomes for NRENs and R&HE institutions. The next stage of this work could have two strands: a) rolling out the activities to new institutions and countries and b) building on the work completed in the pilot countries.

Rolling out the pilot would involve making sure the enabling conditions set out above are replicated as far as possible, and working to address the issues identified. Alongside the ongoing commitment of the existing partners, this may involve finding new partners who share a commitment to the work and can offer the required skills, contacts and resources in different countries.

As for building on the pilot, improved connectivity is just a first step in the process. Whilst the pilot offers some evidence of increased access and contribution to the global research discourse, it is important to maintain the focus on strengthening research and higher education, and so supporting sustainable development.

The NRENs involved in the project are clear that they now wish to engage more with librarians, researchers and academics to make sure that the improved connectivity enhances research and teaching and allows them to take advantage of new opportunities. As one interviewee said, "the whole thing falls flat if it doesn't get to the end users" [1].

The other project partners are also keen to continue the work as "sometimes it can be a long, slow effort to achieve the amount of forward movement we've seen...over the term of the pilot project" [6].

By modelling a solution to the last-kilometre problem, the pilot offers a cost effective, efficient and sustainable way for R&HE to fully benefit from the considerable time and money already invested in infrastructure, journals, books and data.



