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Bilateral R&D Project (this document will be shared with potential Spanish companies)

Project Title

ESITIP Pre-proposal Submitted to the ITAC Collaborative Research Fund

By

Ahmed Khattab, Cairo University

Mohamed Khairy, Smartec Systems

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Egyptian Partners Contacts

Egyptian Academic Partner		**Egyptian Company**	
Date of Request:			
Academic Entity name:	Cairo University	**Egyptian Company name:**	Smartec-Systems
Contact person and title/ designation:	Ahmed Khattab Associate Professor	**Contact person and title/ designation:**	Mohamed Khairy, CEO
E-mail:	akhattab@ieee.org	**E-mail:**	mkhairy@smartec-group.com
Phone number:		**Phone number:**	
Mobile number:	+201006790933	**Mobile number:**	+201223777108
Website:	http://eece.cu.edu.eg/~akhattab/	**Website:**	Smartec-group.com

Proposal Information

Project overview *(Please give brief / to the point explanations. For more explanation on any point below, you may add a short paragraph as an annexure, with this document.)*	
Abstract *The Abstract is a one-page summary of the proposal. It may consist of three paragraphs. The first paragraph describes the general discipline the proposal falls under. The second paragraph explains the benefit of the proposal to the ICT industry. The third paragraph lists*	

the specific deliverables of the proposal plan and its duration. *The pre-proposal length should be 6-8 pages, which requires that applicants clearly identify what this research has to offer to the ICT industry and the outcome of the project if funded.*	
Proposal Area	**<u>Strategic Areas</u>**: Wireless and Cyber Security x Electronics and Embedded Systems for ICT Applications x ICT for Transportation x ICT for Health x ICT for Agriculture x ICT for Energy x **<u>Technology-Trend Areas</u>**: Mobile Applications and Computing x Data Analytics and Big Data x Internet of Things x
Technology Review *This part should report the evolution of the topic and the current state-of-the-art. Set-up the historical evolution of your category. Define recent trends that make your solution possible show the importance of the proposal topic and its relevance to the ICT industry. Explain why your technology is novel and innovative,*	

paying particular attention to the prior art.	
Gap Definition *This section clearly defines the gap in current solutions/products that the proposed research will fill in and the available opportunities if this gap is bridged.*	
Proof-of-Concept *A very important part of the pre-proposal is a clear description of the status quo of the current research of the Principle Investigator (PI), which serves as the starting point of the project. This section may be used to present relevant results from work published by the applicants, a patent owned by the applicants, or promising preliminary results of the proposed research or methodology.* *Details of the technical approaches adopted to obtain such results.*	The following is the academic partner's related expertise in the area of the proposal: 1) Related funded research • **Energy Harvesting Solution for Wireless Sensors in IoT Systems for Smart Environments** Funded by NTRA: August 2017 - August 2019 o ***Research Lead:*** Designing a complete IoT system powered via ambient RF energy harvesting for indoor ambience monitoring in museums and smart buildings. • **Integrated Monitoring System for Plant Disease Forecast** Funded by STDF: April 2015 - October 2017 o ***Co-PI:*** Interdisciplinary project to develop an integrated software/hardware platform to monitor different plant diseases, and realize an expert system to predict the outbreak of the diseases. • **The Web of Objects (WoO)** Funded by ITIDA: June 2012 - December 2014 o ***Co-PI:*** Multinational grant (25 industrial and academic partners from 5 countries situated on 4 continents) outlines a network and services infrastructure for the Internet of Things (IoT) independent of proprietary protocols.

- **4G++: Advanced Performance Boosting Techniques in 4th Generation Wireless Systems**

  Funded by NTRA: May 2012 - October 2013

  - ***Research Lead:*** Provide protocol design principles and guidelines that can be used by the beyond 4G wireless industry to boost the user experience.

2) Industry Experience

The PI was leading the R&D team of Axxcelera Egypt (a subsidary of Axxcelera Broadband Wireless). Axxcelera Egypt is a leading company in the area of embedded systems in the Egyptian market.

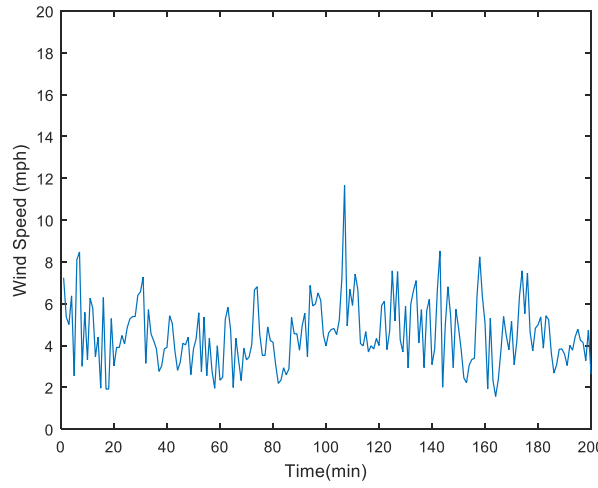
3) Related Networking Standardization and Implementation Experience

- **IETF Neighbor Discovery (ND) RFC 6775 implementation:** The PI led the first world-wide implementation and thorough performance evaluation of the RFC 6775 optimized Neighbor Discovery (ND) protocol. RFC 6775 was developed by the Internet Engineering Task Force (IETF) to standardize IPv6 neighbor discovery over Low power Wireless Personal Area Networks (6LoW- PAN). Such an optimized ND is implemented and integrated with the widely used Contiki OS.
- **IEEE 802.11n, 802.11s, 802.16, 802.20 Standardization Involvement:** Several research items of the PI have been discussed in the aforementioned IEEE standards including his US patent. Some of his work during the course of his study in the United State was funded by Intel and Cisco which were advocating his ideas in the standards' meetings.
- **Standardization of Cognitive Radio Networking:** As an expert in cognitive radio networking, the PI has several publications that target classifying the standardization efforts led by the different standardization bodies in this area.

Selected Related Publications:

	Internet of Things:
	[1] M. Hossam, M. Kamal, M. Moawad, M. Maher, M. Salah, Y. Abady, A. Hesham, A. Khattab, "PLANTAE: An IoT-Based Predictive Platform for Precision Agriculture," in Proc. of IEEE Japan-Africa Conference on Electronics, Communications and Computers (JAC-ECC), Alexandria, Egypt, December 2018.
	[2] S. Emara, A. Elewa, O. Wasil, K. Moustafa, N. AbdelKhalek, A. H. Soliman, H. Halawa, M. ElSalamouny, R. Daoud, H. Amer, A. Khattab, H. ElSayed, and T. Refaat, "Heterogeneous ITS Architecture for Manned and Unmanned Cars in Suburban Areas," in Proc. of IEEE International Conference on Emerging Technologies and Factory Automation (ETFA), Torino, Italy, September 2018.
	[3] G. Alsuhli, A. Khattab "An IoT Monitoring and Control Platform for Museum Content Conservation," in Proc. of IEEE International Conference on Computer and Applications (ICCA), Beirut, Lebanon, July 2018.
	[4] H. Ibrahim, N. Mostafa, H. Halawa, M. Elsalamouny, R. Daoud, H. Amer, A. Shaarawi, A. Khattab, and H. ElSayed, "A High Availability Networked Control System Architecture for Precision Agriculture," in Proc. of IEEE International Conference on Computer and Applications (ICCA), Beirut, Lebanon, July 2018.
	[5] A. Rashed, A. Ibrahim, A. Adel, B. Mourad, A. Hatem, M. Magdy, N. Elgaml, and A. Khattab, "Integrated IoT Medical Platform for Remote Healthcare and Assisted Living," in Proc. of IEEE Japan-Africa Conference on Electronics, Communications and Computers (JAC-ECC), Alexandria, Egypt, December 2017.
	[6] M. Seliem, K. Elsayed, and A. Khattab, "Optimized Neighbor Discovery for 6LoWPANs: Implementation and Performance Evaluation," Computer Communications, Elsevier, 112(C):73-92, November, 2017. (Impact Factor: 3.338)
	[7] M. Elgebali, M. Elbery, A. Mohamed, A. E. Shash, A. Abdel-Hamid, H. Sadek, H. Halawa, M. Elsalamouny, R. Daoud, H. Amer, H. Elsayed, and A. Khattab, "Enhanced Data Gathering for Fireghting Applications," in Proc. of IEEE International Conference on Smart Technologies (EUROCON), Ohrid, Macedonia, July 2017.
	[8] A. Khattab, A. Abdelgawad, K. Yelamarthi, "Design and Implementation of a Cloud-based IoT Scheme for Precision Agriculture," in Proc. of IEEE International Conference on Microelectronics (ICM), Cairo, Egypt,

	December 2016. [9] K. Yelamarthi, A. Abdelgawad, A. Khattab, “An Architectural Framework for Low-Power IoT Applications,” in Proc. of IEEE International Conference on Microelectronics (ICM), Cairo, Egypt, December 2016. [10] A. Abdelgawad, K. Yelamarthi, A. Khattab, “IoT-Based Health Monitoring System for Active and Assisted Living,” in Proc. of 2nd EAI International Conference on Smart Objects and Technologies for Social Good (GOODTECHS), Venice, Italy, November 2016. ***Security:*** [11] M. Mamdouh, M.A.I. Elrukhsi, A. Khattab “Securing the Internet of Things and Wireless Sensor Networks via Machine Learning: A Survey,” in Proc. of IEEE International Conference on Computer and Applications (ICCA), Beirut, Lebanon, July 2018. [12] A. Khattab, Z. Jeddi, E. Amini, and M. A. Bayoumi, “RFID Security: A Lightweight Paradigm,” Springer, 2017. [13] Z. Jeddi, A. Khattab, E. Amini, and M. A. Bayoumi, “Redundant Bit Security in RFIDs: Architecture Design and Security Performance Evaluation,” Journal of Circuits, Systems, and Computers (JCSC), 26(9):1750138, September 2017. Proof-of-Concept Results: **1 Precision Agriculture** In [1,8], we presented a cloud-based IoT architecture that is applicable in different precision agriculture applications. The proposed architecture is composed of only three layers of the architecture: a front-end layer that collects the environmental information and applies the needed agriculture actions; a gateway layer that connects the front-end layer to the Internet, and a back-end layer in which the data storage and processing take place. A prototype of the proposed architecture is built and tested to illustrate its performance as shown in Fig. 1.



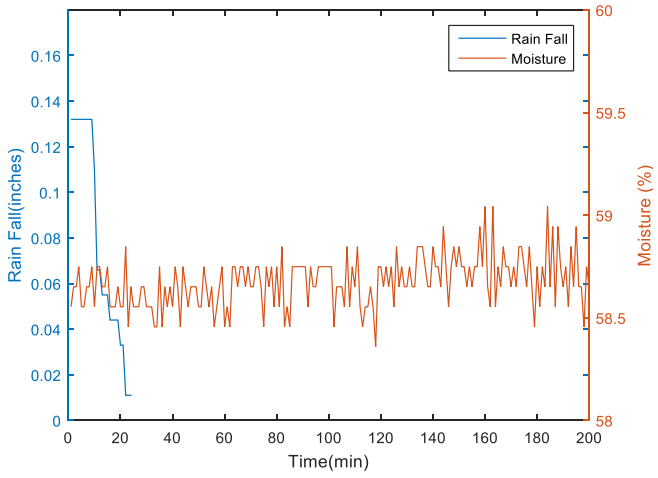


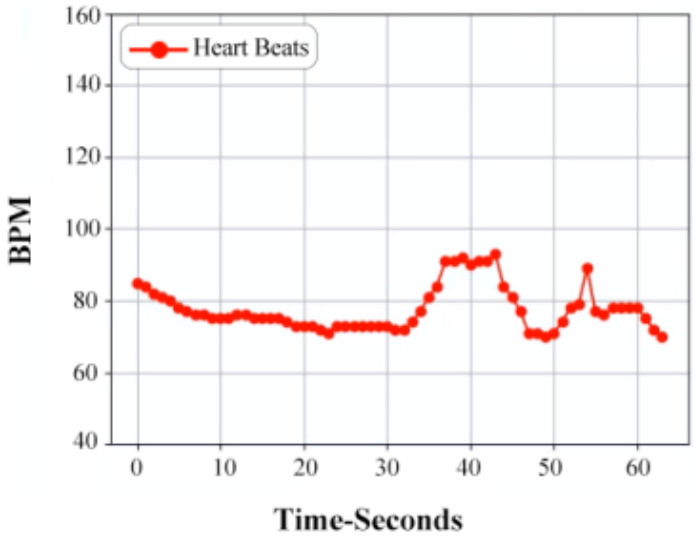
Fig. 1. Sample results of the IoT platform for precision agriculture.

Furthermore, we are currently in the final phases of building the first Egyptian IoT-based integrated monitoring system for plant disease forecast. Funded by an STDF demand-driven project (DDP 5992) and with the objective of taking a step forward in the national strategy of plant disease control and management, we developed the first integrated Egyptian Agro-weather station that is used to reduce crop losses due to airborne disease infections, while minimizing the chemical application use. This will have a great impact on increasing the agricultural production quality and quantity and will reduce the environmental pollution. Producing a high quality crop with no chemical residues will have a great economic impact as it will increase the economic value of the crop and may open new markets for the exporters. To achieve these goals, we designed, validated and implemented a first-of-its-kind Egyptian Agro-weather monitoring station and the software that models the different diseases affecting major crops in Egypt and suggest proper actions. This software is connected to a monitoring system allocated in farms to

predict airborne disease infections and suggest proper actions. This system implements the smart concepts of precision agriculture (PA) that recently gained global popularity to improve Egyptian Agricultural practices.

2 Healthcare and Assisted Living Applications

Ambient Assisted Living (AAL) is receiving significant attention due to its promise to uplift the healthcare sector in general, and to promote care for the frail and aging patients in particular. The Internet of Medical Things (IoMT) technology is a key facilitator for AAL. IoMT provides medical services that make smart hospital, doctors and patients interact in harmony leading to elevated healthcare levels. In [5,10], we develop an integrated medical platform for remote health monitoring. The proposed multi-layer architecture senses and collects information about the patient vitals alongside his/her surrounding environment. Then, it relays such information to a cloud for storage and data analysis where further actions are applied for a better end user experience. Such data is accessible to the patient's healthcare providers and remote family members through a mobile application. We built and tested a prototype of the proposed IoMT architecture to illustrate how it achieves the AAL goals.



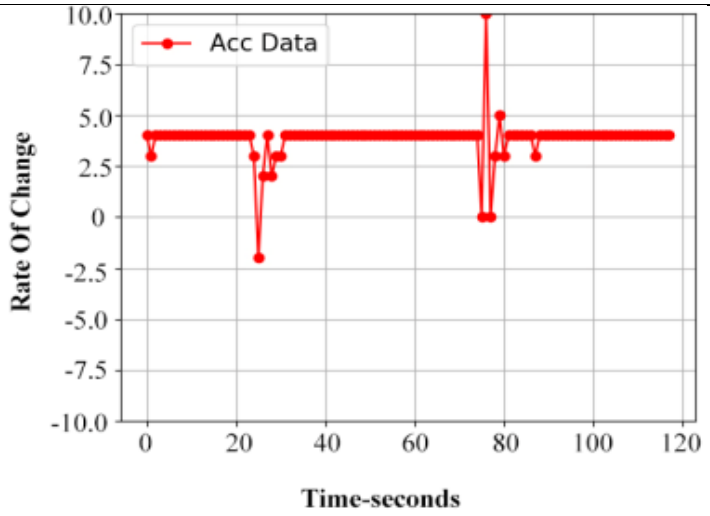


Fig. 2. Sample results of the IoT platform for assisted living.

We also proposed a portable and customizable IoT system that can be used to collect the data needed to facilitate the independent living of senior and challenged citizens to improve their quality of life. The system design philosophy targets having a low-power system that can be worn during the day and be turbo charged as necessary. The system is designed to be light and comfortable to wear. Furthermore, the system is implemented using low-cost components, which makes it an affordable system in [5, 10].

We are currently working of other individual IoT applications such as greenhouse automation, connected vehicles, water quality control and firefighting [7]. All of the aforementioned IoT systems are the building blocks of smart cities. Upon receiving this grant, we will work on facilitating the interoperation among them such that the backend cloud will operate independent of which specific IoT application is generating the data. Nevertheless, the cloud will be capable of optimizing the performance depending of the application using machine learning techniques.

Egyptian Company Profile

Your Company Profile *(Please give brief / to the point explanations. For more explanation on any point below, you may add a short paragraph as an annexure, with this document.)*	
Business Sector	• Software development • Embedded systems • IoT and Wireless Sensor Networks • Telecommunications
Company mission or core functions	Smartec has a mission to provide innovative products to satisfy its customers needs. Smartec has a solid team of qualified professionals who provide quality products in a timely manner. The composition of Smartec's team, with the SW, Telecomm, and HW engineers and project manager is highly experienced and with a good track record in product development.
Date of establishment	2008
Ownership (if public and traded, add stock exchange and ticker symbol)	Private ownership
Total number of employees	60
Number of employees in R&D	10
Key products sold or services provided	• Home Automation (SW, HW, mobile App) • TEMPO network optimization SW • IoT device • Several SW applications
Company core technical competences	• SW and HW development • Telecommunications • IoT • Consultancy • Machine learning • Big Data analytics
Key R&D programs and activities	• Telecommunications • IoT
Examples of accomplishments and clients	• Several operators in Egypt and world wide (Vodafone (Egypt, Ireland) , Etisalat, We, Glo (Nigeria))
Company strategic orientation	

Potential Spanish Partners

Partner of Interest *(Please provide a brief summary of the prospective partner company or organization. This summary may address some or all of the points below)*	
Profile of ideal technology partner	Industrial partner working in SW and/or HW development and/or Telecommunications
Core technological competencies and expertise	• Telecom operator • Technology smart solution providers • Embedded systems providers • Machine learning and AI solution providers
Other essential qualifications (e.g.: ownership, track records etc.)	Proven record in business development and large customer base
A list of possible beneficiary governmental agencies can be listed, explaining how they will benefit from the project output.	
If you have a list of companies with whom you are in contact or interested in contacting, please provide contact details	
Please explain in details the reasons behind the need to have a Spanish company in the project and what technologies, research, …etc they can provide that the Egyptian company cannot provide	
If you are interested in collaboration: please specify details and other important information you want to share with a potential company	
Interested areas of collaboration	• Telecommunications • Smart solutions • Embedded systems • Machine learning and AI solutions
Specific R&D contribution you are seeking/offering *Please indicate the research needed to overcome the problems or achieve opportunities.*	

Appendix 1: Bio of Dr. Mohamed Khairy, Founder and CEO of Smartec Systems

Prof. Mohamed Khairy, one of the renowned Telecommunications experts in Egypt, has a vast industrial in addition to academic experience.

Dr. Khairy received the B.Sc. degree (valedictorian) and the M.Sc. degree, from Cairo University in 1992 and 1995, respectively, and the M.Sc. degree and the Ph.D. degree all in Electrical Engineering from the University of Maryland, College Park, Maryland in 1997 and 2000, respectively. Since 2001 he has been with the Department of Electronics and Communications at Cairo University, where he has been a full professor since 2012.

Dr. Khairy founded Smartec in 2008 to become a regional power-house in software development and telecommunications. Smartec succeeded in producing 2 top-notch products in both areas. The first is a complete building automation solution, performing the full design and implementation of the SW and HW components of the system. The second is TEMPO, a SW platform for multivendor, multi-technology, radio network optimization tool, which is used in several operators worldwide. Using this tool, resulted in significant improvement in the radio KPIs of the operators.

One of the main goals of the company is to provide qualified recourses in the IT domain for its customers. Building on Dr. Khairy's experience and credibility, Smartec was the main provider for resources for Valeo, the world's leading automotive electronic systems provider. Smartec is also one of the main providers of resources to Vodafone Egypt and Vodafone International Services (VIS). Moreover, Smartec serves as the development center for Tradelegs, a US based company working in Web development for the stock market.

In addition, Dr. Khairy was one of the cofounders of SySDSoft, a leading Telecommunication software systems development company. During his tenure at SySDSoft, he served in several top management positions including the CEO of the design services division of the company. To date, SySDSoft has been the only Egyptian company to be acquired by Intel.

Moreover, during his study at Maryland, he consulted for LCC inc., Philips Research Labs and Orbital Sciences. From 2000 to 2001, he was a Senior Member of Technical Staff at Lockheed Martin Global Telecommunications (LMGT), formerly COMSAT, in Clarksburg, Maryland. His responsibilities included research and development of satellite communications systems. In 2001, Dr. Khairy worked for Ellipsis Digital Systems as its director for Physical Layer design, where he was involved in developing the wireless LAN standard IEEE 802.11a.

In 2008, Dr. Khairy cofounded the Center for Wireless Studies (CWS) at Cairo University and is serving as its director ever since. The center was established through funding from the Egyptian telecom regulator (NTRA) and was awarded more than $2 Million (in funds from Egyptian funding agencies (NTRA, ITIDA, STDF) and internationally (QNRF). The center graduated more than 20 Masters Students and currently has 7 faculty members and 15 Engineers working on designing and implementing wireless communications systems. The center successfully organized the 61st session of the IEEE WiMAX standard meeting in May 2009 in Cairo. Dr. Khairy advised more than 30 Master students, most of which pursued their Ph.D. in reputable Universities in North America.

Dr. Khairy is also a senior member of the IEEE and was the treasurer of the Egyptian section from 2010 to 2016. He has been the vice Chairman of Egypt section since 2016.