

## Technology Transfer Alliance offerings from KTH

### Communication Systems Design Fall 2013 Projects



Serengeti Broadband Network node in the Nata Village, Serengeti District, Mara, Tanzania

## **KTH School of ICT 2013 fall semester project offerings in the Technology Transfer Alliance framework**

### ***Technology Transfer Alliance***

KTH is a member of Technology Transfer Alliance (TTA), a growing global partnership between universities supporting each other to increase their impact on society and make such impact part of ranking criteria used to evaluate universities. The approach to accomplish this includes providing opportunities for students and teachers to engage in relevant development projects facilitating problem-oriented, project-driven learning for academic credit [1]. Students from different member institutions can work together in joint projects while they earn their credit from their home institution.

### ***The KTH Communication Systems Design Course (CSD)***

One of the opportunities for students to participate in TTA activities offered at KTH is the Communication Systems Design course (CSD) [2]. The CSD course, and an associated coaching course is offered to students in the senior (second) year of several MSc programs. The coaching course is also offered to Ph.D. students. There are several offerings per year depending on the interest from students.

The CSD 2013 fall semester offering involves 41 senior year master students, four Ph.D. students, 5 teachers and three research engineers in seven project teams consisting of 5-6 students per team. The seven projects are described below.

The offering starts with the kick-off workshop in the week of 2 September 2013 and ends with the final workshop the week of 15 January 2014. There is a midterm workshop in the end of October.

### ***International cooperation***

Some of the projects this semester involve cooperation with students from other TTA member institutions, including Brunel University, Dar es Salaam Institute of Technology (DIT), Karlstad University and University of Lagos. The connections with these teams will be made on a per project basis.

### ***Dissemination of Achievements***

Extraordinary results from the projects this fall will be selected to be presented at the following high-light events. There are limited travel funds available for this purpose.

- EU ICT 2013 in Vilnius November 6-8 (<https://ec.europa.eu/digital-agenda/en/ict-2013>) where an exhibition booth has been reserved.
- 2nd EU/FP7 eIAfrica workshop in Kigali November 13-15
- AU/EU 50th partnership anniversary, Addis Ababa, December 2-6

The project descriptions follow below.

## **Project 1 Consolidation of Technology Transfer Alliance (TTA)**

### ***Background***

TTA is still in its infancy. So far, there is a dozen of member institutions in Africa, Europe, and Latin America that have signed, or are in the process of signing, a membership agreement. The agreement is a commitment to develop the academic framework necessary to offer problem-oriented, project-driven learning as part of the curriculum allowing students and staff to participate in development projects for academic credit. There are no financial obligations.

### ***Goals***

The goal of this project is the consolidation of TTA, including the two branches:

1. The Academic framework including pedagogical methods, learning material, coaching and examination methods.
2. The Project framework including a social network supporting the formation of multi-stakeholder partnerships, formulation of projects, soliciting funding, etc.

### ***Approach***

The approach to reach the goal includes liaison with the KTH working group producing guidelines for problem-based project-driven learning, and to develop the TTA web portal into an advanced Science Gateway in close cooperation with the TTA partner universities.

### ***Objectives***

1. Organisation of the 2013 Annual Meeting, including review of the by-laws, proposal for a strategic plan, nomination of candidates for the new board.
2. Establishment of the TTA Science Gateway with strong authentication and authorization based on Grid-technology (CA, IdP, IdF, etc) and content consisting of guidelines for both the academic and project frameworks, access to project websites, etc.
3. Organisation of the 2nd International TTA workshop in Tanzania spring 2014, including fund-raising proposals to STINT, Sida, SPIDER, WB, etc.

### ***Project owners and coaches***

The project owners include the TTA board and the KTH Vice Presidents for International relations and Industrial Contacts. The coaches include Björn Pehrson, Peter Sjödin

## Project 2. Community Health Portal

### **Background**

Karolinska Institutet (KI) and KTH have a long standing cooperation on ehealth applications in developing regions, focusing on areas like sentinel surveillance of diseases, rational drug management, remote consultation and continuing education of rural health-workers. The Community Health portal project is a joint project with Dar es Salaam Institute of Technology (DIT) and Muhumbili University of Health and Allied Sciences (MUHAS) in Dar es Salaam, Tanzania.

The target communities initially include communities in East African countries. A needs and requirement analysis is currently being conducted in Tanzania by two KTH media technology students as MSc thesis projects [].

### **Goals and Objectives**

A community health portal is to be established with entries for health workers, patients, selected relatives of patients and the general public. The purpose of the portal is to provide health and drug information, guidelines for how to act in different situations, decision support when there are alternative actions to consider, drug management support, a forum for discussion of health problems, health records, and communication channels facilitating contacting the health care system.. A specific focus should be on facilitating continuous education for rural health workers by supporting feedback from cases, even those referred up the referral chain.

Technically, the portal should be implemented as a Science Gateway Framework supporting strong authentication based on certificates, authorisation and third party records of accesses to sensitive resources. It should take advantage of an existing certification authority (CA) and if necessary create add new Identity Providers (IdP) to an existing Identity Federation (IdF).

### **Project Owners and Coaches**

include Jaran Eriksen and Lars Gustafsson, KI, Dennis Mazali, Muhas, Amos Nungu DIT, Erik Eliasson, KTH Project owner is a project board including researchers from KTH and KI in Sweden and DIT and MUHAS in Tanzania, Bjorn Pehrson, KTH



*HDVC session between KTH and Kigali Institute of Technology using the Minisip Open Source Software developed at KTH*

## **Project 3. Robust and optimized utilization of network resources in support of a video conferencing eHealth service**

### ***Background***

As the population in Europe is getting ever older, one way of handling associated cost in caring for the sick and elderly is to utilize Internet based ICT platforms. Acreo, Karolinska University Hospital and KTH have a long standing expertise in researching and prototyping ICT architectures and solutions for eHealth services and are using this expertise in support of developing and prototyping a platform that aims to be used in Karolinska's field-trials within eHealth, with video conferencing being an important application with high requirements on network services. [1,2,3] The eHealth service includes video conferencing, real time transfer of patient data from sensors and secure access to patient records. The service has high requirements on the quality of the Internet connection (e.g. latency, resilience, bitrate), and the service should not rely on the patient's home network.

### ***Goals and objectives***

To meet these requirements the platform will connect to the Internet via several interfaces, including both wireless (LTE/4G, wifi) and fixed Internet connections.

The goal is to develop a highly automated and remotely managed system that is based upon a robust network connection, a system that characterizes and monitors the connections, and then run the eHealth service on top of the most robust connection. The main task in the project is to evaluate and develop mechanisms that enable a robust connection through either a fail over mechanism or through utilizing multi-path techniques. Also, the platform should be very simple to set up at patients' premises. Furthermore the connection should be periodically characterized, and the use of a non service affecting quality monitoring function should be evaluated and possibly supported. The platform should demonstrate security based on a strong authentication and authorization mechanisms based on certificates identity federations developed for Science Gateways [4].

### ***Objectives***

- Literature study on network load balancing and multi-path techniques (e.g. MPTCP), 1+1 protection methods (e.g. BFD based fail-over, and BGP)
- network service quality characterization and monitoring (e.g. BART)
- End-to-end architecture development
- Hardware and Software platform Investigation (multi-path aggregation, quality characterization and monitoring, security)
- Platform development (SW/HW integration and automation)
- Visualization of characterization and monitoring of connection quality

### ***Prerequisite requirements***

Linux, Linux admin, IP/Ethernet/radio networking, programming (C, C++, scripting)

### ***Project owners and coaches***

The project owners include Markus Hidell and Peter Sjödin @ KTH/ICT/COS Network Systems Lab

. Claus Popp Larsen @ Acreo, Kicki Groth and Jonathan Björkehag, @ Karolinska University Hospital. Main coaches: Roland Elverljung roland.elverljung@acreo.se>, Voravit Tanyingyong <voravit@kth.se>

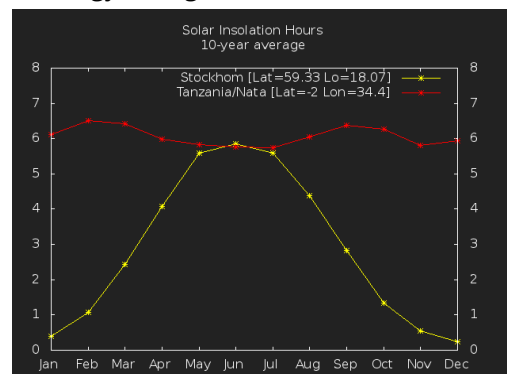
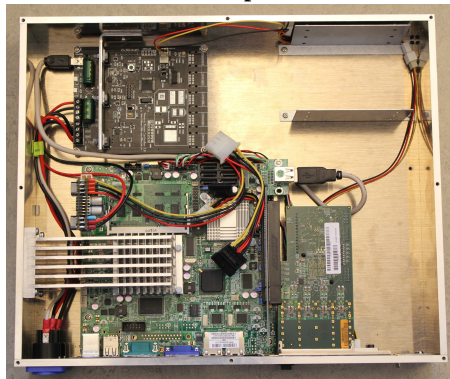
Co-coaches: Erik Eliasson <ere@kth.se>, Anders Gavler <anders.gavler@acreo.se>

## Project 4. Extension of the Serengeti Broadband Network

### Background

Tanzania Commission of Science and Technology (Costech), Dar es Salaam Institute of Technology (DIT) and KTH have cooperated about a decade on the development of a strategy for the Establishment of Sustainable Broadband Markets in Rural Areas [1]. Besides a number of research papers and prototypes, the outcome include a Ph.D. thesis [2] and degree as well as some 15 MSc degrees awarded Tanzanian students.

The main technical challenge is power supply. The solution is as power-lean designs as possible and use of solar power and innovative energy storage.



Left: router with off-the-shelf hardware and open source software routing ~700kpps at 20W  
Right: Insolation in Tanzania and in Stockholm making the case for solar energy in Africa

### Goals and Objectives

The overarching goal is to consolidate and extend of the Serengeti Broadband network to several sites in the African Great Lakes region.

The primary goal is to provide power supply to the wireless backbone nodes to be deployed by Fraunhofer Focus Institute and to extend the Network Operations Centre at DIT to include both the existing and the extended set of network elements and links. Secondary goals include the design of more power-lean routers in the SBN fibre network and to support the establishment of nodes in other member states of the East African Community, primarily Rwanda, Uganda and Kenya.

The objectives include

- Design of power supply for the new wireless SBN nodes to connect UNFDP Agriculture Information Resource Centres (AIRC) in Kibara and Kisorya
- Planning the connection of the AIRCs in Bunda and Mugeta by optical fibre.
- Renumbering of SBN using TERNET addresses, including both the existing network Bunda, Nata, Mugumu, and the wireless extension Bunda Kibara-Kisorya, NATed until directly connected to TERNET (a /24 or /23 network out of ASN 37182 ipv4 41.93.0.0/17)
- Extension and consolidate the NOCs in Bunda, at DIT and KTH including the new nodes.
- Study of how to reduce the power consumption of the existing fiber backbone nodes from max 20W to max 5W.

### Project owners and coaches

Project owner is a board with representatives from the pilot sites.

Coaches: Daniel Turull, Robert Olsson, Amos Nungu, Bjorn Pehrson,

## **Project 5. Environment Monitoring, from Wireless Sensor networks to data sets available via a Science Gateway**

### ***Background***

KTH has been working in the area of wireless sensor networks for several years. The main scenario studied is on environment monitoring, including synoptic weather observations, agricultural and hydrological parameters. On the hardware side, a sensor node is used based on the Atmel ATMega128RF circuit integrating an MCU, an 8 channel ADC and a ieee802.15.4 radio transceiver [1]. Studies have been made of what open source embedded operating system to use leading to the decision to use Contiki [2]. Currently a broadcasting mode is used in which the nodes normally is in deep sleep to save power, wake up at scheduled intervals to transmit data and goes back to deep sleep. A sink node is used that is always awake and connected to a gateway connected to an up-link to facilitate transmission of the raw data to a central repository.

In the case of environment monitoring a grid of observation stations are needed. Some of these stations necessarily end up at very remote locations, sometimes off all sort of grids, which makes upstream connections and power supply challenging. On the up-link side, studies have been made on using dedicated HF, VHF, and UHF packet radio links as upstream connections taking raw data from sensors to a central repository. On the power supply side, the use of alternative energy sources, solar and wind, and innovative energy storage based on ultra capacitors, have been made.

To make the raw data available for research, discussions have been held with users refining environment data into information via different sorts of analyses, including meteorologists making weather forecasts, hydrologists, etc, about what format they would like to see the raw data repackaged in. Our conclusion is that we should start using the Netcdf format [].

### ***Goals and Objectives***

The goal of this project is to demonstrate how to take raw environment data from sensors to a central repository, repackage it in the NetCDF standard format and make it available to users interested in analysing them via a Science gateway while protecting its integrity.

The Objectives include to design, implement, deploy, demonstrate and evaluate pilots at sites in Stockholm and Tanzania. The Stockholm sites will include resources at KTH and Mill Hill (<http://sk0ux.se/>). The work break down structure should include three work packages

- Implementing a FOSS version of a wireless sensor network concept based on the Herjulf hardware and contiki-os [2] with the sink node connected to a Raspberry Pi as gateway
- Demonstrating upstream links based on VHF packet radio and Delay Tolerant Networking protocols facilitating transparent physical transport of data between nodes (DTN).
- Implementing a data transfer and conversion system taking raw data from sensors to NetCDF coded data posted on a Science Gateway available for users while protecting the integrity, authenticating users and checking their authorization.

### ***Project owners and coaches***

Project owner: Amos Nungu, DIT, Julianne Sansa-Otim. Makerere, Joachim Reuder, UiB

Coaches: Pehr Söderman, Robert Olsson, Bjorn Pehrson

## **Project 6. TV White Space and license exempt spectrum: Rural networking opportunities?-TVWS and GSM/GPRS test beds based on Ettus USRP hardware and GNUradio and OpenBTS open source software**

### **1. Introduction**

Although voice and data services are available in most urban and sub-urban areas, this is not the case in many rural areas, not having an already established infrastructure. The reason is often due to the large investments needed and all sorts of risks creating uncertainty in predictions of the profitability of the investments required making traditional operators hesitate to supply services meeting the demand in such areas. This situation is especially problematic in developing regions where the development divide is rapidly widening. This project aims at establishing demonstrator test beds for basic voice/data rate services and broadband back-haul networks using affordable hardware from off-the-shelf suppliers and free open source software.

### **2. Goals**

The goal of is to design, deploy and evaluate test-beds in the Stockholm area:

1. The primary goal involves Broadband Communication in TV White Space bands based on USRP hardware and the GNUradio software (802.22, TVWS, UHF bands)
2. The secondary goal is to Voice and low data rate communication based on USRP hardware and OpenBTS software (GSM/GPRS, 900MHz/1800MHz, license except bands)

Existing test beds:

- South Africa with Carlsson equipment (802.11af, TVWS), and a geo-location spectrum database developed by CSIR.
- Other??

KTH students will be responsible for the establishment of test beds in the Stockholm area. Depending on available human and financial resources KTH students and staff will also support development of test beds in:

- Lagos, Nigeria (coordinated by University of Lagos, Omo Oaiya)
- Serengeti Broadband Network, Tanzania (coordinated by DIT, Amos Nungu)
- Limpopo, South-Africa (coordinated by CSIR, Fisseha Mekuria)

Demonstration, including performance evaluation and comparisons, will be made for available test beds.

### **3. Approach**

Prototype link level designs will be based on the hardware N210 from Ettus research (<http://www.ettus.com>) with the corresponding radio daughter boards.

GNUradio (<http://gnuradio.org/redmine/projects/gnuradio/wiki>) to evaluate link technologies using TVWS (ieee802.11af and/or 802.22).

OpenBTS from Range Networks (<http://openbts.org>) will be used to evaluate GSM links in license exempt spectrum (1800MHz)

Depending on the resources available new radio daughterboards will be needed, and at least one additional N210 is needed. In case of lack of funding, the three already available nodes (including computers) will be shared between the OpenBTS and gnuradio based prototypes.

On the network level the prototype links will be integrated with PC Linux routers.

For performance evaluation on the network (IP) level, pktgen-based software will be used [1].



#### **4. Resources required**

##### **Stockholm test beds**

###### Human resources:

- 5-7 senior year master students supervised by Svante Signell, Jeong-Woo Choo, Robert Olsson, Björn Pehrson from KTH in cooperation with Fisseha Mekuria from CSIR, Marco Zennaro from ICTP and Omo Oaiya from University of Lagos.

###### Equipment:

- Three complete Ettus N210 nodes are available  
(<https://www.ettus.com/product/details/UN210-KIT>)
- One additional Ettus N210 node and 3-4 extra radio boards with wideband transceivers suitable for spectrum sensing need to be purchased
- Depending on the cell ranges to be achieved better antennas and perhaps low-noise amplifiers need to be purchased. For the TVWS test bed regular high-gain UHF antennas can be used.

Space: Adequate office and lab space is available at KTH

###### Equipment:

- 1 USRP N210 (eventually one more as a spare) (14180 SEK)
- 4 WBX 50MHz-2.2GHz TX/RX or 4 SBX 400MHz-24.4GHz (4000 SEK each) or 2 WBX/SBX +2RFX900/RFX1800 (2335 SEK each)

**Lagos test bed: TBD**

**Tanzania test bed: TBD**

**South Africa test bed: TBD.**



*Antenna farm at Mill Hill (sk0ux.se)*

## Project 7. Design of Micro-grid Controller Board

### **Introduction**

This IL2213 course project is related to both to KTH research on green networks and smart DC micro-grids facilitating sharing of investments in solar cells and batteries in local rural community setting. The research is motivated by our experiences from projects aiming at establishment of sustainable broadband networks and services in areas of rural Africa short of infrastructure, including power supply [1,2,3]

The project is also a continuation on earlier student course projects in this area that have included electronic design, network design and MCU programming and evaluation of MCU operating systems supporting Wireless sensor networking (WSN). The relevant projects include Minne, Minne2, Minne3, Minne4, Greenet and the MSc thesis reported in [4]. Documentation from these projects are available via [www.tslab.ssvl.kth.se/csd/projects](http://www.tslab.ssvl.kth.se/csd/projects) and some of them on request from the coaches.

The idea is to device a power management module integrated with the ICT infrastructure that can route electrical currents from sources such as solar cells, wind turbines, etc, between storage batteries and loads. Earlier hardware developments include a charge regulator and a power control module [3]. The most recent previous work was from a student team porting the standalone DCDC controller code [4] to Contiki OS enabling use of IP communication with the DCDC board [5]. Currently the IETF COAP protocol is used. Several boards can form a small a new DC grid energy system.

### **Goals and objectives**

The goal of the project is to design the 2nd generation of the micro-grid controller DC-DC board for Higher voltage/lower current and Higher AD sampling frequency and in the process also set up and document guidelines facilitating the subsequent use of methods, tool-chains for MCU prototype board design and implementation using SMD components and PCB design software

A new and enhanced design of DC-DC board fulfilling the following criteria:

- \* Higher switching frequency for smaller size and higher performance
- \* Higher voltages to deal with power equipment.
- \* Lower idle power consumption,
- \* Current sensor for DC-grid consumption
- \* Bug fixes, improved robustness.

It is required that the work uses open source tools enhancing the design environment that has been established in previous projects.

The deliverables include:

- 1) HW design/gEDA gschem, PCB design/gEDA pcb
- 2) Gerber files to be sent to PCB manufacturers in China or Estonia.
- 3) SMD prototype assembly/soldering at least three PCB prototypes by hand
- 4) SW modifications for new PCB. Standalone code and Contiki code
- 5) HW/SW testing and verification.

The deliverables include prototype systems, technical documentation, a final report and a presentation and demonstration.

### **Project Owners and coaches**

Markus Hidell <mahidell@kth.se>, Robert Olsson <roolss@kth.se>, Bjorn Pehrson <bpehrson@kth.se>, Voravit Tanyingyong <voravit@kth.se>, Zhonghai Lu <zhonghai@kth.se>

## References

- [1] Technology Transfer Alliance ttaportal.org
- [2] Proceedings from the 1st International TTA workshop, Dar es Salaam. Feb 2013
- [3] The EANOV and DOLPHIN proposals, January 2013
- [4] Sara Avén, Eva Olsson, MSc theses on the needs and requirements of a Health portal in Tanzania
- [5] <http://sgw.africa-grid.org/>
- [6] Roberto Barbera Making e-Infrastructures easy: the Science Gateway approach and the Science Gateway concept, webinar 2013
- [7] HDVIPER [www.hdviper.org](http://www.hdviper.org)
- [8] HIPERMED [www.hipermed.org](http://www.hipermed.org)
- [9] CARENET [www.carenet-se.se](http://www.carenet-se.se)
- [10] Tanzania ICT for Rural Development Programme, [www.ict4rd.ne.tz](http://www.ict4rd.ne.tz)
- [11] Amos Nungu, Towards the Establishment of Sustainable Broadband Markets in Under-Served Areas, Ph.D. thesis. <http://people.kth.se/~amnungu/publications.html>
- [12] A First Mile Initiative, report to the UN Broadband Commission June 2011  
The Herjulf wireless sensor node <http://www.herjulf.net/products/WSN/sensors/>
- [13] <http://www.unidata.ucar.edu/software/netcdf/>
- [14] Dimitrios Tsompanides, Design and implementation of a test bed for network hardware using Pktgen, MSc thesis KTH
- [15] Jorge Querol, MCU Controlled DC-DC Controlled Buck/Boost Converter for Supercapacitors. MSc thesis, KTH/NSLab, Aug 2012
- [16] <http://ttaportal.org/menu/projects/microgrid/csd-2012-fall/>