Ivan Dimitry Ribeiro Zyrianoff

EDUCATION AND TRAINING

31/10/2020 – CURRENT – Mura Anteo Zamboni 7, Bologna, Italy

PHD IN THE PROGRAM "ENGINEERING AND INFORMATION TECHNOLOGY FOR STRUCTURAL AND ENVIRONMENTAL MONITORING AND RISK MANAGEMENT - EIT4SEMM" – University of Bologna

Supervisor: Prof. Marco Di Felice
Co-supervisor: Prof. Tullio Salmon Cinotti

Thesis: Deploying Adaptive and Interoperable IoT-based Platforms for Structural Health Monitoring

https://phd.unibo.it/eit4semm/en/phd-programme

05/02/2019 – 02/05/2019 – Avenida dos Estados, 5.001 – Bairro Santa Teresinha, Santo André, Brazil

MASTER IN INFORMATION ENGINEERING – Federal University of ABC

Field(s) of study

- Engineering, manufacturing and construction

Thesis: FOG-AWARE COMPUTING: Automated Fog Computing Support for The Internet of Things - Supervised by Prof. Carlos Kamienski

Grade Point Average: 4 (max 4) | https://www.ufabc.edu.br/en/

28/02/2013 – 04/08/2017 – Avenida dos Estados, 5.001 – Bairro Santa Terezinha, Santo André, Brazil

BACHELOR IN COMPUTER SCIENCE – Federal university of ABC

Grade Point Average: 3.327 (max 4) | https://www.ufabc.edu.br/en/

28/02/2013 – 14/12/2016 – Avenida dos Estados, 5.001 – Bairro Santa Terezinha, Santo André, Brazil

BACHELOR IN SCIENCE AND TECHNOLOGY – Federal University of ABC

Grade Point Average: 3.226 (max 4) | https://www.ufabc.edu.br/en/

PROJECTS

2020 – CURRENT

Arrowhead Tools

https://www.arrowhead.eu/arrowheadtools
The Arrowhead Tools project aims for digitalization and automation solutions for the European industry, which will close the gaps that hinder the IT/OT integration by introducing new technologies in an open-source platform for the design and run-time engineering of IoT and System of Systems. The project will provide engineering processes, integration platforms, tools, and toolchains for the cost-efficient development of digitalization, connectivity, and automation system solutions in various fields of application. Ivan collaborates with the development of applications that integrate known IoT standards to the Arrowhead ecosystem.

2016 – 2021
Smart Water Management Platform (SWAMP)

http://swamp-project.org/
The primary objective of the SWAMP project is to develop IoT-based methods and approaches for smart water management in the precision irrigation domain and to pilot the approaches in four places, two pilots in Europe (Italy and Spain) and two pilots in Brazil. Different activities have been undertaken, such as the development of a Sensor Simulation System for performance analysis of IoT Platforms, development of General Enablers for the FIWARE Platform, development of a REST API for external applications to interact with the SWAMP Platform, and configuration of secure communication between LoRaWAN ChirpStack Server and FIWARE Platform.

2016 – 2020
INCT of the Future Internet for Smart Cities

https://interscity.org/
The project goal is to tackle the scientific and technological challenges and offer innovative solutions to the problems of the Future Internet and Smart Cities. Ivan collaborates with other researches in the development of dynamic IoT architectures in scenarios of Smart Cities and Smart Agriculture.

2016 – 2019
Fog Computing Support for Smart Societies Based on Internet of Things

Ivan's Master's project fully funded by FAPESP that aimed at studying Fog Computing architectures and challenges to enable IoT technologies to Smart Cities, in addition to proposing and implementing a new framework to place applications in a dynamic environment and comparing it with the traditional cloud-based centralized model through a rigorous performance analysis study.

2012 – 2016
IMPReSS: Intelligent System Development Platform for Intelligent and Sustainable Society

The IMPReSS is a joint EU-Brazil project that aims to provide a Systems Development Platform which enables rapid and cost-effective development of mixed-critically complex systems involving Internet of Things and Services. Ivan's role in the project was to design, develop, code, test, and operate a prototype for IoT-based energy efficiency management. This activity involved a combination of hardware and software skills that ended up in two fully functional prototypes for the IMPReSS Project.

WORK EXPERIENCE

2017 – 2020 – São Paulo, Brazil
COMPUTER SCIENCE TEACHER – FMU

Teacher in a private college in the following courses: Programming Logic, Game Engine, Data Structures for Game Development, and Technical Certification Fundamentals.

https://portal.fmu.br/

2016 – 2020 – Brazil
TECH TRAINER – GRANDE PORTE

Trainer in several IT courses, such as Front-end Developer (Angular), DevOps, Java Back-End Developer, Java, C/C++, and Embedded Programming for the Internet of Things.

https://grandeporte.com.br/

2017 – 2021 – Brazil
ASSOCIATED RESEARCHER – SWAMP - UFABC

Ivan works in the design, development, installation, deployment, testing, and operation of software and communication components belonging to an IoT Platform for Smart Irrigation.

DIGITAL SKILLS

My Digital Skills

Web Programming: HTML, CSS, Javascript (front-end), Java (back-end) | Nodejs - Backend | API Programming | Solution Architecture with IoT | Edge Computing | Data Science Fundamentals | Architecture (APIs + Microservices + Queueing + Distributed Systems) | GitHub, Dockers, Kubernetes | Git | Object-Oriented Programming | Web Development | JavaScript | RESTful api | Logic programming | Relational Databases: SQL | JSON | Basic knowledge of Java, C, C++, C# | NestJs (TypeScript) | Cache

LANGUAGE SKILLS

Mother tongue(s): **PORTUGUESE**

Other language(s):

	UNDERSTANDING		SPEAKING		WRITING
	Listening	Reading	Spoken production	Spoken interaction	
ITALIAN	B1	B1	A1	A2	A2
ENGLISH	C2	C1	C1	C1	C1

Levels: A1 and A2: Basic user; B1 and B2: Independent user; C1 and C2: Proficient user

PUBLICATIONS

A Management Architecture for IoT Smart Solutions: Design and Implementation

Springer's Journal of Network and Systems Management
https://link.springer.com/article/10.1007/s10922-022-09648-6 – 2022
The management of IoT solutions is a complex task due to their inherent distribution and heterogeneity. IoT management approaches focus on devices and connectivity, thus lacking a comprehensive understanding of the different software, hardware, and communication components that comprise an IoT-based solution. This paper proposes a novel four-layer IoT Management Architecture (IoTManA) that encompasses various aspects of a distributed infrastructure for managing, controlling, and monitoring software, hardware, and communication components, as well as dataflows and data quality. Our architecture provides a cross-layer graph-based view of the end-to-end path between devices and the cloud. IoTManA has been implemented in a set of software components named IoT Management System (IoTManS) and tested in two scenarios - Smart Agriculture and Smart Cities - showing that it can significantly contribute to harnessing the complexity of managing IoT solutions. The cross-layer graph-based modeling of IoTManA facilitates the implemented management System (IoTManS) to detect and identify root causes of typically distributed failures occurring in IoT solutions. We conducted a performance analysis of failure detection time and scalability of the IoTManS implementation to demonstrate the application scenarios and capabilities of the proposal. The results show that it can meet the needs of delay and scalability of IoT solutions.

Seamless Integration of RESTful Web Services with the Web of Things

First International Workshop on Internet of Things Pervasive Real-World Deployment
https://ieeexplore.ieee.org/document/9767531 – 2022

The chaotic growth of the Internet of Things (IoT) generated an unprecedented fragmented landscape, each solution adopting its specific IoT interfaces, data models, protocols, and infrastructure. One of the most prominent countermeasures is the Web of Things (WoT), a joint effort to standardize architecture and interfaces for IoT environments. However, the W3C WoT initiative does not provide methods or guidelines to convert dissonant interfaces to its ecosystem. Hence, integrating third-party applications to the W3C WoT requires custom code, a significant burden for application developers. To bridge this gap, we proposed a technique that converts RESTful web services into Web Things. Consequently, we provide a uniform interface for all actors encompassed in an IoT-based system, enable seamless communication of WoT-based applications with multiple web services, and decouple the RESTful interface from its underlying protocol -- i.e., HTTP. We implemented our technique through C3PO, a tool that enables the online conversion of web services to Web Things by both its RESTful API and graphic interface. We evaluate the efficiency and scalability of our solution through a series of experiments performed under realistic workloads. Further, we showcase its usefulness through a use case that depicts a seismograph-based web service utilization connected to a sensor network in a Structural Health Monitoring (SHM) scenario based on the MAC4PRO project.

Interoperability and Scalability Trade-offs in Open IoT Platforms

1st International Workshop on IoT Interoperability and the Web of Things - Workshop of IEEE CCNC
https://ieeexplore.ieee.org/document/9700622 – 2022
The Internet of Things is getting momentum and generating new demands over infrastructure, systems, and platforms. One of the main aspects that hamper the large-scale development of IoT-based systems is the lack of interoperability. IoT Platforms aim to solve this issue by providing a uniform interface to access data from heterogeneous sources. However, integrating new protocols and applications can impose additional overhead, hindering the platform's overall performance and scalability.This study provides an insight into the trade-off between interoperability and performance of IoT platforms. First, we present a qualitative analysis of three open-source platforms - FIWARE, ThingsBoard, and Konker - analyzing their interoperability features. Second, we conduct a performance evaluation emulating two IoT-based environments -- smart cities and smart health -- to understand each platform's scalability, response time, and computer resource usage. Finally, we analyze the possible trade-offs between interoperability features and scalability based on the qualitative and quantitative analysis. The results show that interoperability features do not have a direct impact on the performance of the platform.

IrrigaSim: An Irrigation Simulation, Processing, and Animation Environment

2021 IEEE International Workshop on Metrology for Agriculture and Forestry (MetroAgriFor)
https://ieeexplore.ieee.org/abstract/document/9628455 – 2021
Simulation plays an essential role in agricultural and IoT research. Despite recent efforts to foster IoT applications in agriculture, we did not find an integrated simulator that combines crop simulation with an IoT platform. This paper presents IrrigaSim, an environment that integrates a crop simulator (PCSE), a water need estimation platform (SWAMP), and an irrigation animation, or visualization, tool (IrrigAn). IrrigaSim has a web interface and can simulate a center pivot irrigation system, communicating with the PCSE crop simulator and the SWAMP IoT platform.

A Soil Moisture Calibration Service for IoT-based Smart Irrigation

2021 IEEE International Workshop on Metrology for Agriculture and Forestry (MetroAgriFor)
https://ieeexplore.ieee.org/abstract/document/9628393 – 2021
IoT plays a vital role in precision agriculture, enabling modern farm management technology to improve crop quality and quantity. Sensors can cover large farm areas, transmitting soil and weather data to an IoT Platform. For IoT smart irrigation, raw soil measurements generated in a physical quantity need to be converted into a percentage of soil moisture via a calibration process before usage. Most commercial soil moisture sensors transmit calibrated data using a generic calibration method, thus losing accuracy given that they do not consider the inter and intra-field variability. We developed an open-source application called SWAMP Kali, responsible for the online calibration of raw moisture data transmitted by soil probes. SWAMP Kali calibrates each data point according to a polynomial equation specific for each soil type. Our application is fully integrated into a smart irrigation platform (SWAMP) and one open-source IoT Platform (FIWARE). SWAMP Kali was deployed in a real smart agriculture scenario and calibrated more than 18,000 data points.

A Toolchain Architecture for Condition Monitoring Using the Eclipse Arrowhead Framework

IECON 2021 – 47th Annual Conference of the IEEE Industrial Electronics Society
https://ieeexplore.ieee.org/abstract/document/9589532 – 2021
Condition Monitoring is one of the most critical applications of the Internet of Things (IoT) within the context of Industry 4.0. Current deployments typically present interoperability and management issues, requiring human intervention along the engineering process of the systems; in addition, the fragmentation of the IoT landscape, and the adoption of poor architectural solutions often make it difficult to integrate third-party devices in a seamless way. In this paper, we tackle these issues by proposing a tool-driven architecture that supports heterogeneous sensor management through well-established interoperability solutions for the IoT domain, i.e. the Eclipse Arrowhead framework and the recent Web of Things (WoT) standard released by the W3C working group. We deploy the architecture in a real Structural Health Monitoring (SHM) scenario, which validates each developed tool and demonstrates the increased automation derived from their combined usage.

Two-way Integration of Service-Oriented Systems-of-Systems with the Web of Things

IECON 2021 – 47th Annual Conference of the IEEE Industrial Electronics Society
https://ieeexplore.ieee.org/abstract/document/9589619 – 2021
The Internet of Things (IoT) is nowadays affected by significant interoperability issues. One of the most popular countermeasures is the Web of Things (WoT), proposed recently in a consistent standardization effort. On the other hand, several IoT-oriented frameworks are already established in industrial scenarios and provide SOA-like features such as discovery and orchestration. In this paper, we study how to bridge these two worlds by proposing a tool that enables a two-way translation between a WoT ecosystem and a System-of-Systems composed of well-described Web services. We evaluate the efficiency and scalability of our solution over the Eclipse Arrowhead framework through a series of experiments that assess the scalability of our solution under realistic workloads.

WoT Micro Servient: Bringing the W3C Web of Things to Resource Constrained Edge Devices

2021 IEEE International Conference on Smart Computing (SMARTCOMP)
https://ieeexplore.ieee.org/abstract/document/9556223 – 2021
The chaotic growth of the Internet of Things (IoT) determined a fragmented landscape with a huge number of devices, technologies and platforms available on the market, and consequential issues of interoperability on many system deployments. The recent W3C Web of Things (WoT) standards aimed to ease the deployment of heterogeneous systems by introducing uniform and well-defined software interfaces among the systems' components. Although the WoT reference architecture is generic and agnostic to the target devices, its widespread adoption depends on the availability of specific tools named Servients, which enable the run-time operations of WoT applications. In this paper we aim at contributing to the adoption of the W3C WoT standards by presenting WoT Micro-Servient (WMS), a framework for bringing the WoT paradigm to the extreme edge of an IoT environment. Through WMS, developers can design, compile and install WoT applications on micro-controllers and embedded systems with constrained hardware capabilities. We describe the architecture and functionalities of the tool, and demonstrate its effectiveness in terms of reduced latency and energy consumption compared to the state-of-art proxy-based solution enabled by Node-wot, i.e. the official implementation of W3C WoT. Finally, we discuss a real-world application related to smart home, where WMS is used to enable a WoT-based remote monitoring and control of indoor plants, by enabling seamless integration between micro-controllers and mobile devices.

Interoperability in Open IoT Platforms: WoT-FIWARE Comparison and Integration

2021 IEEE International Conference on Smart Computing (SMARTCOMP)
https://ieeexplore.ieee.org/abstract/document/9556300 – 2021
The rapid and exponential growth of the Internet of Things (IoT) has been generating a new breed of technologies that introduce several different protocols and interfaces. The Web of Things (WoT) architecture stands out as an emerging and potential solution to improve interoperability across IoT platforms by describing well-defined software interfaces. However, few studies analyze and compare WoT to other interoperability solutions proposed in the IoT literature. In this paper, we attempt to bridge the gap by three main contributions. First, we qualitative compare the WoT approach with the well-known FIWARE-based interoperability solution.Second, based on the previous analysis, we design and implement a

connector to bridge the WoT architecture to the FIWARE ecosystem. Third, we conduct a performance analysis emulating a real IoT-based environment to understand scalability, response time, and computer resource usage of the two interoperability solutions. The results reveal that conceptual design choices impact the applications' performance: the WoT architecture effectively enables interoperability across IoT Platforms, though it incorporates several characteristics that hinder the implementation of applications. On the other hand, the FIWARE IoT Agent solution is platform-specific. Hence new implementations are needed for each different IoT data model.

IoT-based Measurement for Smart Agriculture

2020 IEEE International Workshop on Metrology for Agriculture and Forestry (MetroAgriFor)
https://ieeexplore.ieee.org/abstract/document/9277546 – 2020
Smart agriculture is increasingly seen as a solution to global sustainability problems such as global warming, waste of water resources, excessive use of pesticides, and low economic activity. The core of this technology is the acquisition of data from the soil, crop, and climate to act in the production. Several solutions exist, but many are proprietary, high cost, hard to install, maintain, and integrate with third-party solutions. This paper presents an IoT technology set applied to the acquisition of agricultural data using open source solutions such as FIWARE and LoRaWAN, which allow extensive customization and integration with advanced weather forecasting, Machine Learning, and real-time dashboard services. The results obtained by the combination of different tools and platforms in pilots located in Brazil and Europe reveal a high versatility of the IoT technology applied to smart agriculture.

Understanding the tradeoffs of LoRaWAN for IoT-based Smart Irrigation

2020 IEEE International Workshop on Metrology for Agriculture and Forestry (MetroAgriFor)
https://ieeexplore.ieee.org/abstract/document/9277566 – 2020
As LoRaWAN has been increasingly used in the Internet of Things (IoT) smart agriculture, efficacious deployments of this technology need a clear understanding of its performance and scalability tradeoffs. This paper proposes a two-step methodology to evaluate the performance of LoRaWAN based on simulation for understanding the behavior of the air interface and measurement for understanding the behavior of the IoT Platform. We conducted a performance analysis study in a smart irrigation scenario, varying the distance from sensors to the gateway, the sensor density (number of sensors), and the LoRaWAN spreading factor. Our results show that the LoRa air interface poses the most stringent scalability limits, mainly related to the number of sensors actively transmitting from a farm parcel to the gateway. The IoT Platform adds some delay but does not notably interfere with the overall performance of the solution.

The SWAMP Farmer App for IoT-based Smart Water Status Monitoring and Irrigation Control

2020 IEEE International Workshop on Metrology for Agriculture and Forestry (MetroAgriFor)
https://ieeexplore.ieee.org/abstract/document/9277588 – 2020
Smart agriculture requires new hardware and software solutions in order to achieve its goals of improved productivity. The SWAMP project develops a platform for smart water management using IoT, cloud and fog computing, and machine learning, among other technologies. This paper presents the SWAMP Farmer App for water status monitoring and irrigation control. The app improves farmer's situation awareness regarding water status by showing current and past moisture data from the fields, including map and charts views. The app also includes irrigation planning and drone capabilities.

Architecting and Deploying IoT Smart Applications: A Performance–Oriented Approach

Sensors - MDPI
https://www.mdpi.com/1424-8220/20/1/84 – 2020
Layered internet of things (IoT) architectures have been proposed over the last years as they facilitate understanding the roles of different networking, hardware, and software components of smart applications. These are inherently distributed, spanning from devices installed in the field up to a cloud datacenter and further to a user smartphone, passing by intermediary stages at different levels of fog computing infrastructure. However, IoT architectures provide almost no hints on where components should be deployed. IoT Software Platforms derived from the layered architectures are expected to adapt to scenarios with different characteristics, requirements, and constraints from stakeholders and

applications. In such a complex environment, a one-size-fits-all approach does not adapt well to varying demands and may hinder the adoption of IoT Smart Applications. In this paper, we propose a 5-layer IoT Architecture and a 5-stage IoT Computing Continuum, as well as provide insights on the mapping of software components of the former into physical locations of the latter. Also, we conduct a performance analysis study with six configurations where components are deployed into different stages. Our results show that different deployment configurations of layered components into staged locations generate bottlenecks that affect system performance and scalability. Based on that, policies for static deployment and dynamic migration of layered components into staged locations can be identified.

Scalability of an Internet of Things Platform for Smart Water Management for Agriculture

2018 23rd Conference of Open Innovations Association (FRUCT)
https://ieeexplore.ieee.org/abstract/document/8588086 – 2018
The emergence of a new breed of smart applications requires middleware platforms that enable the rapid development of IoT-based solutions, which can be hosted partially in fog nodes, as well as in a traditional cloud datacenter. Currently, there is no scalable de facto open IoT platform but the European Commission is pushing FIWARE to fill this gap. We analyzed the performance of FIWARE under different platform configurations comparing fog/cloud and cloud-only scenarios for precision irrigation in smart farming. Our results reveal interesting and non-intuitive findings, such as that fog computing does not always improve the overall system performance and in some cases it even makes it worse. Also, the network between the farm and the cloud datacenter causes some unexpected differences between different scenarios.

Profiling Service Function Chaining Behavior for NFV Orchestration

2018 IEEE Symposium on Computers and Communications (ISCC)
https://ieeexplore.ieee.org/abstract/document/8538657 – 2018
The concepts of Software Defined Networks (SDN) and Network Function Virtualization (NFV) have promoted network chaining, or Service Function Chain (SFC), quickly and simply. In dynamic infrastructure scenarios, the management of SFC introduces challenges both for the connection of these elements and for understanding their behavior when automatic elasticity is required. Currently, most existing approaches have addressed this challenge with probabilistic heuristics or AI-based techniques, considering only static management. This paper presents an approach for profiling SFC that can be used for predictive NFV orchestration purposes. We conducted a performance evaluation study based on testbed experimentation and queueing modeling. Our results confirm that an analytical model can be used for managing SFC orchestration, not only as a validation technique for NFV, but also as a heuristic for predictive resource allocation in production environments.

Scalability of Real-Time IoT-based Applications for Smart Cities

2018 IEEE Symposium on Computers and Communications (ISCC)
https://ieeexplore.ieee.org/abstract/document/8538451 – 2018
The Internet of Things (IoT) is getting momentum, which drives us to design solutions able to deal with huge amounts of data coming from different sorts of sensors in order to make decisions to adapt system behavior automatically. While in recent years many IoT-based reasoning systems have already been proposed, there are no comprehensive results reporting their performance, particularly in complex environments. As an answer to that challenge, developers often choose an architecture design based on previous experience that have an impact on the system performance and scalability. This paper shows experimental results of a performance analysis study of different implementations of context-aware management architectures for IoT-based smart cities. Results show that different architectural choices affect system scalability and that automatic real time decision-making is feasible in an environment composed of dozens of thousands of sensors continuously transmitting data.

Context Design and Tracking for IoT-Based Energy Management in Smart Cities

IEEE Internet of Things Journal
https://ieeexplore.ieee.org/abstract/document/8024168 – 2017
The advent of the Internet of Things (IoT) and its innumerous applications for Smart Cities emphasizes the need for context-aware systems able to adapt behavior automatically to instant environment conditions. Currently, there is a gap in terms of understanding how context information is interrelated, as well as

tracking which events occurred under which conditions within certain context scopes. Visualizing, specifying, tracking and monitoring typical contexts involved in IoT-based applications are still challenging activities since context modeling remains a low level process that requires much human expertise. In this paper we propose a new context life cycle that involves context design and context tracking. We developed a context-aware management framework, where contexts are modeled as graphs and can be explicitly designed and their occurrences can be tracked down. We believe that this feature of designing and tracking context graphs may help developers, administrators, and end-users in harnessing the wealth of information generated by highly scalable IoT systems.

Context-aware energy efficiency management for smart buildings

2015 IEEE 2nd World Forum on Internet of Things (WF-IoT)
https://ieeexplore.ieee.org/abstract/document/7389139 – 2015
The importance of energy in our society has been growing drastically but still, public buildings are very inefficient when it comes to managing energy. Current management systems are usually designed for automating lighting and HVAC. We see the potential of using IoT in this scenario but unfortunately developing context-aware IoT systems still takes tremendous efforts. In the IMPReSS project, we built a Systems Development Platform (SDP) that enables rapid development of IoT and context aware systems for energy efficiency in smart buildings. Our solution has been implemented and evaluated through a prototype, covering a university classroom scenario where lighting and temperature are controlled automatically. We observed that the IMPReSS Context Manager enables rapid system changes, as expected.

NETWORKS AND MEMBERSHIPS

2020 – CURRENT
IoT Prism Lab

University of Bologna
http://iot-prism-lab.nws.cs.unibo.it/