A Peer-to-Peer Commons for Closing the Global Digital Divide

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Abstract

An estimated fifty-three percent of the world's population do not have Internet access. As a consequence, they lack information capital that could be key toward bettering their lives in the way *they themselves* want it to be improved. In this paper, we describe a Commons-based Peer Production (CBPP) system, that provides people offline with *digital content – papers, video, audio – they request*. After discussing key concepts such as CBPP, Open Access and Open Educational Resources, we then describe the components (technology, human actor roles (e.g., Requester, Searcher, Intermediary Courier), and communication processes). We then provide two "existence proof" examples where offline Requesters in school and library contexts in rural Malawi, are assisted by an online Searcher team at the University of Massachusetts, USA. We close with reflections and next steps.

I. Introduction

Historically, the phrase "the Digital Divide" describes the gap between people who have access to information and communication technology (ICT) and those who do not (Compaine, 2001). Undoubtedly, the rapid diffusion of mobile phone technology throughout the world,[1] has provided many more people with access to the Internet, albeit subject to government censoring policies (Freedom House, 2015). However, despite this global ICT penetration, by the end of 2016, 3.9 billion people – or 53% of the world's population – still have no access to the Internet, and in African countries, almost 75% of people are offline (ITU, 2016b: 2; Fig 1.).

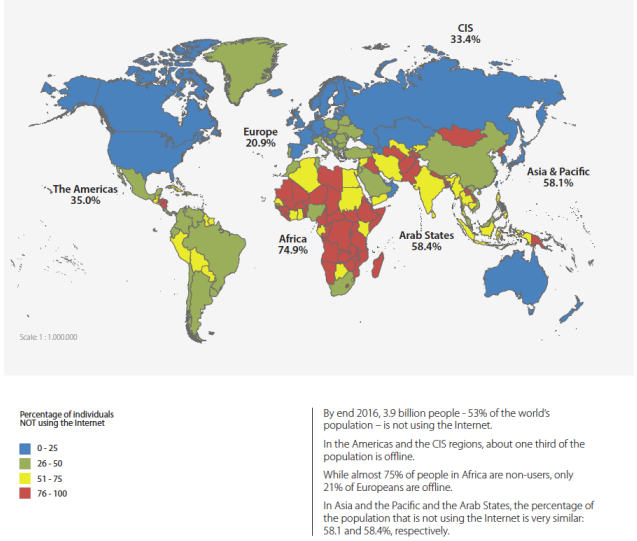

Figure 1. The World's Offline Population, 2016. Source: ITU, 2016b, p. 2.

As Richard Heeks explains: "…the diffusion and even usage [of ICT] has been dramatic," but "…[a]ccess inequalities of location, age, gender, education, and – often underpinning all four others – income, have not gone away. The kids growing up as 'digital natives' in suburban Bangalore are far removed from their counterparts in the 'bit-less deserts' of remote rural Africa" (2010: 626). One might ask: Why should the 'bit-less deserts' be a concern?

Gigler (2014) hints at this question, building on economist and philosopher Amartya Sen's capability models of human well-being (Sen, 1993; 1999), and the importance of creating environments where individuals can be empowered to expand their capabilities so that they

[1] For example, according to (ITU, 2016a: 11] at the end of 2016, there are almost as many mobile-cellular subscriptions as there are people on earth, and 95% of humanity lives in an area that has a mobile-cellular signal.

can lead the life they wish to lead. Obviously, access to information is key to empowering people in the lines that Sen argues. Returning to the point above, 'digital natives' with their access to information through the Internet are arguably potentially more empowered compared to the 'bit-less' ones. Gigler (2014: 23) continues by introducing the idea of a person's "information capital," defined as "…the level of livelihood resources or assets a person has at his disposal in terms of information." In short, 53% of the world's population, due to their lack of Internet access, lack information capital that could be key toward bettering their lives in the way *they themselves* think it should be improved.

There are many efforts underway that seek to close this digital divide. For example, in 2013, Google began an effort called "Project Loon" that would send a network of solar-powered balloons to transmit broadband to Internet-less areas (Muoio, 2016). Rival company Facebook is developing an unmanned aerial system called "Aquila" that they eventually hope can fly for months at a time, powered by the sun, that would provide Internet access to areas without broadband (Metz, 2016). The company SpaceX is working on the design of a network of satellites which, if operational, could provide high-speed Internet to the globe (The Guardian, 2016). The company OneWeb has a similar satellite-based vision (Oneweb, 2017). Undobtedly, it will be some time in the future before one of these efforts becomes successful. SpaceX has estimated a five-year or more build period for its constellation, but this idea has been around for more than twenty years and it still hasn't been implemented (Kelleher, 2017). Moreover, these ideas will be expensive to implement. One estimate projects the SpaceX project to cost nearly $20B to put into orbit and then more to maintain (Smith, 2016). This raises the question of who pays for all this investment, and what the cost will be to the end user, particularly in less developed countries. After all, many people in the developing world have access to the Internet via their mobile phone subscriptions, but the cost of the data plans are out of reach for them financially.

In this paper, we describe an alternative to these efforts, that is not about getting *the Internet* to the hands of people who are currently 'bit-less', but an effort to get them information – especially educational material – that *they want and need.* In other words, in this paper we describe a system and workflow that is trying to ensure that people living in 'bit-less' locations in the world can still gain access to high-quality, digital information, even without an Internet connection. This system is founded on the "RACHEL"[2] offline WiFi router and open access educational knowledge commons built and maintained by the nonprofit organization "World Possible" (World Possible, 2017). We augment this by adding an information search workflow that combines Twitter messaging between "peer-to-peer" information have-not "requesters" and information have "searchers," Open Educational Resources (OER), Creative Commons (CC), and Open Access (OA) library searching, and a data transmission process that requires in-country, on foot, delivery. This peer-to-peer system is motivated by our interest to establish a digital information gathering and transmission system driven by what offline participants want rather than having "information-haves" decide what they receive. Currently, we are using the above listed technologies (e.g., Twitter), but we are not tied to them. As new

[2] RACHEL: Remote Area Community Hotspot for Education and Learning.

tools and technologies become available, we hope to maximize the ability to communicate with internet-starved communities around the world.

With that introduction, this paper describes this system and our pilot efforts implementing it. In Part II, we describe key concepts that are foundational to the project. In Part III, we describe the general actors required (requesters, searchers, and the intermediary and courier). We then describe the general workflow or process. In Part IV, we provide two examples of "request-search-courier" cycles between a remote offline library and a school in Malawi, and our "World Librarian" search team at the University of Massachusetts, Amherst. We conclude the paper with some reflections to date, and next steps.

II. Key Concepts Underlying this Project

Underlying the system we are proposing, as one approach toward solving the global digital divide, are two key concepts: (1) the ideas of Open Access (OA) Licensing and Open Educational Resources (OER); and, (2) Commons-based Peer Production. Below we describe each, in turn.

1. Open Access and Open Educational Resources

The ideas of Open Access and OER are concepts that will probably be well understood to people at a conference on the commons. But for those who may not be, in this section we provide a short primer.

Open Access information, as Peter Suber (2012: 4) defines it, is "digital, online, free of charge, and free of most copyright and licensing restrictions." There are a variety of different OA kinds of outlets that are described very well in Suber's book *Open Access*, but for our purposes the key idea is simply to use copyright licensing to make digital information available for global distribution without a price or access restriction.

There are a variety of copyright licenses that have been developed to promote open access to information. One of the first, was actually a copyright license developed by MIT programmer Richard Stallman to protect "sharing freedom" of documentation that accompanied a specific so-called free/libre software called the GNU operating system, first released in 2000, called the Free Documentation License (GNU, 2008). Stallman (1999) coined the term "Copyleft" – a play on copyright – for his innovation of using copyright law to require the sharing of software or digital content.

A few years later, the non-profit organization Creative Commons was formed, that developed a variety of open access copyright licenses that allow the author or licensor to retain some rights to the digital information and give other rights away to the licensee or user. For example, an author might be open to allowing others to share their work, but might wish to keep the requirement that if the work is used or referenced in some way, the requirement for original author attribution is maintained. Or, the author may allow the sharing and copying of

the work, but prohibit the use of the work in commercial activities (Hill, 2005). Creative Commons provides various copyright licenses to provide authors these kinds of rights management choices.

Open Education Resources, simply put, are digital educational content that are made available online or via a "deep web" library webpage, or OER repository such as MERLOT, the Open Textbook Library, or MIT's OpenCourseWare site, and are readable or available for download and for digital sharing at no monetary cost to the reader (Billings et al, 2012). The key point for this project is that *only digital content (e.g., pdf files, videos, etc.) with a copyright license that permits the sharing and further distribution of the content can be used*.

2. Commons-based Peer Production (CBPP)

Legal scholar Yochai Benkler (2006) coined the phrase "Commons-based peer-production" (CBPP) or "peer-production" for short, and has since argued that it is "…the most *significant organizational innovation* that has emerged from Internet-mediated social practice" (Benkler, 2013:1). CBPP is a concept grounded on the concept of Copyleft (see above), coupled with the dramatic expansion globally in the use of the Internet to collaborate and driven by the advances of the World Wide Web. Collaboration in the context of free/libre or open source software, is, to Benkler (2006), the "quintessential instance" of CBPP, but at least some of its principles have expanded into other areas, such as open collaborative writing (e.g., Wikipedia) and OER (Smith, 2009), "open data," (Gray, 2014) "open hardware," (Pearce, 2015), and "open science" (Everts, 2006; Allen, 2011; Christian et al., 2011; Bagla, 2012).

But what exactly is CBPP and why is it such an important new development to humankind? Benkler (2013:1) argues that CBPP occurs when three core characteristics are present:

(1) the decentralization of conception and execution of problems and their solutions;

(2) the harnessing of diverse participant motivations; and,

(3) the separation of governance and management from property and contract.

Benkler (2013) also explains that it is along these dimensions where instances of CBPP distinguishes itself from other forms of decentralized, Internet-based modes of production and innovation such as Crowdsourcing, Online Labor Markets, Prize Systems, Open Collaborative Innovation, and Firm-hosted peer-production. Given the fundamental importance of these characteristics for what we are trying to explain in this paper, we need to unpack these concepts further.

The first characteristic, "decentralization of conception and execution of problems and solutions," describes situations where conception, such as a new idea of something to be developed or accomplished, and the execution of the idea, are separated. Benkler uses the example of the idea of a new feature in an open-source software, or the idea of a new article

that needs writing in Wikipedia as classic examples of this conception. The person who identified a bug in some open source software or a raises a question about the accuracy of some text in a Wikipedia article may not be the same person as the one who implements the solution to those problems. In CBPP instances, ideas and their execution are often undertaken by different people.

The second characteristic, "the harnessing of diverse motivations," suggests that while some participants in CBPP cases are motivated by pay, there are many others who participate for other non-monetary reasons, enjoyment or "serious leisure" (Stebbins, 2001), the intrinsic desire to learn, and/or support for the "freedom philosophies" (Stallman, 1999). In the example of open source software collaboration over the Internet, programmers may contribute to a project because they are paid by their organization to do so, or because they want to use their professional programming skills to contribute to some software that helps society in some way, or that they enjoy contributing to (such as a video game), or because they respect other programmers on the project and they learn from reading their code. So any given project may have participants motivated for very different reasons.

The third characteristic, "the separation of governance and management from property and contract" describes CBPP as cases where inputs and outputs of the case are governed as either "open commons" or as "common property regimes" where some subset of participants have property rights to the products being worked on, but share them as a community. Let us use a technology example to explain this idea. The company Apple, governs and manages the iPhone's operating system (e.g., OS X) both as a project and as a technology. That same company has property rights to that technology and contracts people (employees) to work on that project. In the iPhone case, Apple governs, manages and hold property rights to the iPhone as a device, and its operating system. Alternatively, in open source software instances, certain individuals have property rights to the software repository in that they have control over what enhancements are included in the next release of the software product through their rights and control of the versioning system (Schweik and English, 2012). But the governance of an open source software project is often run and guided by a different set of people. Further, instances of CBPP will be characterized by governance or management systems that avoid the use of contract or property rights to steer or constrain new ideas, exploration, and experimentation by the peers (Benkler, 2013: 6). CBPP is not an instance where some overarching governor, like Steve Jobs of Apple, has the property rights permitting him to decide what goes into that next release. Rather, in open source software CBPP instances, new enhancements often flow from a participant or user's need or idea, rather than the boss with authority telling them what or what not to implement.

We support Benkler's claim that CBPP is perhaps the most important phenomenon that has emerged from Internet-mediated social practice because through the above distinguishing characteristics, it allows the world to collaborate in a way that is different from how most work gets accomplished. In the United States, and most other places in the world, we organize into three types of organizations to get work done: for profit firms, government agencies, or not-for-profit institutions. But in the context of CBPP, we could have situations where actors from all

three types of organizations are collaborating on the same problem or project. This is a very important point with regard to the innovation of CBPP and its potential for humanity. In the context of this project, it means that people from a variety of different organizational types can participate, rather than it being a project run by one organization with overarching governance and property rights.

These principles of CBPP are foundational to the system we describe below, and we will now describe how, after we describe the generic system we have implemented and piloted.

III. The Generic Peer-to-Peer Commons System Described

The Components

The system we have developed to locate and distribute online content to communities without Internet access involves a combination of actors and technologies. It requires:

1. A peer information "***Requester***": an end-user organization needing information, with one person who has access to the internet via a smartphone mobile data plan can communicate with a "Searcher" via a low bandwidth messaging platform such as Twitter, What's App, Slack, or Facebook Messenger;
2. A World Possible "**RACHEL *(*Remote Area Community Hotspot for Education and Learning) Plus**": a WiFi-enabled device deployed at the information requester's location;
3. A peer information "***Searcher***": an organization, group. or even a single individual, who has access to the Internet and open educational resource repositories, and the time available to monitor messages from the Requester, and to search for open access information on behalf of the Requester; and,
4. An in-country "intermediary ***Courier***": a technology support person or organization who does have access to the Internet, Twitter and Google Drive (or comparable messaging and cloud-file-sharing system) access.

Specifically, the *Requester* can be a library, a school, a nonprofit or any other organization (e.g., a rural hospital) that needs content on specific topics, but has no access to the Internet. They do, however, need to have some computer or Wi-Fi enabled device to access information served on the RACHEL Plus, and someone with access to a smartphone device and a cellular data plan, such as a teacher or a librarian. This cell-phone enabled person acts as the contact person for the Requester organization, and will communicate their information needs, via Twitter information request messages, to their peer Searcher node. This Twitter-based communication is described below.

We use Twitter for communication for two reasons. First, with its 140-character messaging limit, we are striving to keep the mobile data costs are relatively low for the mobile phone support person at the Requester location, for that data plan cost could very likely be on their own personal cellular plan, and in some lesser developed country contexts, could be a cost

that is substantial relative to their income. Second, the Tweet communication can be monitored by the Searcher, the intermediary Courier, and other interested parties such as other schools in the same region, who might have an interest in the content being distributed.

The *RACHEL* Plus device (Figure 2) is a hardware device that acts both as a digital information content database and a Wi-Fi server that can be accessed by people working at the Requester's physical location. For example, users might be children in a computer lab in a remote school. The RACHEL database contains snapshots of various World Wide Web open access educational content (such as Wikipedia articles, Khan Academy and many others; see Figure 3) and is a form of common property regime, curated by the team at the non-profit World Possible (2017). The effort we describe here, complements what the World Possible team is doing, by providing a search and distribution service to provide tailored information needed by participants at individual Requester sites in the World Possible network of rural user locations. Importantly, the RACHEL Plus device has an upload function that allows for tailored content to be added to the RACHEL Plus database. This is described in more depth below.

Figure 2. The RACHEL Plus device. A video of the device is available at https://tinyurl.com/y88lzr85

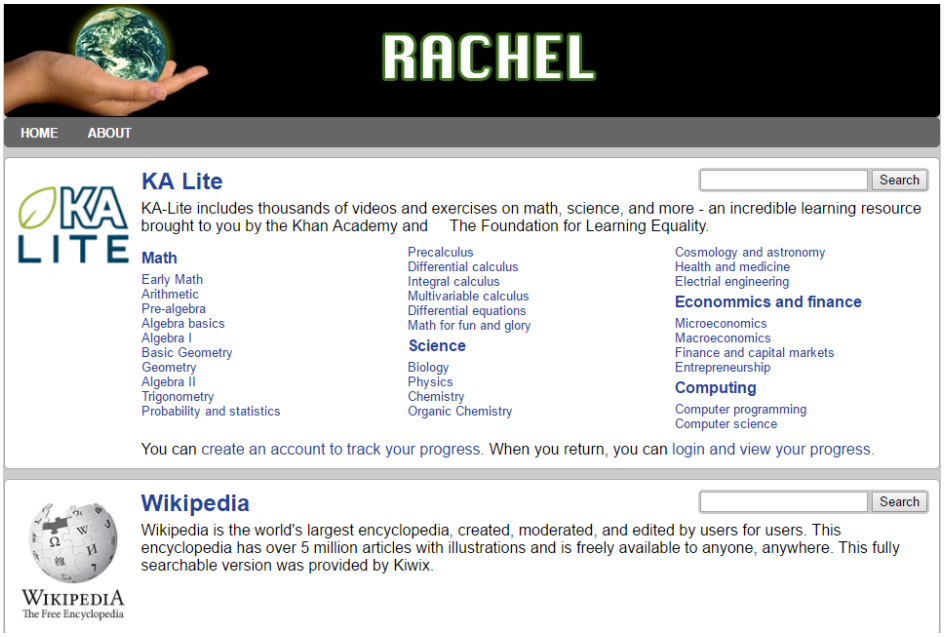

FIGURE 3. The RACHEL Plus content user interface viewed via a web browser. These are just the first two entries. There are many more open access items listed when the user scrolls down. Also, there are three languages available: English, Spanish and French. Live previews of these databases are available at https://racheloffline.org/collections/frontpage/products/rachel-plus

The peer *Searcher*, is an organization or individual somewhere in the world that has Internet access and access to digital open access educational resource libraries and databases. In the case we describe below, our university – the University of Massachusetts, Amherst – is acting as the Searcher organization. Using an established Twitter account, the Searcher:

(1) receives Twitter content request or clarification messages from their associated Requester(s);

(2) searches for requested content using their privileged access to the Internet and open access content repositories; and,

(3) provides found digital content licensed open access (e.g., Creative Commons) to the intermediary Courier (described next) via Google Drive-based file sharing (or other online cloud based data sharing mechanisms) to get the identified digital content geographically proximate to the area where the Requester organization resides.

The *Courier*, is an organization or individual residing within the country or region where the Requester is located. The Courier helps both in initially deploying RACHEL in Requester offline community locations (e.g., rural schools, libraries in lesser developed countries) and

periodically delivers updated versions of the RACHEL database. However, importantly for the system we are describing here, the Courier also retrieves content provided by the Searcher via Google Drive (or alternative data transmission service), and then physically travels and delivers the content via a USB stick or other computer technology to the Requester's location for uploading onto their local RACHEL Plus device. The RACHEL Plus interface provides the Courier or designated administrator at the Requester location the ability to upload and "File Share" the Requester specific content the Courier brings on the USB stick or Wi-Fi enabled device (Figure 4).

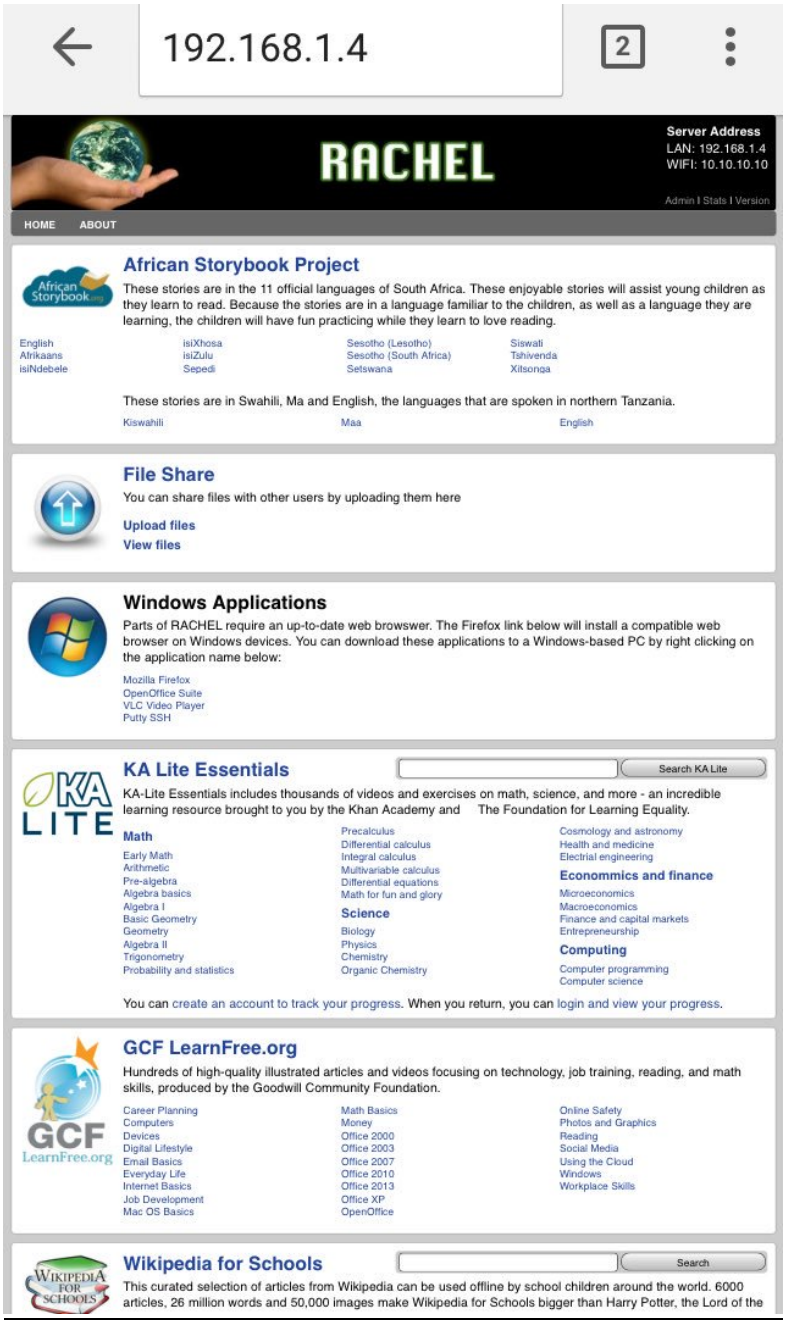

Figure 4. The "File Share"/Upload and View Files option on the RACHEL system

The Idea of "Peer-to-Peer" and Process

As stated earlier, the World Possible nonprofit organization has created, and is constantly maintaining and updating, their RACHEL database of open educational materials. The reason we refer to "Peer-to-Peer" and "Commons" in the paper's title is that the process we describe in this section is meant to be initiated through the formation of a relationship between two units: the Requester's organization, and the Searcher's organization. We consider these organizations as peers in that, in our view, ideally, they would be similar organizations with similar interests and where the only difference is that the Requester organization does not have access to the Internet, and the Searcher peer organization does. While this is not a hard-and-fast rule, the idea of referring to this system as peers is in part a signal of respect to both participating units, and also a tie-back to the earlier discussion of commons-based peer production. The idea we have is similar to a "sister city" relationship we see sometimes in the world. For example, one high school in Canada (Internet haves) might be the Searcher for a high school Requester somewhere in Africa (Internet have-nots).

The following steps describe the general process of initiating the relationships and the workflow and communications between Requester peers, Searcher peers, and the Courier.

Step 1. Create Requester – to – Searcher peer relationship, supported by a local, in-country (to the Requester) Courier who is (hopefully) not too geographically distant from the Requester. This tri-organizational relationship could come about in many ways, but in our case (described in the next section) the relationship between our team at the University of Massachusetts, and the schools and libraries in Malawi, were established through our already established relationship with the Courier in that country (ShiftIT, discussed below).

Step 2. Establish communication between participating organizations using Twitter. Twitter serves as the main channel of communication between the Requester peer and the Searcher Peer for content request and content search updates, and, obviously, both organizations need to establish a Twitter account to initiate this kind of communication. On the Requester's side, this account needs to be established and maintained by whoever (a teacher, a librarian, a principal) in that organization has a smartphone and mobile data plan, and can incur the communication costs. On the Searcher side, the Twitter communicator simply have to establish their Twitter account. In our context (described more specifically below), our team at the University of Massachusetts, Amherst created a Twitter account called "UMA World Librarians" with a twitter handle @Keepreq[3]_UMA to facilitate communication about content requests.

Step 3. The Requester tweets a content search request to their peer Searcher after connecting on Twitter. Each request carries a "#keepreq" hashtag to differentiate the tweets carrying content requests from other tweets. All subsequent communication on content carry the this

[3] The term "keepreq" is a legacy term that is not worth explaining in this paper.

hashtag for easier extraction and management of the dialog stream. The content requests can be on any topic the Requester is interested in.

Step 4. The Searcher acknowledges the content request by clicking on the 'like' button on the tweet with the content request and also replies to it noting the goal of a week's time to locate content. We have a norm established that we strive to keep as Searchers at the University of Massachusetts: "One week from the Tweet". As mentioned earlier, the peer Searcher's tweet also carries the tag "#keepreq". If the initial request is not clear, the peer Searcher asks for more specific details on the content requested.

Step 5. The Searcher searches for relevant digital content that is licensed open access. The Peer Searcher looks for content in open access content repositories. We often start by using the search system provided by Creative Commons (CC Search, 2017) but then also expand to a variety of other library databases when needed. As mentioned earlier, an open access (e.g., Creative Commons) license allows free distribution of an otherwise copyright work. Under these, the author gives right to other people to share, use and/or build upon his work free of cost. All content, including videos, is saved in a folder and reviewed carefully to ensure that the content is relevant and does not involve copyright infringement.

Step 6. The Searcher shares the content with the in-country Courier. After finalizing the content, the peer Searcher shares the folder (with the requested content) with the in-country Courier through Google Drive. The Courier downloads the content in a USB stick (or other device) and Tweets to the peer Requester that the requested content is ready and will be delivered to them shortly.

Step 7. The in-country Courier physically delivers the content to the Requester. The in-country Courier carries the USB stick or other device with content to the Requester's location and uploads it on the Requester's local RACHEL Plus device. Once uploaded, the content can be accessed by all users through the devices at the peer Requester's organization.

Step 8. The *Requester* reviews the content and Tweets a message to the *Searcher* telling them that the content sent suits their needs, or possible provides new clarification on what might be missing.

<u>Connecting back to the idea of Commons-based Peer Production</u>

At this juncture, the reader might be asking: "OK, but how does this system and workflow described above connect back to the ideas of Open Access and Commons-based Peer Production?"

The concept of Open Access and its importance to this project is, perhaps, obvious. Simply put, both the World Possible RACHEL database and the additional requester-searcher-courier system we propose mandates that only digital information content that has permission

by its author or licensee to be shared can be used. Creative Commons Share-alike licenses or something comparable is a requirement for content to be shared via this system.

What might be more difficult to connect is how the idea of commons-based peer production maps to this generic system we just described. Taking the three key principles of CBPP sequentially, let us explain.

CBPP Core Principle 1. Decentralization of problems and their solutions

In the digital divide case, the problem – lack of access to some topic of information – is identified by one person or organizational requester, and the solution – the identification and distribution of digital information on this topic – is solved by other people or organizations doing the searching for relevant content and the delivery of that content by the courier. Our generic system satisfies this first core principle of CBPP.

CBPP Core Principle 2. The harnessing of diverse motivations

Recall from the earlier discussion the example of diverse motivations in the context of open source software projects (e.g., for pay, for leisure, to learn). In the context of the system we propose here, some searchers may be intrinsically motivated to participate because they want to help someone in another part of the world get information they need. In other instances, the motivation to search might be driven to use leisure time putting their own professional knowledge to use in some hobby or leisurely activity. In other instances, someone might search and help a requester because they want to learn through that participation (consider, for example high school aged children studying African Studies in the USA, helping peers in a request school somewhere in Africa). Or, in some instances, a person might be paid by some organization to contribute to the project, such as a university research librarian whose job may have an element of outreach beyond the walls of their university. Our generic system satisfies this second core principle of CBPP.

CBPP Core Principle 3. The separation of governance and management from property and contract

World Possible's RACHEL Plus technology is a system where the governance and management is not separated from property and contract. The World Possible non-profit team decides what goes in the main RACHEL database and new hardware releases of the RACHEL Plus technology. In other words, one organization, World Possible, governs and manages the RACHEL system, and it also has property rights over the RACHEL Plus technology. However, the system we describe above complements and takes advantage of the RACHEL Plus as a delivery mechanism, and *separates governance and management from property and contract of content added through the File Share upload function (Fig. 4)*. In other words, the governance and management of what gets uploaded to a particular instance of RACHEL Plus in the field and the property rights to that particular device's instance is separated from the governance and property of the main, general RACHEL Plus project at World Possible's main headquarters.

In short, what we describe here is a different kind of CBPP situation than the high profile examples, like open source software projects or Wikipedia pages, but the RACHEL Plus instances in field locations fit the CBPP definition criteria.

IV. Example Request-Search-Courier Cycles with Peer Requesters in Malawi

In this section, we describe several real-world examples of the Request-Search-Courier cycle we have described above. These instances started through a connection we had with an information technology consulting organization called "ShiftIT" in Malawi. ShiftIT is a non-profit organization with a core vision where "…girls, boys and communities have equal access to education and are connected to quality learning resources through low cost, high quality ICT solutions" (ShiftIT, 2017).

Related to our project, ShiftIT's technology deployment strategy to rural schools and libraries in Malawi is grounded on three key technologies:

(1) A USB Android computer operating system called a "Keepod" that can "…revive old computers to work like new" (Keepod, 2017). These devices allow school children in Malawi to own their own "computer" – a USB stick – that they can carry "their own computer" (and associated downloaded files) to and from school. The Keepods have application software such as a web browser (currently, Chronium) that allows the user to view World Possible's RACHEL. These 8GB devices cost approximately $12 USD.

(2) Refurbished laptops or other computers in the school or library's facilities that can work with the Keepod USB.

(3) The World Possible RACHEL Plus database and WiFi server.

ShiftIT already had connections to a large set of schools and libraries in Malawi that do not have Internet access. ShiftIT does have Internet access at their main office. Consequently, ShiftIT became the intermediary "Courier" in our Malawi pilots, and was instrumental in setting up the Twitter-based communication system we have been using with their Requester organizations. In the examples to follow, we show two example dialogs between two Malawi organizations as Requesters, and our team at the University of Massachusetts, Amherst we call "World Librarians" that act as the peer Searcher for each of these Requesters.

In Figure 5, we show the Twitter dialog between one Requester, the offline Malawian National Library System (NLS), Blantyre Branch, and our World Librarian team's Twitter account at UMass Amherst, Massachusetts, USA. In the first Tweet, transmitted by a librarian or someone affiliated with NLS Blantyre who has a smartphone and a mobile data plan and can afford to pay for 140 character Tweets, asks the team at UMass Amherst to search for "…content on aeroponics and what nutrients they require." Our team at UMass Tweeted back acknowledging the Tweet request and specifying the social norm we have established of "one

week from the Tweet" to find relevant open access material (video, pdfs, etc.) and get it to the intermediary Courier ShiftIT. As stated earlier, the key search requirement is that any relevant material found needs to have an appropriate Copyleft license giving the Searcher the permission to share the material, ultimately, on the RACHEL Plus server at the Requester's location. When we as Searchers find relevant information, we use a Google Drive folder to transmit and share the material to the in-country Courier, Shift IT, who, recall, has Internet access. In the third Tweet, the Courier, ShiftIT, using a "Keepreq" Twitter account, notifies the Requester, NLS Blantyre that the material the UMass World Librarian team found is being physically brought to their organization by some member of the ShiftIT organization to be uploaded to the RACHEL Plus via the File Share function. In the final Tweet in Figure 5, the Requester NLS Blantyre is confirming receipt of the content.

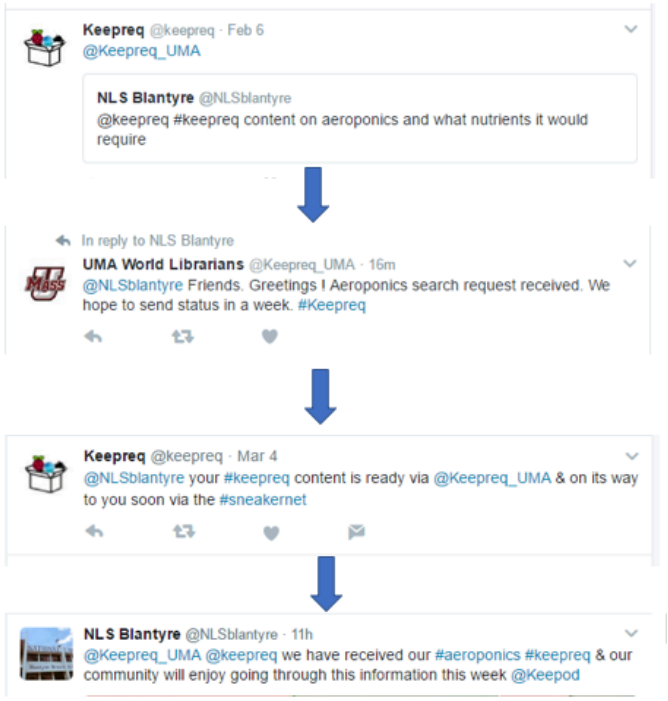

Figure 5. A Request-Search-Courier Twitter Dialog between the Requester National Library System (NLS) Blantyre Branch, Malawi, the Searcher "the University of Massachusetts, Amherst World Librarians," and the local Malawian Courier, ShiftIT, using a "Keepreq" Twitter account.

In Figure 6, we present another Twitter Request-Search-Courier cycle with a remote, offline Malawian school named "Green Malata" where the search request on "…how to dry tomatoes in subtropical weather" needed a bit more clarification. A similar process of request-search-transmit via Google Drive to the courier, and the hand carry of the digital data transmitted by the Courier and file upload to the RACHEL Plus instance at their school. In the last Tweet, Green Malata confirms they have received the content.

Figure 6. Twitter Request-Search-Courier dialog between Requester Malawian school "Green Malata", Searcher UMA World Librarians, and Courier ShiftIT (using Keepreq Twitter handle)

The above provides "existence proofs" of two cycles of the Request-Searcher-Courier system we have implemented. We have several other such cycles, not shown, due to space limitations.

V. Results, Reflections, Conclusions and Next Steps

The commons-based peer production system we have described above is an effort to help close the digital divide with an eye toward providing offline, bit-less requesters with information *they want*, rather than providing information that we (e.g., some Internet access-have group in the northern hemisphere) think they need. With this system and process piloted, we are now in the phase of trying to standardize the flow of request-search-courier cycles. Very rapidly, these Twitter dialogs and the work to search for content and ship to couriers will get unwieldy. Our overall goal is to develop a standardized commons-based peer production system (with training documentation) that can allow for a broad distribution of the peer requester, searcher and courier relationship to be replicated in other World Possible RACHEL Plus deployment instances. It is that potential for scaling up that is the real power of this idea – the idea that, for example, many universities or schools with Internet access could support rural universities or schools without Internet access following the approach and workflow we present here. Our intention is to establish the workflow system, and then scale this up to allow many decentralized peer–to–peer Requester, Searcher, Courier systems to emerge (discussed more below).

One discovery made through these cycles (Figures 5, 6 and others) is the importance of transmitted video content over textual content, because many in the schools or libraries in Malawi that we support understand spoken English better than they can read English text. Audio or video with audio helps to overcome the language barrier. We are currently working with a graduate student from Malawi who is studying at our university who speaks Malawi's official language of Chichewa, to develop closed caption translations into educational videos we discover that serve the Requester's information needs. This is another example of the principle found in CBPP where the problem (not understanding English) is decentralized and solved by someone else. One potentially easy way to solve this problem is to establish requester and searcher peer relationships in the same country.

There are other improvements to this first version or workflow of the system we have described here. We can readily envision one Searcher organization supporting multiple peer Requester organizations, in the way we are at UMass Amherst. As multiple Twitter request-search-courier communication cycles come in on our Twitter message feed, it rapidly becomes unwieldly to manage the different requests and keep track of where we are in each individual cycle. We've considered the idea of developing some very simple Twitter syntax to help us with the management of these dialogs – codes that the Requester might put at the beginning of a Twitter message to help us understand what the message is (e.g., an initial request, versus a clarification to a previous request, versus a cycle conclusion message telling us that the content was received). But we have not yet implemented such an idea, in part because that will add rules to what the requester needs to do, which might be very difficult to implement.

Working with several others, we have also started to contemplate a more automated control system to monitor various Tweets from Requesters. We have one colleague affiliated with co-author Meyer and ShiftIT who has implemented an app to extract tweets with a generic hashtag (#keepreq) to help us sift out these dialogs from other "noise" coming in on Twitter which we are about to test. Similarly, co-author Richard has developed a mechanism to harvest

#keepreq Tweets and automatically enter them into a Google Spreadsheet. While we have yet to determine which system we might use, both of these efforts are seeking to help with what undoubtedly will become a more unruly management problem as content searching requests for searching grow over time.

Over the next year, our hope is to get to a point where we have the request-search-courier process well-worked through and standardized and a "Tweet management" system also well-established so that this can expand to other peer requester-searcher-courier instances. But scaling up or replicating what we have done to other requester-searcher-courier instances requires further thinking about the second attribute of Commons-based Peer Production: diverse incentives. But we can see several instances where incentives for searcher participation will readily exist. An example of an area that could rapidly scale globally would to enhance learning between youth in peer schools across countries. For example, in our local high school, there is an Africa Studies Club where the students and their teacher and school librarian would welcome the opportunity to support, as a searcher, a peer school somewhere in Africa that has no online access. The benefit to the Searcher high school students would be to establish direct interaction with other peers in countries they are trying to understand in their studies. Co-author Richard, has already been working on scaling up the school-to-school idea through a program he has started called "Project Empathy" working with middle-school children in Chicago and a peer school in Malawi. He recently moved to India, and is setting up to become another Intermediary Courier in that region of the world. Similarly, one could see such peer-to-peer school being established in higher education. We can easily envision a whole network of World Librarian searcher peer teams like the one at UMass Amherst established across the network of Research Libraries in the United States and elsewhere.

The incentives for establishing Couriers in country, is perhaps a harder one to envision and establish. But in our preliminary work, we have identified the Malawi nonprofit ShiftIT who is acting as our Courier and helping to develop the initial peer-to-peer connections. We recently interviewed another similar organization working with World Possible in Guatemala, but have not yet implemented our peer-to-peer system there. These are examples of "social enterprises" in country who are trying to improve the educational systems in these countries through their efforts. Consequently, they have some "providing social good" incentives to act as Couriers already. Our next step is to continue understanding what other incentives or financial arrangements potentially can be in place to establish local-country Couriers more permanently and allow these Couriers and critical intermediaries to earn a decent living.

In conclusion, in this paper we have tried to describe a system we are deploying, with the significant help of the nonprofit World Possible and our Courier in Malawi, ShiftIT, the works to harness the ideas of Commons-based Peer Production and Open Access to develop mechanisms that allow in-country offline "requesters" to get information on topics they want, rather than having an organization from somewhere else tell them what they should read or view. At this juncture, we have existence proof cycles of Request-Search-Courier workflow that appears to be working. Over the next year we hope to improve the communication process or develop systems to help better manage multiple conversations between Requesters and one Searcher

organization. We also hope to start to expand this to create other self-sustaining Requester-Searcher-Courier systems beyond our organizations (UMass, ShiftIT). If anyone who reads this paper is interested in participating as a searcher or requester, please contact us (see cover page contact information).

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