Collaboration Circles: empowering job seekers to find work using ad-hoc collaboration networks

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ABSTRACT
Recent trends combine smart phones with social networking platforms to bring new opportunities that can enable people to collaborate anywhere and at any time. For example, organizations can be given the opportunity to recruit part-time job seekers such as software developers using social media tools. Previously, collaboration was static in nature, but today loosely enabled collaboration needs to support flexible schedules, ad hoc processes and members that may not be known in advance. Furthermore, current crowdsourcing platforms that enable software developers to contribute their skills to projects do not meet the social needs of participants as they collaborate. This paper presents a cost-effective approach to collaboration that aims to assist users to find suitable collaborators to team up with. The proposed Collaboration Circles application is able to find the best time to collaborate using Google+, Google calendar and a weighted assignment algorithm. The Collaboration Circles application includes features such as the administration of collaborative task activities and communication channels. The Collaboration Circles application is implemented as an Android social network application supported by Google tools. The application is experimentally evaluated to demonstrate that the Collaboration Circles application successfully supports collaboration in the virtual world.

Keywords
Collaboration, social network, Google+, Google calendar, schedule, tasks, cloud

INTRODUCTION
Collaboration in the modern day has become a vital tool to achieve cooperative success (Sun, Zhuang, Wei, Shan & Jiang, 2015). As business competition is rapidly increasing, it is important that teamwork and creativity within, and outside the bounds of the workplace is encouraged to improve productivity (Awolusi 2012). Through the mechanism of ad-hoc collaboration, workers can share ideas, knowledge...
and skills, driven by a common goal. In such situations, effective solutions can be delivered in an accelerated manner (DiMicco, Geyer, Millen, Dugan & Brownholtz, 2009). Current research points to the fact that job seekers are increasingly using social media to investigate potential employment opportunities, and their social network contacts for potential leads. Statistics from Jobvite (2015) indicated job seekers generally make use of Facebook (67%) (www.facebook.com), Twitter (45%) (www.twitter.com) and LinkedIn (40%) (www.linkedin.com) (Collmus, Armstrong, & Landers, 2016). Within organizations, enterprise social network applications provide a similar platform to expose employment opportunities, but these tools may be too expensive for medium to small enterprises (SMMEs) in the African context (Lekhanya 2013) (Ellison, Gibbs, & Weber, 2015). In addition, such applications are limited by organizational boundaries.

Consider the services provided by IT (Information Technology) entrepreneurs and startups located in Africa. A challenge faced by these companies is the limited skill set that is available (Tredger 2012). The proliferation of laptops, mobile phones and Internet access can enable skilled software developers to be more readily available to startups in a temporary and collaborative manner. An important question to be answered by the manager of such a startup is whether reliable software developers can be found who have the right skills and who can be trusted to perform quality work within a specific timeframe and budget. The formation of ad-hoc software development teams via crowdsourcing is a current research focus (Stol & Fitzgerald 2014). Due to the nature of crowdsourcing platforms, real collaboration is not always supported between participants (Gray, Suri, Ali, & Kulkarni 2016). Castells (2009), a sociologist, reasoned that these developments can be seen as evidence of a move to a network society where people organize their work by using ad hoc networks of individuals. Such networks are adaptive and open-ended in order to exchange information.

Recently, the use of smart phones and social networks to facilitate collaboration is being adopted more and more (Awolusi 2012). The use of smart phones and social networks makes it possible for people to collaborate despite of their geographical boundaries. This supports collaboration anywhere at any time (DiMicco et al., 2009). In addition, advances in cloud computing provide a myriad of tools such as Google+ (plus.google.com) (Kairam, Brzozowski, Huffaker & Chi, 2012) to enhance and support communication. While these new technologies are becoming more popular for collaboration, a new set of challenges have come to light due to emergent situations where time, processes and collaborators are unknown (Sun et al., 2015). The central research questions this work addresses is to identify what the requirements are that need to be satisfied to support job seekers to collaborate in an informal economy, and to identify how a cost-effective collaboration solution can be defined for jobseekers who may not necessarily be working for the same organization.

This research follows the design science research approach (Peffers, Tuunanen, Gengler, Rossi, Hui, Virtanen & Bragge, 2006), finally resulting in the construction of an artifact, an enterprise social network application called Collaboration Circles. The Collaboration Circles application is designed to ensure cost-effective collaboration using smart phones, Google tools and a web service. This paper is structured as follows. In the next section a literature review is presented that provides background on collaboration in the workplace, the emergence of enterprise social networks and factors that influence collaboration success. Based on an analysis of relevant literature, four requirements are identified that need to be addressed when implementing a collaboration environment using freely available and open
technologies to enable organizationally-independent collaboration. The Collaboration Circles social network application architecture operation and implementation is then described. To verify the artifact, it is evaluated with regards to the stated requirements. Finally, the paper is concluded.

LITERATURE REVIEW
This section provides a literature review conducted, regarding topics such as collaboration and factors that ensure collaboration success, online social networks, and enterprise social networks. Technological developments in social networks are reviewed to provide a foundation for the approach followed by this research. The purpose of this literature review is to describe the problems being faced when job seekers such as software developers want to informally collaborate on projects, and how these problems can be addressed by technological advances in social networks and social media by identifying a set of requirements.

Collaboration
The use of technology to facilitate collaboration within the workplace is not a new idea. The terms computer supported cooperative work (CSCW) (Mattessich & Monsey, 2001) and groupware (DiMicco et al., 2009) describe how new technology can be used to support team collaboration. The increased advancement of technology and supporting applications in industry led to an increased number of professions that have developed a need for the use of collaborative technology within the workplace (Awolusi 2012). As a result, numerous terms have emerged to describe the concept of collaboration using technologies such as digital collaboration, knowledge management technologies and e-collaboration (Awolusi 2012). Technologies have been an inherent part of collaboration for a long time such as email, instant messaging, audio conferencing and electronic bulletin boards. Of these, email is the most popular electronic communication channel for both business and personal use (Li, Chen, Zhang, & Fu, 2015). Instant messaging supports communication in a near synchronous manner via chat rooms to facilitate for collaboration (Yunus, Salehi & Chenzi, 2012). Electronic bulletin boards provide asynchronous communication but compared to email, it has the capability of maintain structure through topics, enquiries and replies (Mattessich & Monsey, 2001).

At the heart of software development lies the concept of collaboration as developers need to interact with each other. In this regard, collaboration can be defined as any form of interaction between distributed software developers or teams (David & Borges, 2004). Collaboration is prevalent between team members, but is also found beyond the confines of the software team. For certain tasks, random workers who may be external to the organization, can be selected using traditional crowdsourcing platforms. Research has shown that when crowdsourcing platforms do not support collaboration activities, workers define their own mechanisms to enable collaboration due to social and technological needs that exist. It is therefore clear that a need exists to support collaboration that incorporates social interactions (Gray et al., 2016).

Factors that influence collaboration success
Factors that influence the success of collaboration include the environment, membership, process/structure and communication. Each of these factors are now described further.
Environment
The environment focuses on geographic location and the social context within which a group of people who want to collaborate are situated in. Such groups of people have no control over these factors, but they can have an impact on them. Collaboration is known to have higher chances of success in places where some amount of collaboration has been facilitated and encouraged. Additionally, this factor is important in providing a level of trust to the collaborators with regards to the specific processes agreed upon (Huxham & Vangen 2013). Another important factor is when the perceived leadership of a collaboration group has influence over the community which the group intends to lead (Mattessich et al., 2001) (Huxham & Vangen 2013).

Membership
Membership addresses the factors that focus on the variety of skills, knowledge, opinions and judgments of the individuals that are involved in collaboration (Mattessich et al., 2001). There is much importance to be placed on the inclusion of members from different organization’s departments who may be impacted by the activities of the relevant collaboration. Thus, the identification and selection of key people should be done carefully. To avoid situations such as conflicts that arise because of the lack of understanding, it is important that structures are put in place to allow for basic interaction, building of trust and sharing of knowledge (Huxham & Vangen 2013).

Process/Structure
Process/structure includes the factors that focus on the process used when collaborating and the structure, including the size, of the organization in which collaboration takes place (Helmstetter, Mattessich, Hamberg, & Hartzler, 2017) (Mattessich et al., 2001). The fact that members share a stake in both process and outcomes is essential for the provision of ownership fulfillment of both collaborative work and result to the members of the collaboration group. This factor results in the continuous commitment and motivation essential for work done effectively. Multiple layers of decision making focuses on ensuring that, in collaboration, all levels of the organization take part in the process of decision making. Finally, the extent by which a collaboration group improves its flexibility in regard to structure and methods can ensure better thinking and behavior as than has been imposed by norms.

Communication
Communication addresses the variety of channels that are used in collaboration to discuss, share ideas and knowledge. Effective communication is known to be one of the basic necessities for successful collaboration (Keast, 2016). Additionally, channels of communication can also be used in for solving conflict in an open manner; encouraging trust and healthy relationships amongst the members collaborating. Both informal and formal communication links should be available to create strong personal relationships between members of collaboration.

Online Social Networks
Online social networks are popular tools to enable individuals to communicate with a wide set of people. Ellison (2007) defines an online social network as a multidimensional construct that enables people to build a profile, define their list of contacts within a system, and to form relationships with those contacts. An online social network is based on two parameters namely nodes and links where nodes represent individuals or organizations and the links represent the different types of relationships or interdependencies between nodes. Over the past years, interesting new features have been introduced to encourage and support different types of communication patterns. The ability to communicate directly with either a set of people with a common social connection such as family or friends, or with those
interested in a topic such as software development is a promising way to support the social and other needs of people. For example, one can build sub-groups for specific purposes (Kairam, Brzozowski, Huffaker, & Chi 2012) and solicit help or information from the group members (Evans, Kairam, & Pirolli 2010). These features are defined as “lists” or “groups” in Facebook or “circles” in Google+ (plus.google.com).

One of the main challenges of using online social network sites for ad hoc collaboration is the management of relationship context. The creation of semantically meaningful groups may not be adequate for users’ collaboration needs as it was found that people define contexts such as family, high school friends, and co-workers, which still did not meet their content sharing needs (Jones & O’Neill, 2010). A user’s friends on Facebook may be composed of hundreds of acquaintances and even strangers making it difficult to determine the reach of their information, leading to accidental disclosures and embarrassment (Watson, Besmer & Lipford, 2012). In this regard, Google+ introduces circles, a mechanism that enables users to group friends and use these groups to control their social network feeds and posts.

**Enterprise Social Networks**

An enterprise social network is a private online social network that is implemented with the sole purpose of promoting collaboration across an organization or corporation (Li et al., 2015) (Ellison et al., 2015). Such a social network can be viewed as an important asset of an organization. This is especially true in circumstances where the organization’s staff is geographically dispersed or the organization is going through a crisis where communication becomes vital (DiMicco et al., 2009). Enterprise social networks differ from the popular social networks such as Facebook, Twitter, and LinkedIn, which are open and available for use by the general public. Enterprise social networks have their advantages and disadvantages, as discussed next.

Advantages of enterprise social networks are that employees can start discussions without needing to follow formal communication processes (Li et al., 2015). Informal communication yields more effective collaboration amongst knowledge workers because it enables spontaneous collaboration (Awolusi 2012). The use of enterprise social networks supports the sharing of knowledge and skills amongst employees in an effective manner thus employees are able to learn from each other (Yumus et al., 2012). Enterprise social networks provide an effective platform for individuals within an organization to connect and form relationships (DiMicco et al., 2009) to improve the trust amongst individuals and ensure a level of harmony. Geographically dispersed individuals are able to connect despite their location within the world (Ellison et al., 2015). On the negative side, the use of enterprise social network can be considered disruptive (Li et al., 2015). Some employees excessively make use of the enterprise social networks to waste time on unrelated work (Awolusi 2012). The implementation of enterprise social networks can become costly especially through the third party (Awolusi 2012). Faster bandwidth resources can also become costly to maintain because of enterprise social network media features such as video conferences (Li et al., 2015).

In the current collaborative economy, independent workers wish to find virtual or other work and managers of companies such as startups need to quickly hire on-demand or temporary staff (Owyang, Tran & Silva, 2013). Central to the development of an integrated collaboration tool are social network features because they could provide the ideal platform for an open collaborative social network where employers can find workers with the right set of skills.
Social networks and social media technologies

Advances in social networks and social media technologies are changing the manner in which ad hoc collaboration can be managed by improving how teams connect and communicate. Instant access to a broader audience can be provided than was previously possible with conventional means. The manager of a startup company can quickly and cheaply mobilize a team of people using the cloud and open source software tools. Meetings can be held regularly using video and other technologies. There is a very large variety of tools that can be used for collaboration. Consider the following set of categories which is by no means complete.

- **File sharing**: Dropbox, Google Drive, Fileshare, SkyDrive, iCloud
- **Online editing of documents**: Word, Google Docs, iCloud, SkyDrive
- **Instant messaging**: Skype, Office Communicator, Google Hangout, Whatsapp
- **Social networking**: Facebook, LinkedIn, Twitter, Yammer, Google+
- **Video collaboration**: Collaborate.io, Teamviewer
- **Email**: Outlook, Gmail
- **Scheduling**: Doodle, Google calendar
- **Project management**: Trello, Evernote, Shotgun, JIRA, tgaant, Wunderlist, Teambox

There are thus a large variety of tools that can be used that may be difficult to keep track of. The manager of a startup in charge of a software development project would minimally need to find suitable collaborators who are skilled and can be trusted to perform their work, assign tasks to them and track the progression of tasks, communicate using a variety of means, and share documents. Ideally, these functionalities should be available within a single tool, which currently is not supported by freely available collaboration tools.

**Google+**

Google launched Google+ (plus.google.com) in 2011 with the objective of competing with other major players in the online social network environment. An important aspect of Google+ is that it acts as a social layer across all of Google's services. Google+ users are found across all regions of the world, and are a more educated audience such as college students or IT professionals (Schiöberg, Schneider, Schmid, Uhlig & Feldmann, 2012). Google+ assigns a numerical user ID consisting of 21 digits and a profile to each user. A profile contains personal and/or professional information, such as employment, education, relationship status, or gender. If enabled, the GPS coordinates of the places entered by the user can be recorded. As in Facebook, communication between friends is supported. Similar to Twitter, relationships are unidirectional as a user can follow another and view their public posts without requiring the relationship to be reciprocated. Google+ circles provide a highly visible and integrated group-based sharing mechanism across various Google products and services. A circle is a named list of users consisting of existing or recommended contacts (Kairam et al., 2012). Even though Google+ provides a default set of circles such as Friends, Family, and Acquaintances, users can easily create their own or rename existing circles. Users are notified if they are added to others' circles and have the option to add them back or not. A circle indicates who the user can send posts to and is used to both alter incoming streams and to target outgoing posts.
Google applications
Google+ can build upon a large user base from user making use of Google apps. Google apps are cloud-based offerings that can enrich collaboration (Kurelović, Rako & Tomljanović, 2013). There is a wealth of productivity tools such as Gmail, Google Calendar, Google Classroom, Google Docs, Google Drive, Google Sheets, Google Sites, Google Slides, and Google Vaults. In practice, Google apps have become the most widely employed cloud-based productively suite to ideally provide a foundation for the collaboration tool proposed by this research.

This research aims to apply features of collaboration, online social networks, enterprise social networks and advances in social network technologies and social media to environments where skilled job seekers form social groups in order to sell their skills to others. Next, a set of requirements are identified that need to be addressed when performing ad hoc collaboration that is supported by advances in social networks.

REQUIREMENTS FOR COLLABORATION USING SOCIAL NETWORKS
Previously, most of the successfully accomplished collaborations involved a specific process in a specific time by certain collaboration members (Sun et al., 2015). The members of collaboration as well as the time for collaboration were strictly defined. Today, the widespread use of smart phones and open source, cloud-based tools for collaboration within the social networking realm has become a reality (Awolusi 2012). Collaboration between people can now take place anywhere at any time. An important constraint of enterprise social network tools is cost, which can be prohibitively high for medium to small organizations. Tools such as LinkedIn that may possibly be used as the foundation for enterprise social network tools, do not support open APIs (Application Programming Interfaces) by which data can be accessed for integration and computational purposes. As described, social networking tools such Google+ may be a better choice. By using an open collaboration platform, employers and workers can find each other and proceed to collaborate on projects. Even though the use of cloud tools, smartphones and social networking makes such collaboration more flexible and inexpensive, there are several problems that emerge as a result.

Based on a critical analysis of literature, current technologies and the problem scenario, the following four requirements are identified and discussed in more depth.

Suitable collaborators need to be found successfully
Previously it was highlighted that membership is a factor that influences success in collaboration. A requirement for a successful solution using new technologies is that the identification and selection of members that have the best suited skills for collaboration should be carefully done. Current social network platforms such as Facebook cannot assist to find suitable collaborators as they may be unknown to a user (Sun et al., 2015). The user is expected to conduct his or her background research in an attempt to find the people suitable for the intended collaboration (Awolusi 2012). It would be important to identify potential collaborators based on their skill or role within or out of the organization.

The process of collaboration needs to be appropriate
When attempting to find suitable collaborators, another problem that emerges is how to identify appropriate processes to use, contacts to communicate with, and relevant collaborators (Sun et al., 2015). Considering the numerous social networking platforms and other relevant communication
channels that are available for contact, choosing the most appropriate platform is a challenging decision (DiMicco et al., 2009).

The best suitable times need to be selected for meetings
The third problem emerges is how to identify suitable times to schedule physical meetings for all members or how to schedule online meetings through synchronous communication channels (DiMicco et al., 2009). Members of a collaboration may be employed in different departments or even different organizations. As a result, their daily schedule may have significant differences.

The implementation needs to be cost effective
The cost to develop a custom-built collaboration application varies greatly depending on the software company doing the development, the complexity and variety of functionality that will be implement in the product, as well as on the comprehensiveness of the design. The cost of purchasing a ready-made product may also be very prohibitive. To be more cost effective, the use of current cloud-based tools and applications can bring down the cost substantially.

RESEARCH METHODOLOGY
The research approach used is the design science approach (Holmström, Ketokivi, & Hameri, 2009). This approach involves the building of an artefact to solve a problem situation, and then evaluating the artefact. Design refers to the creation of a new artefact that did not exist before (Vaishnavi & Kuechler, 2004). Since new knowledge is required to create the artefact, it can be considered innovative. Such an innovative design can fill knowledge gaps and may result in new research contributions.

Design science involves the identification of a problem and motivation for the research, identified objectives for the solution, a created artefact to solve the problem, artefact evaluation with performance measures, and finally a conclusion presented with results (Vaishnavi & Kuechler, 2004). In design science research, evaluation is concerned with examining DSR outputs, including design artifacts (Gregor & Jones, 2007). An important goal of evaluation is to determine how well a designed artefact achieves its expected purpose. Another key goal is the substantiation of design theory in terms of the quality of the knowledge outcomes (Baskerville et al, 2007; Vaishnavi & Kuechler, 2012) by providing evidence that the theory that leads to the artefact that will be useful for solving some problem or making some improvement.

These steps were applied by firstly identifying that a need exists for a tool to support ad hoc collaborations. A review of literature identified features of collaboration to be considered. Advances in social network technologies were described that could support such features. Finally, a set of four requirements were identified that the proposed artefact should comply to. Next, the Collaboration Circles social network application, the proposed artefact, is introduced, that aims to address the set of identified requirements. Thereafter, the artefact is evaluated and results presented. The artefact is evaluated to ensure that it achieves its goal by evaluating it against the set of identified requirements namely: suitable collaborators need to be found successfully; the process of collaboration needs to be appropriate; the best suitable times need to be selected for meetings and the implementation needs to be cost effective.
COLLABORATION CIRCLES APPLICATION
The Collaboration Circles application is introduced by discussing the architectural design of the proposed application as well as the technologies chosen for implementation.

Architecture and implementation
The architecture of the Collaboration Circles application is shown below in Figure 1. The Collaboration Circles application consist of both a mobile client and web service implementation. A collaborator interacts with other collaborators using the Collaboration Circles application installed on his Android mobile device, shown to the left of Figure 1. In its turn, the Collaboration Circles application interacts with Google apps such as Google+ and Google calendar (www.google.com/calendar) via REST (REpresentational State Transfer) (Fielding 2000) calls to source information.

Google+ is used to source profile information and Google calendar to access schedule information of any relevant collaborator. The retrieval of this information is made possible through integrated Google login functionality in the Collaboration circles application. The Collaboration Circles application is managed using the Collaboration Circle service shown at the bottom of Figure 1 via REST calls. This service securely administers the data of the Collaboration circles application such as users, tasks, schedules and other activities. Google+ thus provides the essential user profile and contact information, whereas the Collaboration Circle service supports all further collaboration features.

![Figure 1. Architectural design](image)

Android is chosen as the platform because it is open source and very popular (Gandhewar et al., 2010) (Lomas 2015). Android is defined as a “stack of software” which includes an operating system, middleware and key application software (Speckmann 2008). Google tools used in the implementation of the Collaboration Circle Android application include Google+ and Google calendar that are both available through an API (Application Programming Interface). Google calendar is an application that
can be used time-management using personal and public calendars. A variety of other Google apps may be incorporated into the application.

**Collaboration Circles operation**

The Collaboration Circles application supports a number of features such as creating users, creating collaboration circles and inviting members to circles, creating and assigning tasks, and setting meeting times. Any user wishing to find part-time work in software development can make use of the application to assist them in this regard. Each of these features are discussed next.

**Create collaborator**

A potential collaborator downloads the Collaboration Circles application to create an account by logging in with their Google+ account, as it is assumed that all Android users have a current Google account. The Collaboration circles application retrieves Google+ profile information and creates a new user profile to be stored on the Collaboration Circle service. The profile information retrieved from the user’s Google+ account include their full name, gender, locations, skills, birthdate, email address, occupation and the organization in which they may be employed. When a user registers, he/she needs to select the skills that he/she wants to be identified with in the Collaboration circles application. The user selects from a carefully selected set of skills. For example, a user who is skilled in programming will be asked to select from large numbers of skills belonging to this field. The Collaboration circles application aims to be comprehensive to ensure that every potential skill is included as to minimize the need to define custom skills. Any future Google+ profile information changes will be synchronized to the user profile stored in the Collaboration Circle service storage.

**Create collaboration circles**

After logging in, a user can create a circle by specifying the name such as “Mobile Program Project” and a description, shown in the middle of Figure 2. The collaboration circle is stored on the Collaboration Circle service and is linked to the user via their user id. The user id links a user to all circles that they are part of, including those created by others. Next, a user invites other collaborators to the circle or can search for suitable in other circles. Invitation requests are shown to the right of Figure 2.

![Figure 2. Collaboration Circles application screenshots](image-url)
Finding suitable collaborators

A user interface, shown on the left of Figure 3, enables a user to search for the most suitable collaborators to add to the circle based on their skill set, as shown in the middle of Figure 3. The Collaboration Circle service stores user profiles and their skill sets which can be searched. The user is given the option of limiting the search to those in their organization, location or occupation. A search request is sent to the Collaboration Circle service to find suitable collaborators. The Collaboration Circle service employs an efficient algorithm that makes use of a priority queue data structure to find the closest matching candidates according to the request at hand. The algorithm takes a weighted assignment approach where every profile in the Collaboration circles application is assigned specific weighted score points for each of the relevant matching criteria. The criteria include four attributes—occupation, organization, location and skill. The algorithm processes all candidates as follows:

- A candidate with a matching skill is assigned 10 weight score points as such a candidate would be the most suitable collaborator.
- A candidate with a matching occupation to that of the owner of the circle is assigned 4 weight score points. If the candidate’s current organization matches that of the request, 2 more weight score points are assigned. This can ensure that collaborators in the same organizations are able to create an environment to influence success in the organization.
- A candidate that shares one or more collaboration circles with the requestor is assigned 3 weight score points. As literature has identified that trust is an essential aspect of collaboration, members that have previously collaborated have a level of trust or mistrust in each other compared to those who are strangers.

The set of weighted candidate objects that result from the above process are now inserted into a priority queue data structure. The weight of the candidate (key) and the candidate’s user id (value) form key-value pairs which are input into the priority queue. Using the priority queue data structure, the most matching (suitable) candidates (those with the highest weight score points) are identified in a quick and efficient manner. Next, the Collaboration Circle service responds to the search request with a list of suitable collaborators. From this list, the user can select potential collaborators. Before selection they can view candidate collaborator profiles to further get more information about them. For example, the trust level of the candidate collaborator indicates their reputation and performance over time. After selecting potential collaborators for a circle, invitations are sent to them. Potential collaborators receive these invitations and are able to view information regarding the collaboration circle that they are invited to and the inviter’s profile information. They can either accept the invitation to join the circle that they are invited to or decline the invitation. Notifications are sent to all participants to serve as reminders, keep awareness and maintain commitment. Information regarding the invitation, invitation status and notifications are stored in the Collaboration Circle service from where collaborators are able to retrieve the information upon attempts to access, view, accept or decline invitations.
Process of collaboration
After the formation of a collaboration circle, members of a circle view each other’s profile information and can send messages to each other. Synchronous communication is used as it ensures that circle members can see if others are online and have received their messages in real time. If a member wants to leave a circle he/she requests the circle owner to remove them. The main function of a circle is to provide features for tasks administration and scheduling. Tasks can be created by any collaborator within a collaboration circle by specifying the details of the task such as task title, description and the due date as shown on the right of Figure 3. The collaborator can assign a task to a specific collaborator in the collaboration circle or any other know collaborator in the system. The assigned collaborator accepts or rejects the task assignment. In the case where a task is accepted, the application sets a reminder on the smartphone’s calendar of both the requesting and accepting collaborators. Collaborator can select a specific task to get more details about the task such as the title, description of task’s activities, the username of the user that created the task, the name of the collaboration circle the task was assigned and the due date of the task. Tasks are shown in different colors where tasks that are due soon (i.e. in 3 days) are colored in red and tasks that are due between 5 days and 10 days are colored in orange to support a collaborator to focus on completing tasks at the right time and avoid late delivery of work. Upon completion of a task, a collaborator returns the task to the requesting collaborator for review. The requesting collaborator reviews and rates the completion of the task based on how satisfied he/she is using a 0 to 10 rating scroll bar. The ratings submitted, including those from other collaboration circles, are used to calculate the average rating of a collaborator. This average rating forms part of the user’s profile as their reputation and it plays a role when a potential collaborator decides who may be the best to collaborate with. The features of tasks support the importance of the maintenance of process and structure and ensures tasks ownership and responsibility.

Finding the suitable time for collaboration
The collaboration circle provides a feature to find the best suitable schedule for a meeting of all participants. The title, description and preferred date of a schedule is specified. For a specific date, many time intervals can be selected e.g. from 6am until 10pm every 30 minutes. Notifications about the schedule request are sent to all invited collaborators in a collaboration circle for which the schedule
request was created. Each collaborator is expected to select his/her preferred time intervals for the specified schedule. The Collaboration Circle service keeps track of collaborators that have not provided reacted on the schedule request and send appropriate notifications. A matrix of Boolean values is computed where each row of the matrix represents a collaborator and each column of the matrix represents the time interval, represented as a two-dimensional array. The Collaboration circles application computes the most suitable meeting time by reviewing columns with the highest number of “1” in its rows. The results are then sent to each collaborator for approval and a reminder is set on the mobile device of each collaborator that approved the schedule. The meeting is also inserted in the collaborator’s Google calendar.

**Evaluation**

To demonstrate the efficacy of the artifact to solve the problem, an evaluation was conducted to assess the effectiveness of the Collaboration Circle application. Following the design science research approach, the aim of the evaluation was to determine is the artefact met with its expected purpose, as was articulated by the set of four requirements. Five potential collaborators registered and their Google+ account profile information identified was retrieved and stored by the Collaboration Circle service. Three of the potential collaborators worked in the same organization while the other two worked in different organizations. The potential collaborators had to select their skills to be identified with in the application. Potential collaborators were asked to test the features of the Collaboration circles application. The results of the experiment are discussed below.

The five potential collaborators had to search for others to collaborate with. Lindani had not joined any circle and was employed in a different organization to the others. When choosing a skill that one of the others possessed, he was able to access suitable collaborators, but no collaborators were found within his organization. The searches of Oluwabamigde, who with two others are employed at the same organization, gave more interesting results. When Oluwabamigde conducted a search for a skill that none of the four others had, no results were found. When he limited the search to his organization, two collaborators were found that had some similarities with him. The remaining three collaborators, Themba, Nomkhuleko and Carrington, were grouped into collaboration circles. Themba and Nomkhuleko shared a circle called Mobile development while Themba and Carrington shared a circle called NeuroHack. When Themba searched for suitable collaborators, the results included Nomkhuleko and Carrington as Nomkhuleko and Carrington share similar circles with Themba.

A 100 percent success rate is achieved where collaborators with matching skill are found, and who share a circle and an employer with the requesting user. These are the most suitable collaborators. The next best success rate was possible if matching skill attributes were found. Weaker matches were based on aspects such as the trust between potential collaborators because of the shared membership of circles, employment in the same organization, or both.

The five collaborators used in the experiment where invited to join one collaboration circle called Mobile development. Themba, one of the collaborators, created a new schedule, shown in Table 1, to facilitate for meeting with the other collaborators. Themba chose the three intervals 2, 7 and 13 including 7AM till 7:30AM, 10AM till 10:30AM and 1PM till 1:30PM. The notifications were sent to the other four collaborators. The schedule algorithm returned schedule time interval 7 (i.e. 10AM till 10:30AM) as the most popular time for all collaborators. Oluwabamigbe and Nomkhuleko could not approve this time interval and could not attend the specified meeting at the time resulted from the
schedule functionality. A second round with new times could rectify this problem so that every collaborator would be able to attend the meeting.

<table>
<thead>
<tr>
<th>User</th>
<th>Selected time intervals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Themba</td>
<td>2, 7 &amp; 13</td>
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<tr>
<td>Lindani</td>
<td>7, 9 &amp; 10</td>
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<tr>
<td>Oluwabamigbe</td>
<td>1, 4 &amp; 5</td>
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<tr>
<td>Nomkhuleko</td>
<td>2, 8 &amp; 11</td>
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<td>Carrington</td>
<td>1, 5 &amp; 7</td>
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Table 1. Preferred schedule intervals by each collaborator

All participants reported that the mobile application was user-friendly and easy to use. The fact that it was deployed on a mobile phone made the application very accessible. Due to the free cloud-based components that were the main features of the application, the implementation is very cost effective. Each of the four requirements are now revisited.

**Suitable collaborators need to be found successfully**

Participants indicated that they found the application very useful in this regard. The most important factors related to a person’s expertise level, competence and physical proximity is addressed. It is well known that people prefer to contact those who are physically or organizationally close and that is confirmed by the results presented here. The search facility allows one to search for a specific set of skills. From a list of potential candidates, a choice can be made that enables more research on a potential candidate to determine their suitability and trust. If one should not want to choose a particular candidate, it is not necessary as the other party would not be aware they were selected. The manner in which choices were made fostered trust, as more preference is given to those closer in your circle. Notifications ensured that all participants were always kept informed.

**The process of collaboration needs to be appropriate**

Participants were positive about how the tool ensure that teams can be created very quickly, tasks can be created, assigned and scheduled, and progress can be tracked to ensure that the project runs smoothly. Discussions can be effectively performed and turned into action quickly, very often not requiring unnecessary meetings. No matter where team members were located, they were all kept synchronized with each other. The tool provided an excellent platform for communication and conversation to ensure that all members were informed. Positive comments were made about the immediacy of communication. Members within a circle could quickly provide assistance to each other.

**The best suitable times need to be selected for meetings**

Participants indicated that the scheduling of meetings worked well. A constrain was that they had to ensure that they populated their Google calendar with all meetings and events that they had to attend. As meetings could take place in the real world or could be performed virtually using tools, the scheduling was found to be successful.
The implementation needs to be cost effective

Due to the fact that all Google apps and Google+ is freely available, the cost implications were limited. The Collaboration Circles application can be provided to startup companies at a very low cost when compared to enterprise tools.

From the results of the evaluation, the artefact met its expected purpose and the set of requirements were thus sufficiently satisfied.

CONCLUSION

This paper proposed a new approach to facilitate collaboration using free social networking tools, smartphone devices and a Collaboration Circle service. Key problems were identified when people attempted to make use of current social networks for collaboration. In situations where collaborators, time and processes used for collaboration were unknown prior to collaboration taking place, many challenges came up. Four requirements were identified to be addressed when collaborators need to find others, not necessarily within the same organization, to assist them to complete tasks.

A social network application called Collaboration Circles was implemented over the Android platform to evaluate if the identified requirements were met. Android was chosen to be the mobile platform of choice because of its effortless support of Google tools as well as its market size and features. A Collaboration Circle service was implemented to store the data and enable additional functionalities. Compared to current social network platforms such as Facebook and Twitter, the Collaboration Circle application includes features to support real-world ad-hoc collaborations such as finding the suitable collaborators based on skill, scheduling meetings, and enabling the assignment of tasks to members in circles.

Future work aims to address many improvements. More potential collaborators can be found if all skills that the user may have enlisted on his Google+ account are used. Using data analytics other skills of collaborators could be identified from his/her actions within the Collaboration circles application. The collaborator’s messages in the circles could be used to further understand the collaborator and his/her capabilities in an effortless manner. The trust rating of the user, currently displayed only in the user profile, can also be considered in the algorithm that finds the best suited collaborators, as those with higher rating should be recommended higher than those who do not.

Collaborators may be recommended as suitable collaborators even though they do not have the skill requested. This is because weight score points are assigned to the collaborator when he/she shares the same circle with or is employed under the same organization with the requesting collaborator. These attributions should not be used in isolation with skills if accuracy is to be improved. In cases where the collaborators are employed in the same organization but have a different spelling of the organization name, the organization of the collaborator is treated as a different organization. Thus, common misspellings mistakes can hinder the process of finding suitable collaborators with specific organizations; using semantic analysis such mistakes can be counteracted. The relationships between collaborators that share collaboration circles can be extended further for the creation of communities leading to an increase level of trust.

The task features can be improved by supporting more granular tasks and enabling the sharing of tasks within the circle. Tasks should also support task progression using a task status option to enable better monitoring. The reviewing of tasks can include a text review that can be processed with sentiment analysis.
analysis. These extensions of tasks and their administration would enable more commitment and interest from the collaborators while ensuring inclusion.

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