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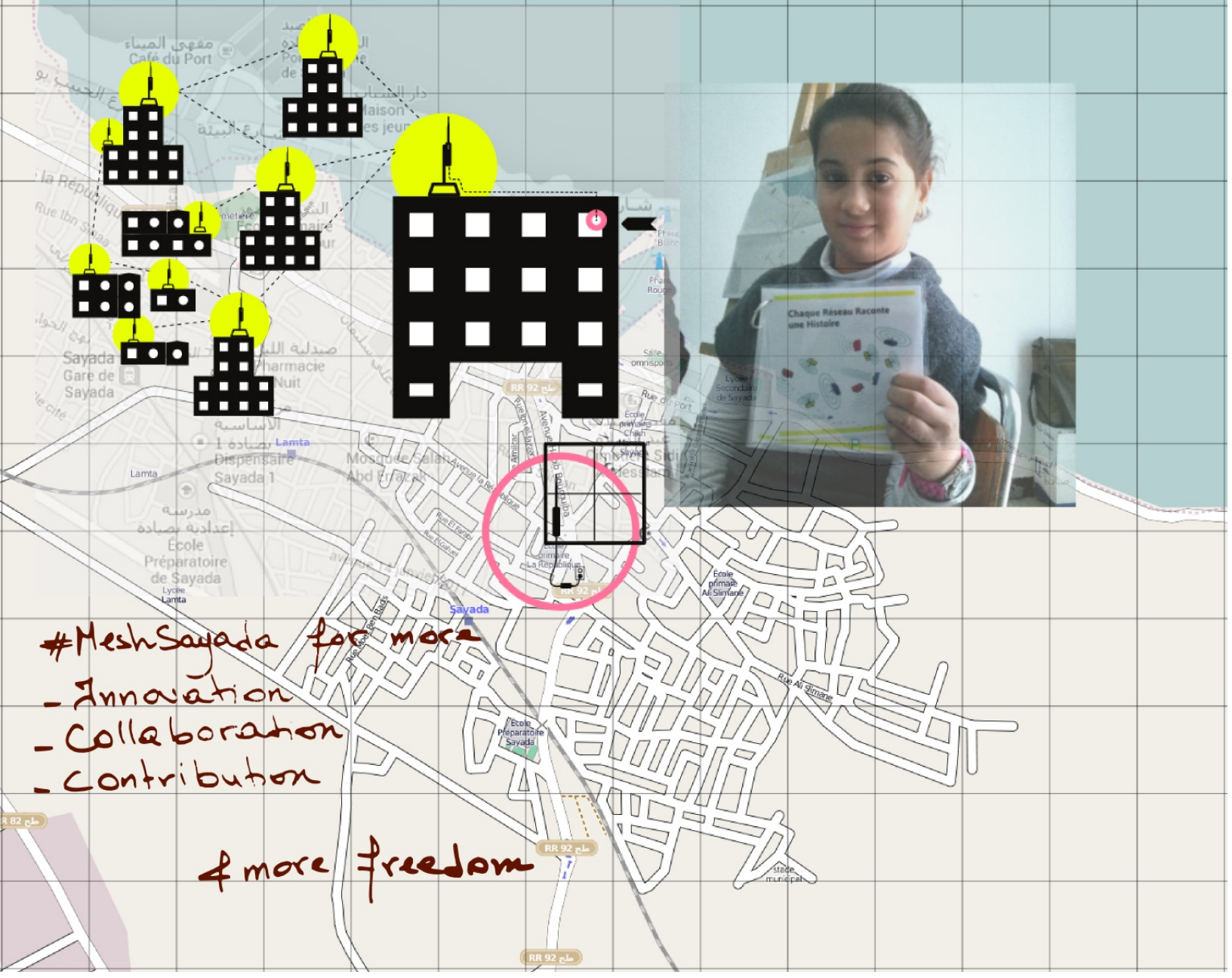

Case Study: Mesh Sayada
Building a Community Wireless Network

February 2014
A joint project of CLibre and The Open Technology Institute

Mesh Sayada for innovation, collaboration, contribution and freedom[1]

Case Study: Mesh Sayada

Building a Community Wireless Network

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The Sayada community network, Mesh Sayada, is a collaboratively designed and built wireless network. The town of Sayada is located on the Tunisian coast, 140 kilometers from Tunis. The network serves as a platform for locally-hosted content, such as Wikipedia and Open Street Maps, and is expected to expand to include locally created content. Local residents and CLibre, a Sayada-based free technology association, initiated the network in December, 2013.

Over a four day workshop, community members from Sayada and interested people and groups from around Tunisia came together to build the first network links and set up a community server. Much like a traditional barn raising,[2] community members came together for a common purpose and contributed different skills -- building mounts for routers, identifying ideal rooftops, reaching out to neighbors, setting up and administering a server, designing the server portal, crimping Ethernet cables, configuring routers, teaching others, and leading children's activities in order to build a shared digital resource.

For decades, the Zine el-Abidine Ben Ali government tightly controlled the media environment and restricted freedom of expression in Tunisia. The government maintained significant control over the Internet, spectrum regulation and the telecommunications sector. The media and telecommunications sectors were tied, either directly or indirectly, to the government, and the government exercised strict controls.[3] This regulatory framework was directly tied to Tunisia's notorious surveillance and censorship practices.

Following the ouster of Ben Ali in January 2011, community media, civic engagement and open government initiatives in Tunisia emerged to push for and take advantage of the political opportunity for greater freedom of expression and freedom of association. The continued expansion of these initiatives is critical in preserving and solidifying the democratic transition in the country.

To support the emergence and growth of community-based media and technology projects, OTI engaged with local partners to share our experience growing the technical resources of a community through the planning and building of communications infrastructure based on principles of participatory design and governance. This local infrastructure can serve as a platform for community focused media, allow for community-governed Internet distribution, and engage community members in broader debates over Internet governance policy.

Sayada and CLibre

The town of Sayada is at the forefront of open technology and open government initiatives in Tunisia. Beginning in 2011, with the support of the local municipal government, civic technologists in Sayada initiated several projects: they built a town website, published the municipal budget, administered and supported the Wikimedia site for Sayada, conducted technology trainings, and contributed to free software projects. Out of these activities, CLibre was formed in May 2013 to solidify the gains in Sayada and spread the lessons

Image: The green area represents an estimated rooftop coverage area - within which new rooftop nodes can be added. Additional equipment may be needed for indoor and street level coverage. The yellow area is the additional coverage area that will be added when the High School router is installed. Blue markers indicate planned nodes.

learned there to other municipalities in Tunisia.

OTI met with CLibre in July 2013 to discuss their plans to use wireless hotspots to facilitate access for all Sayada residents to the information and applications they had put online. Together, the two organizations identified the value a community wireless network could add to the association's broader open technology and open government objectives, especially one that was built and maintained with the participation of local residents.

Digital Stewardship and Commotion

OTI engages local organizers and technologists to build community wireless networks through project-based learning and collaborative teaching practices. OTI and Allied Media Projects developed this approach through the Digital Stewards training program in Detroit to grow local digital resources while also creating educational tools that can be used in other contexts. OTI has used these teaching tools with local partners in Detroit, Michigan, and Brooklyn, New York and Dharamshala, India to teach youth and community organizers the skills they need to built community wireless networks. OTI works with local partners to integrate this approach into their current work, so they build the technology that augments their existing efforts to strengthen their communities.

In order to facilitate the building of community wireless networks globally, the Open Technology Institute leads the Commotion project, an open-source communications tool. The goal of Commotion is to simplify the process of building secure infrastructure so that community members can plan and build networks themselves. Commotion networks are designed to support local applications and/or distribute Internet access.

The Commotion Construction Kit (CCK)[4] is a "build-it-ourselves" guide for planning, designing, installing, and configuring community wireless networks using OTI's Commotion Wireless technology. The open-source kit is entirely self-guided, with an accessible visual language and game-based activities that make it appealing to all ages and skill levels. In addition, it is modular: users can choose their own path through the curriculum, allowing for customization and flexibility based on local needs. These materials are the basis of OTI's community wireless network trainings.

Sayada Community Wireless Network

The Sayada network was initiated over the four day workshop held in Sayada in December, 2013. CLibre and OTI facilitated the workshop, and together with a diverse group of

Image: Mouting routers on rooftops.

community members built a network backbone covering approximately 70% of the town and installed a local community server. At the close of the training, the network had 11 rooftop sites (12 routers), including the Cultural Center, Town Hall and 9 residences. The network links connect major areas of the town and cover critical areas such as the main street, weekly market and train station. Local partners tested the Lycée High School rooftop and planned to install equipment there and at 5 additional rooftops within a short period of time.

The community installed one network server with Open Street Maps of Tunisia, Wikipedia in French and Arabic, a collection of 2,500 free books in French, an Etherpad application for collaborative document editing, and a MediaGrid application for secure chat and file sharing. A local developer created a local portal that links to each of these services. A DNS server on the network allows people to use comprehensible names such as SAYADA.MESH, WIKIPEDIA.MESH, and so on, to access the local applications.

The municipal government agreed to provide bandwidth for synchronization and proxy of particular sites (as providing an open connection to the Internet over the network would violate existing regulations). The community is planning to synchronize the existing Sayada web portal and the existing Sayada Wikimedia site, which are currently hosted in France. Several developers from around Tunisia have volunteered to contribute additional applications for the local network. The Mesh Sayada Facebook group is currently running a survey for community members to suggest and vote on new local applications for the network.

Image: Planning the network.

Participatory Process

On the first day of the event at ten in the morning, several computer scientists and engineers gathered in the Cultural Center with three OTI staff. They were joined by a group of young women (10 to 14 years old) that had come for a music class. The odd combination proved a surprisingly ideal start to a much larger community process. As these initial participants invited others, and people slowly filtered in, the level of participation dramatically increased over the course of the day.

Community members, people from nearby towns, and groups from across Tunisia came together to learn and contribute different skills toward building the network. For instance, the Ubuntu Tunisia Association arrived from Sousse on the second weekend to help set up the community server and create the network portal page.

While many participated in the entire training, others came when they were available or to contribute particular skills. For instance, one community member with construction experience came to the site installations to install poles to mount routers. As new people arrived, participants would teach them skills and discuss the network plan. Each day approximately 25 people participated.

Network building requires a combination of social, technical and physical tasks, such as talking to people, listening, forming partnerships, solving wireless engineering problems, building rooftop mounts, configuring routers and setting up servers. These skills are rarely found in a single

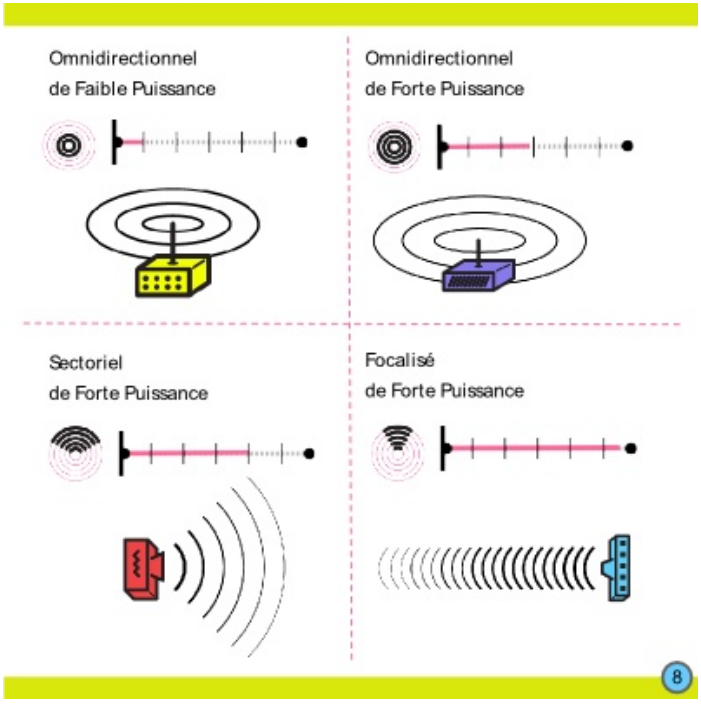


Image: Participatory network planning game teaches basic principles with an easy visual language.

person, which is one reason broad community participation is critical.[5]

Hands-on Learning

Based on the principle that community-based learning occurs through action and mutual discovery, the network was built by the community using a hands-on, participatory process.

> Are we just talking or are we really going to build a network?
> (12 year-old participant)

To ground the network in shared values, the workshop began with a discussion of digital justice and community technology principles, referencing the Digital Justice Principles[6] developed by the Detroit Digital Justice Coalition. The group discussed ideas and concepts that were particularly salient with their own concepts of digital justice and community-based technology. As the principles focus on access, participation, common ownership and healthy communities, they are ideal for cultivating a shared agenda and vision of community technology at the beginning of a project.

Digital Justice Principles community members identified as compelling:

• Digital justice demystifies technology to the point where we can not only use it, but create our own technologies and participate in the decisions that will shape communications infrastructure.

• Digital justice advances our ability to tell our own stories, as individuals and as communities.

• Digital justice provides spaces through which people can investigate community problems, generate solutions, create media and organize together.

Image: Students present their wireless network plans after learning basic principles of planning and design.

Building on this foundation, the first day of the workshop focused on participatory network planning, site planning and Commotion configuration and terminology. On the second day, after a morning exercise solving wireless challenge puzzles (e.g. solving "line of sight" problems)[7], everyone put those skills to practice and installed two directional routers on the Town Hall and used the router interface to test mesh link distances in the street using battery powered routers. Later in the day, everyone gathered around computers and routers to configure more mesh nodes and began planning the community server. In the evening we installed routers at the Cultural Center and one residence.

Day three and four focused on mounting routers on rooftops to expand the network, learning more about configuring Commotion on the routers, and getting the community server fully functional. The skills learned included basic network planning, Commotion installation and configuration, rooftop mounting, making Ethernet cables, and monitoring and troubleshooting the network.

In addition to other activities on the fourth day, CLibre organized an hour-long workshop with approximately fifty

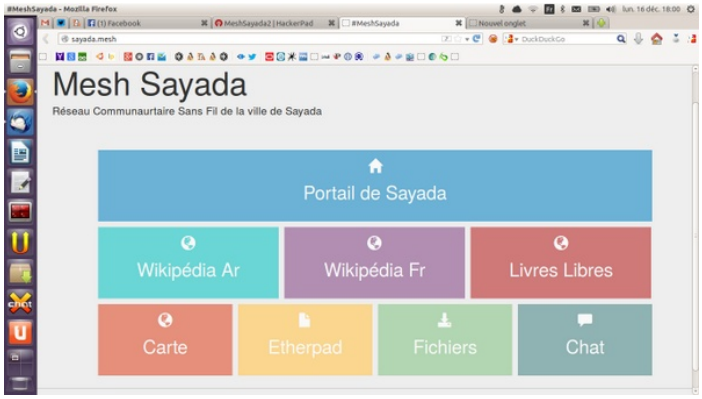


Image: Local Portal on http://sayada.mesh

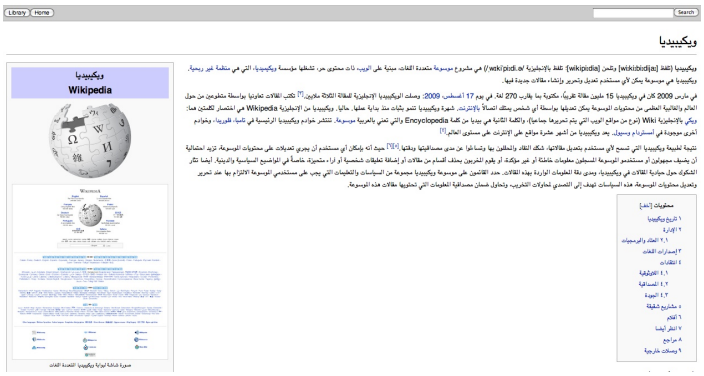


Image: Local Wikipedia Arabic

young students, where the students learned about the three basic types of routers, basic wireless propagation principles, how to identify important community anchor institutions and spaces, and concepts of network design through a participatory game.[9] Students drew maps of Sayada and planned networks using omnidirectional, sector, and focused router icons. Notification of the event through the schools alerted more of the community to the event, increasing participation during the last two days of the workshop.

Additionally, during the workshop a local technologist successfully meshed a small, inexpensive router using OpenWRT. If the process were simplified and documented, it would be an important step for growing the network.

Each afternoon everyone took a deserved break from work to have lunch at Fast Food Lamama—one of the many, many delicious Sayada restaurants.

Network Performance

After the network was constructed, OTI and local technologists conducted point-to-point bandwidth tests across

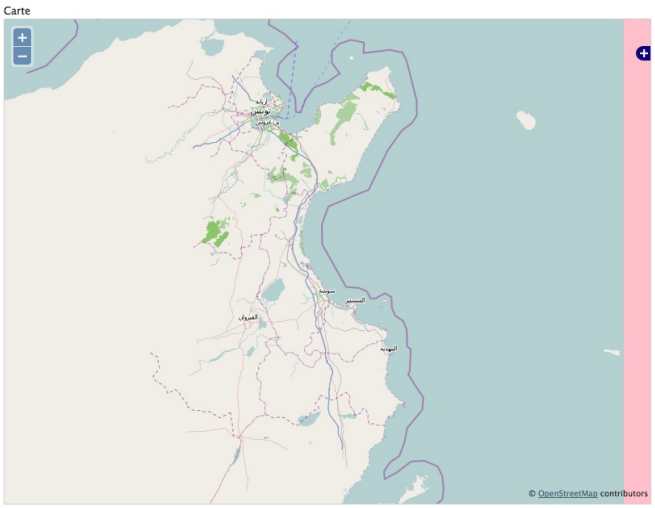


Image: Open Street Maps Tunisia on https://maps.mesh

the network. These involved running instances of the IPERF bandwidth measurement tool on the routers to get a point-to-point throughput number. The results are shown in the table below.

Client Node	Server Node	Hops	Throughput
SayadaLibre-15	SayadaLibre-3	1	13.4 Mbits/sec
SayadaLibre-0	SayadaLibre-3	2	2.8 Mbits/sec
SayadaLibre-4	SayadaLibre-3	1	3.6 Mbits/sec
SayadaLibre-9	SayadaLibre-3	1 or 2	2.0 Mbits/sec
SayadaLibre-A1	SayadaLibre-3	2	1.1 Mbits/sec
SayadaLibre-M1	SayadaLibre-3	1 or 2	2.4 Mbits/sec
SayadaLibre-5	SayadaLibre-3	2 or 3	850 kbits/sec
SayadaLibre-1	SayadaLibre-M1	1	11.3 Mbits/sec

Most points on the network are only one or two “hops” away from each other, with only a few routes on the network having three or four hops. It was difficult to verify the number of hops a given bandwidth test would take, due to the dynamic and automatic nature of the mesh routing protocols.

For the most part, throughput on single hop connections is very good. The maximum throughput on the PicoStation M2 units, under perfect conditions, is 32Mbits per second. Two of the well-connected single-hop links displayed good throughput numbers, 12.3Mbits per second on average. The discrepancy with the third single-hop link result of 3.6Mbits per second may result from a fluctuation in the link quality between two of the routers (SayadaLibre-4 and SayadaLibre-3).

Image: Facebook group for Mesh Sayada.


Image: Local technologist successfully meshes small, inexpensive router using OpenWRT.

Performance declined between two- and three-hop connections. On average, the two-hop throughput was 2Mbits per second, and the three-hop links averaged 1.8Mbits per second. However, the links are of an acceptable quality given the nature of the content on the local server; for web pages, text chat, and web-based maps the throughput constraints over the network should not result in a degraded user experience. More bandwidth intensive tasks, such as file sharing and video streaming, would require additional work by local network administrators to optimize links and increase throughput. It may not be possible to increase the multi-hop throughput above 3 to 5Mbits per second, given other tests run by OTI in laboratory conditions.[9]

Cost of the Network

There are often large costs associated with building any infrastructure, and a community wireless network is no different. Particularly with community-built infrastructure, the donated labor and time of local residents is critical. A great deal of time is required for community organizing, planning, rooftop mounting, and maintenance.

Local residents and individuals from around Tunisia donated their time and labor to build the Sayada network. The cost for the wireless routers, local server, and installation hardware was less than $2500 USD, but the in-kind expense of the time and labor of everyone gathered may have been ten times that amount. Additionally, institutional support from CLibre and OTI was important to organize and facilitate the workshop, and will be critical to maintaining the network and expanding participation.

Summary of the major costs:

• Donated labor from local residents and participants from across Tunisia.

• Rooftop space donated by local residents.

• Support of Tunisian technologists to set up the local server.

• Institutional support from CLibre and OTI to facilitate the workshop and support the network.

• Wireless hardware: Approximately $85 each for three Ubiquiti NanoStation M2 routers and nine PicoStation M2 routers, for a total of around $950. In addition, a $125 spool of Ethernet cable (330 meters) was used for data and Power over Ethernet connections to rooftop routers.

• Local server: Approximately $1000 for a Small Form Factor PC with 128GB solid state drive, 16GB RAM, Intel i7 Quad-core processor, and available bays for adding hard drives in the future for additional storage capacity.

• Installation: Each site took about 2 to 3 hours of work and two or three people per site.

• Bandwidth to synchronize the local server is to be donated by the municipality.

Lessons and Conclusions

Although the network is in the early stages of growth and development, the initial planning and implementation process revealed the following:

1. Participatory design processes facilitated community engagement in the network planning and construction. Each community member had a shared responsibility in identifying rooftops, selecting the next sites, discussing new

Image: Gathering together to discuss next steps.

applications for the network, and explaining the process and project to new participants.

2. Activities easily shared across all ages and technical backgrounds encouraged participation and expanded engagement from workshop participants, as well as attracted others to join. Visual language games kept children and teenagers involved and the variety of activities allowed technical and non-technical participants to work on skills that interested them (server set up, rooftop scouting, teaching others, router configuration, etc.).

3. Participants with technical skills from other regions of Tunisia were essential components of the process, and will be good resources for the long-term support of the network. These participants heard about the network through social media and peer networks, and were excited about the concept of an open network, build by the community itself.

4. The community workshop provided the initial momentum necessary to get the network through the slow and challenging early stages of the process, achieving the necessary widespread community participation and a compelling scale and demonstration of utility.

5. Community outreach to a wide cross-section of the community is essential. The event was successful because despite limited outreach initially, word-of-mouth travelled quickly and participation dramatically increased.

As the network expands over the next year, we foresee several opportunities and challenges. First, maintaining local interest and participation will be a critical challenge. The community will need to develop a participatory process for expanding the network and making governance decisions. The Mesh Sayada Facebook group now has over 300 members. While many of these members are interested individuals from other municipalities, it has become a hub of information and exchange. The success and sustainability of the network will be closely tied to sustaining community support. CLibre will need to facilitate strong community ownership over the project. This will ensure that there are enough individuals able to grow and troubleshoot the network, discuss new features, develop local applications, and raise funds or invest in new equipment.

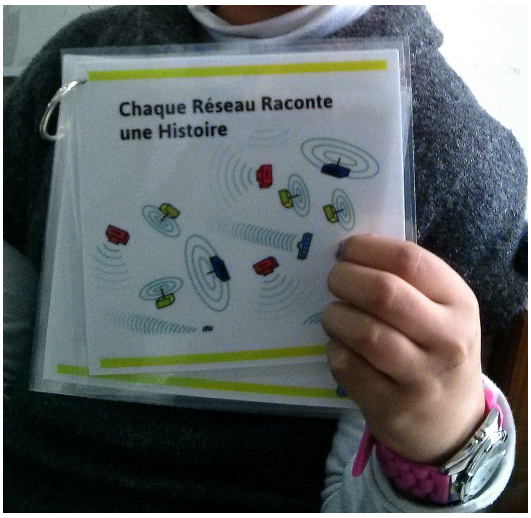
Second, as the network expands, network design decisions will increase in complexity. OTI anticipates the need for generic network expansion templates that will help communities make better plans for growth and enhancing network performance. Expansion also requires that Commotion supports additional router hardware.

Mesh Sayada was built using equipment that is not currently available in Tunisia. Commotion primarily supports Ubiquiti equipment, which is high-quality, reasonably priced, and widely available. While this equipment is available in many parts of the world, it is not currently available in Tunisia. It is not ideal to build a network with equipment that is not locally-sourced. The Commotion project is currently working to support more router models, which will be a critical step in ensuring the sustainability of the network.

Given the focus on civic engagement and local content, we envision rich ecosystems of local applications, which would support and encourage civic engagement, a healthy community media environment, and local innovation in Sayada. The lessons learned in this process will be valuable for all technologists focused on addressing community needs with local solutions.

Additionally, spectrum and Internet service provider (ISP) regulation reforms are needed to encourage and support innovative community-based alternatives. Current regulations inhibit the growth of these alternatives that are necessary for the development of a healthy digital media ecosystem. More broadly, if Tunisia adopts policies that support the digital civic engagement and community media innovations that helped transform the country, it will become a model for the rest of the world to follow.

Finally, communities across Tunisia have expressed interest in building their own community-governed wireless networks, following the example of Sayada. CLibre is already working to share their open government initiatives with other municipalities. The spread of community-owned communications infrastructure and the experience of participatory design and governance has the potential to complement the larger social and political innovations that are transforming the country.



Translation: Every Network Tells a Story

Notes

1 Nizar Kerkeni, CLibre; December, 2013.

2 For more information see: http://en.wikipedia.org/wiki/Barn_raising

3 Chakchouk, M., Kehl, D., Ben-Avie, J., Coyer, K.. From Revolution to Reform: Recommendations for Spectrum Policy in Transitional Tunisia. Journal of Information Policy.

4 https://commotionwireless.net/docs/cck

5 http://commotionwireless.net/docs/cck/planning/identify-neighborhood-skills

6 Detroit Digital Justice Coalition. http://detroitdjc.org/principles/ (EN); http://goo.gl/pzcjdn (FR).

7 http://commotionwireless.net/docs/cck/planning/wireless-challenges

8 http://commotionwireless.net/docs/cck/planning/design-your-network-every-network-tells-story

9 https://wiki.commotionwireless.net/doku.php?id=lab_environment_testing

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