IC 1301 - WIPE

WIPE
COST IC1301

International Spring School

on

Electromagnetics and emerging technologies for pervasive applications: Internet of Things, Health and Safety

18th – 20th April, 2016

Bologna, Italy

Organizers:

Prof. Alessandra Costanzo, Prof. Diego Masotti

Fondazione Guglielmo Marconi

Alma Mater Studiorum A.D. 1088

cost EUROPEAN COOPERATION IN SCIENCE AND TECHNOLOGY

Welcome to Bologna!

"Asinelli and Garisenda Towers"

"Excellent Food"

"Neptune Statue"

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http://www.youtube.com/watch?v=ObBreSoNzZY

"The Little Venice"

"The Oldest University"

"Anatomic School-Room"

Welcome to Bologna!

Fondazione Guglielmo Marconi

Venue:

Villa Griffone – Guglielmo Marconi Foundation,
Via de' Celestini 1, 40037, Pontecchio Marconi (BO), Italy

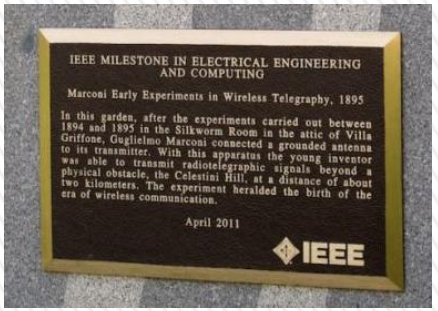
"The most inspiring aspect of science is that it encourages man to persist in the realisation of his dreams. Science requires a flexible mind. You cannot interrogate the universe with a formula. You have to observe it, take what it gives up you and reflect with the help of science and reason. Science keeps you young."

G. Marconi

How to reach:

Shuttle service from/to the hotel
Public bus n° 92

Aim: "The school is dedicated to scientists and students interested in new emerging technologies related to the pervasive exploitation of Wireless Power transfer (WPT) and Energy Harvesting (EH) techniques. System- and circuit-level advanced solutions will be presented, such as: passive and active localization; smart WPT; wearable, stretchable and epidermal electronics; home-assisted living; implantable devices. Furthermore scientific approaches to creative thinking that can pursue risky avenues will be presented."



cost

Electromagnetics and emerging technologies for pervasive applications: IoT, Health and Safety

Day	Schedule	Title	Speaker	Affiliation
Monday	10:00 – 10:45	Registration		
	10:45 – 11:00	Welcome	E. Sangiorgi -Vice Rector for Teaching and Education- & A. Costanzo -School Co-Chair-	University of Bologna (Italy)
	11:00 -12:00	Passive Wireless Sensor Networks – Combining backscatter communications with WPT	N.B. Carvalho	University of Aveiro (Portugal)
	12:00 – 13:00	Novel antenna design paradigms for the Internet of Things	H. Rogier	Ghent University (Belgium)
	13:00 – 14:00	*Lunch*		
	14:00 – 15:00	The driving force of IoT for the development of electronic technologies	L. Roselli	Univesity of Perugia (Italy)
	15:00 – 16:30	Chipless RFID, State of the art & current Developments	S. Tedjini	LCIS lab - Université Grenoble Alpes (France)
	16:30 – 17:30	Near-field focused antennas for wireless communications and power transfer	P. Nepa	University of Pisa (Italy)

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Electromagnetics and emerging technologies for pervasive applications: IoT, Health and Safety

Day	Schedule	Title	Speaker	Affiliation
Tuesday	8:30 – 9:30	Substrate Integrated Waveguide (SIW) Components on Paper, Textile, and 3D-Printed Substrates for the Internet of Things	M. Bozzi	University of Pavia (Italy)
	9:30 – 10:30	Radiative and non-radiative Wireless Power Transfer: theory and applications	G. Monti	University of Salento (Italy)
	10:30 – 11:00	*Coffee Break*		
	11:00 – 12:00	Operating regimes for single and multiple wireless power transfer links	M. Mongiardo	University of Perugia (Italy)
	12:00 – 13:00	Implantable Wireless Medical Devices and Systems	J.C. Chiao	University of Texas at Arlington (USA)
	13:00 – 14:00	*Lunch*		
	14:00 – 15:00	Flexible, organic photonic sensor system for a large spectrum of portable applications: from health to security	B. Fraboni	University of Bologna (Italy)
	15:00 – 16:00	Inverter and Rectifier Design for Inductive Power Transfer	P.D. Mitcheson	Imperial College London (UK)
	16:00 – 17:00	Your home as doctor: Smart homes enable medical diagnosis	D. Schreurs	KU Leuven (Belgium)
	EVENING	***Social Event***		

Electromagnetics and emerging technologies for pervasive applications: IoT, Health and Safety

Day	Schedule	Title	Speaker	Affiliation
Wednesday	8:30 – 9:30	Beyond incremental research: the science of creative thinking	G. E. Corazza	Marconi Institute for Creativity – University of Bologna (Italy)
	9:30 –10:30	Radiative Wireless Power Transfer at Holst Centre / imec and TU/e: past, presence and future	H. Visser	Technische Universiteit Eindhoven (The Netherlands)
	10:30 – 11:00	*Coffee Break*		
	11:00 – 12:00	RFID Technology for IoT-based Personal Healthcare in Smart Spaces	G. Marrocco	Roma Tor Vergata University (Italy)
	12:00 – 13:00	EM Positioning for IoT	F. Viani	ELEDIA – University of Trento (Italy)
	13:00 – 14:30	*Lunch*		
	14:30 – 15:30	Ultra-wideband Backscatter Signaling for Zero-power Radio Identification and Positioning	D. Dardari	Univesity of Bologna (Italy)
	15:30 – 16:30	Leaky-wave antenna design for analog-signal-processing oriented devices for WPT, Energy Harvesting, Smart Cities and IoT devices	J. L. G. Tornero	Technical University of Cartagena (Spain)
	16:30 – 17:30	Intentional Wireless Power Transmission via Time-modulated Arrays	D. Masotti	University of Bologna (Italy)
	17:30 – 18:30	Marconi's Museum Visit		

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Passive Wireless Sensor Networks – Combining backscatter communications with WPT

Instructor: Nuno Borges Carvalho

This talk will address some of the backscatter radio design strategies for development of radios that do not use DC power for communications. In this talk these radios will be combined with WPT to increase radio coverage and battery substitution.

Novel antenna design paradigms for the Internet of Things

Instructor : Hendrik Rogier

The Internet of Things (IoT), which requires that billions of “things” are wirelessly interconnected, introduces new challenges to antenna design. Indeed, acceptable radiation performance must be achieved by low-cost devices that are small, low-profile and invisibly integrated inside a challenging environment. In this lecture, we will discuss novel design strategies to conceive such antenna systems with very stable and high radiation characteristics, even in very difficult deployment conditions. Since IoT antennas need to be extremely low cost, cheap materials and construction processes are applied. This results in uncertainties in antenna dimensions and material properties. Therefore, we will introduce a stochastic framework to assess how these random variations affect antenna performance. A stochastic collocation method relates the antenna’s input parameters to its figures of merit by a polynomial chaos expansion. This enables the designer to quickly construct the statistical distributions describing the variations in antenna performance. This technique may also be applied to account for randomness in the antenna’s deployment conditions. As an application, we will study the distribution of the resonance frequency of a wearable antenna which suffers from bending due to deployment on arms with different radii of curvature. Next, we will discuss three new enabling technologies for the construction of high-quality low-cost Internet-of-Things antenna systems. First, we outline the design of substrate integrated waveguide antennas on textile and cork substrates. Such compact low-profiles antenna may be easily integrated in garments, floors, walls and ceilings. The application of rectangular-waveguide-like structures in a planar low-profile topology provides excellent antenna-platform isolation and also enables compact integration of active electronic circuits. Second, we leverage this property to come to a pervasive integration strategy where transceiver, microcontroller, memory and power management system circuits are directly integrated onto the antenna feed plane. Moreover, energy harvesters may be placed directly on top of the antenna patch, without reduction in radiation performance. Third, we exploit the large area that garments, floors, walls and ceilings offer to deploy multiple textile antenna modules. Multi-antenna processing may then be applied to increase the reliability of the wireless channel, by countering multipath fading and body shadowing and/or by increasing the data throughput. We will outline a number of applications that may benefit from this novel design paradigm. These range from wireless off-body communication by rescue workers during interventions, over satellite-based localization, to remote sensing by body-worn radars.

The driving force of IoT for the development of electronic technologies

Instructor : Luca Roselli

A great paradigm shift is taking place under the umbrella of the IoT “buzzword". Since more than twenty years ago, Internet provided connection among computers all over the words with an increasing granularity among computers. With the advent of mobile terminals such as notebooks, tablets and smartphones, this connectivity became mobile and virtually ubiquitous but still limited to object strictly controlled and interfaced by humans. The real IoT gate has been crossed with the interconnection of independent and autonomous objects that is what is happening today. Nowadays, in fact, the available sensing and telecommunication technologies allow many objects to gather information from the environment and to share it on the Internet. Looking at the future and assuming a continuous increase of the granularity of connected objects we can forecast some additional feature to be guaranteed to support IoT evolution. Beyond sensing and interconnecting capability, in fact, objects should also be energetically autonomous, very low cost, compatible with manufacturing processes of objects and, last but not least very low environmental impact. This seminary, after an introduction describing the reference scenario and motivating the related technological challenges, will describe several technological implications supporting them with state of the art examples; the seminary will eventually draw some inspiring conclusions for the future activities.

Chipless RFID, State of the art & current Developments

Instructor : Smail Tedjini

In this lecture, we will explore the evolution of chipless technology from its birth in 1940s until these years. First the physics behind the operating principle of Chipless technology will be recalled. The parameters like Radar Cross Section, Electromagnetic Signature, Radar and Friis equations will be highlighted for application to Chipless technology. Then, we will review the different approaches to implement information into chipless tags. Coding techniques in frequency domain, time domain and hybrid techniques will be discussed and compared in terms of coding capacity and practical implementation. Several examples from the literature will be considered and compared. Then reader architectures for chipless technology will be discussed. The impact of RF regulations on chipless RFID will be reviewed. The last part of the lecture will focus on the evolution of chipless RFID towards chipless sensors. Practical examples with their main characteristics will be discussed

Near-field focused antennas for wireless communications and power transfer

Instructor : Paolo Nepa

Focusing the electromagnetic field at a point in the antenna near-field region allows to increase the electromagnetic power density in a size-limited spot region close to the antenna aperture. At microwave frequencies, near-field focused antennas are receiving an increasing attention in several short-range wireless applications, such as radio frequency identification systems, non-destructive microwave sensing technologies, foreign object detection inside lossy media, plasma heating, high-data-rate point-to-point communications, wireless power transfer systems. In general, a focused antenna is a better solution with respect to conventional far-field focused antennas in all those short-range wireless links where electrically large antennas can still be tolerated. The course is aimed at presenting the basic working principles and design criteria of near-field focused microwave antennas. The parameters used to characterize this class of antennas will be introduced, together with an overview of some realizations based on different antenna technologies: microstrip arrays, leaky wave antennas, planar lens antennas, slotted waveguide antennas, dielectric resonator antennas, reflectarrays and transmitarrays.

Substrate Integrated Waveguide (SIW) Components on Paper, Textile, and 3D-Printed Substrates for the Internet of Things

Instructor : Maurizio Bozzi

The development of Wireless Sensor Networks (WSN) and the advent of the Internet of Things (IoT) demand for the development of new classes of wireless microwave systems, which are cost-effect, compact, and suitable for the implementation of eco-friendly and wearable devices. These results can be achieved by a careful selection of a suitable materials, manufacturing process, and integration technique. This lecture presents the development of substrate integrated waveguide (SIW) components and antennas, with particular emphasis on the use of paper substrates for eco-friendly wireless systems, textile for wearable components, and 3D-printed substrates for fully-3D cost-effective structures.

Radiative and non-radiative Wireless Power Transfer: theory and applications

Instructor : Monti Giuseppina

Wireless Power Transmission (WPT) represents a promising technology for wireless powering of electronic devices as, for instance, medical implants, where contactless charging plays a key role. WPT is generally implemented by using resonant systems communicating by means of their electromagnetic field. Depending on whether the communication uses the far- or the near-field, two main strategies can be identified for implementing a WPT link. In a far-field communication (also referred to as radiative WPT), antennas are used to transmit and receive power; in a near-field communication (also referred to as non-radiative WPT) electrically or magnetically coupled systems are used. In this contribution, the basic theory of both radiative and non-radiative WPT links will be introduced and some examples of applications will be presented. As for radiative WPT links, the focus will be on rectifying antennas (rectennas) which are devices designed to convert a propagating electromagnetic wave into direct current (DC) power. The basic architecture and the main issues related to the rectenna design will be discussed, and some experimental results referring to the design of UHF rectennas will be illustrated. As for non-radiative WPT links, the focus will be on Wireless Resonant Energy Links (WRELs) based on inductive coupling. The basic theory will be introduced, and possible strategies for improving the efficiency of WREL links will be discussed. Finally, some examples of applications referring to the powering of medical implants and to portable contactless-chargers will be illustrated.

Operating regimes for single and multiple wireless power transfer links

Instructor : Mauro Mongiardo

Authors: A. Costanzo, F. Mastri, M. Mongiardo, G. Monti

In this contribution we consider the operating regimes first for the case of a single transmitter and a single receiver.In this case we show that we can operate in such a way to maximize the efficiency or the received power at a fixed frequency. As a different possibility, a frequency agile scheme can be used in order to achieve constant efficiency and power even when changing the coupling.Possible extensions when multiple transmitters and multiple receivers are present are also considered.

Implantable Wireless Medical Devices and Systems

Instructor : J.C. Chiao

The presentation focuses on the development of wireless micro devices and systems for medical applications at UT-Arlington. They are based on technology platforms such as wireless energy transfer for batteryless implants, miniature electrochemical sensors, nanoparticle modified surfaces, MEMS devices and wireless communication. An integrated wireless body network for chronic pain management will be discussed. The system provides a wireless closed loop for neurorecorders to recognize pain signals and neurostimulators to inhibit pain. Batteryless endoluminal sensing telemeter architecture will also be discussed with an esophagus implant for remote diagnosis of gastroesophageal reflux disease (GERD), an endoscopically-implantable wireless gastro-stimulator for gastroparesis management, and a wireless bladder volume monitoring implant for urinary incontinence management. These applications enable new medicines to improve human welfare and assist better living.

Flexible, organic photonic sensor system for a large spectrum of portable applications: from health to security

Instructor : Beatrice Fraboni

Organic semiconductors, thanks to their light weight, simple processability, and mechanical flexibility, have recently led to the realization of remarkable and novel opto-electronic devices. Moreover, organic materials can be deposited and grown by means of easy, low temperature and low cost technologies as inkjet printing. In the field of ionizing radiation detection, organic semiconductors have been proposed so far mainly in the indirect conversion approach, i.e. as scintillators, which convert ionizing radiation into visible photons, or as photodiodes, which detect visible photons coming from a scintillator and convert them into an electrical signal. Organic semiconductors are very promising candidates also for the direct detection of high energy photons (X- and gamma rays) and we recently reported how organic semiconducting single crystals (OSSCs) offer real time, direct X-ray detection, room temperature operation and a "designed for industrial production" approach. The OSSC-based sensors deliver operationally robust and environmentally friendly devices surpassing current state-of-the-art sensors thanks to brand new and highly needed new functionalities like conformability, flexibility, large active area coupled to low weight, low power consumption, portability, optical transparency, recyclability and/or sustainable disposability (zero waste, according to REACH directives). The integrated sensor system we are developing within the framework of a EU-funded project (www.iflexis.eu), integrates three major novel concepts, recently demonstrated as a proof-of-principle operation at laboratory scale, allowing for totally new sensing systems: i) organic single crystals as the active, X-ray direct sensing material, ii) high mobility thin film transistors based on nm-thin films of novel high mobility oxide materials operating at ultra-low voltages and iii) flexible transparent electronics, all integrated onto low cost plastic substrates, away from conventional silicon technology. These new concepts, developed and implemented using organic and hybrid micro/nanotechnology will be integrated into a final 2x2 sensor matrix prototype realized with printing techniques. To validate the sensor performance and to highlight its wide application potential, we apply it to two portable demonstrative contexts: 1) health diagnostic: an X-ray sensor thin patch to be positioned directly on the body area to be exposed to radiation to determine the received dose; 2) RFID Identification tag: a luggage tag capable to monitor the luggage X-ray screening history in airport security procedures.

Radiative and non-radiative Wireless Power Transfer: theory and applications

Instructor : Paul D. Mitcheson

The need to achieve relatively high power in many IPT scenarios, even in IOT applications, means that driving the inductive link at high efficiency is a difficult but interesting challenge for the engineer. In this talk I will discuss the trade-offs I system design for IPT systems and discuss how efficient drive and rectifier circuits (often operating at hundreds of watts and a few MHz) can be achieved. The circuits are soft switched to reduce switching loss and allow high frequency operation and a modifications can be made to the often used class E circuit to reduce stresses on the transistors (by using class EF and E/F topologies). I will also discuss work we have been doing on the gate drive circuits for these high frequency power circuits, where energy recovery techniques become vital to achieve a high system efficiency.

Your home as doctor: Smart homes enable medical diagnosis

Instructor : Dominique Schreurs

The Internet of Things is not restricted to communications, but has a wide range of applications. This lecture focuses on how wireless sensor networks can be adopted to achieve biomedical monitoring in residential environments. It will be explained how well-known technologies such as radars can be re-engineered as to achieve remote characterisation of the residents' vital signs and localisation. Challenges such as co-existence of wireless communications and radar operation, antenna leakage, and energy consumption will be elaborated on. It will be explained that the emerging massive MIMO concept may offer the solution for powering the ubiquitous radar sensors nodes.

Beyond incremental research: the science of creative thinking

Instructor : Giovanni Emanuele Corazza

At first sight, PhD research could apparently involve a lot of thinking freedom, but in reality it must undergo a large variety of constraints, coming from the supervisor, the scientific community, and the PhD student him/her-self. In fact, it is perfectly reasonable to decide that, in order to be fairly sure about achieving publishable results, a well opened research path should be followed. Quantity of publications is taken as a success criterion, which clearly points to the convenience of pursuing the most accredited trends, leading to incremental research. This is fine 95% of the time. Still, 5% of a PhD activity should be devoted to the pursuit of risky avenues, truly original ideas, disruptive innovation. This small investment may in fact turn out to give the most significant results in one's life. This seminar will discuss scientific approaches to creative thinking that can allow to approach this kind of unconventional activity in a disciplined and systematic way.

Radiative Wireless Power Transfer at Holst Centre / imec and TU/e: past, presence and future

Instructor : Huib Visser

In the presentation a general history of radiative Wireless Power Transfer will be given. The WPT activities that have taken place at Holst Centre / imec and Eindhoven University of Technology will be outlined in more detail. The rectennas developed will be compared to physical limits, regulations and the State of The Art. Near and far-future activities aimed at an increase of RF-to-dc power conversion efficiency and aimed at obtaining more power at a distance will be discussed. Demonstrations will be given.

RFID Technology for IoT-based Personal Healthcare in Smart Spaces

Instructor : Gaetano Marrocco

The current evolution of the traditional medical model toward the participatory medicine can be boosted by the Internet of Things (IoT) paradigm involving sensors (environmental, wearable, and implanted) spread inside domestic environments with the purpose to monitor the user's health and activate remote assistance. RadioFrequency Identification (RFID) technology is now mature to provide part of the IoT physical layer for the personal healthcare in smart environments through low-cost, energy-autonomous, and disposable sensors. It is here presented a survey on the state-of-the-art of RFID for application to body centric systems for gathering information about the user's living environment and above all about his physiological state and behavior. Many available technological options to design RFID bodycentric sensors (wearable, epidermal and implantable) are described up to the application level with some examples of true RFID systems able to collect and process multichannel data about the human behavior (gestures and sleep dynamics) and his interaction with the surrounding environments in compliance with the power exposure and sanitary regulations. Open challenges and possible new research trends are finally discussed.

EM Positioning for IoT

Instructor : Federico Viani

Authors: A. Massa, F. Viani, A. Polo, and F. Robol

Within the framework of IoT, the position information is going a key role for enabling advanced and high-added value applications and services. As a matter of fact, it turns out here more important to define the location of a "thing" (i.e., single person, group of people, a device, a system of devices, etc...) than having information describing it, since there latter and the corresponding semantic can be derived from the position information. Towards this end, electromagnetic techniques for positioning (i.e., detection, localizaion, tracking, occupancy estimation, crowd flowing, etc...) are very important since they are able to guarantee a good trade -off between architectural costs and performance needed by each application (depending on required spatial resolution). This talk will review the state-of-the-art and more innovative approaches (active vs. passive AND cooperative vs. non-cooperative, wereable vs. non wearable, opportunistic vs. dedicated architecture, etc...) EM "positioning" also presenting an overview of the corresponding applications and services (e.g., fleet management) within the area of IoT. On-line demos will corroborate the theoretical lesson.

Ultra-wideband Backscatter Signaling for Zero-power Radio Identification and Positioning

Instructor : Davide Dardari

Authors: D. Dardari, N. Decarli, A. Guerra

Ultrawide bandwidth (UWB) technology is a promising solution for the merging of advanced radio-frequency identification (RFID) and real-time locating systems (RTLS) to provide both identification and high-definition localization of objects with energy autonomous devices. In this talk, a survey of current progresses in the application of the UWB technology for RFID systems with high-definition tag localization capability is presented with particular attention to low complexity solutions based on backscatter modulation and non-regenerative relaying. The main results obtained in related European and National Projects SELECT and GRETA, respectively, will be illustrated.

Leaky-wave antenna design for analog-signal-processing oriented devices for WPT, Energy Harvesting, Smart Cities and IoT devices

Instructor : Jose Luis Gomez Tornero

Wireless Power Transfer technologies for ubiquitous wireless sensors and actuators, attempt to empower low-power devices distantly in an efficient manner, so they depend less and less on usual batteries. This is still a big challenge to be addressed, and a fundamental objective in the frame of Smart Cities, IoT and related technologies/techniques (RFID, D2D, Smart Spaces, Wearable and implantable devices, On-body area networks, indoor localization...etc) for diverse applications such as IoT, e-Health and e-Safety. In this general context, RF,microwave and milimeter-wave low-consuming devices are a need. Analog signal processing (ASP) is a general approach to process signals, so that A-D converters and subsequent digital circuits can be avoided if the wireless RF signals are processed in their natural analog domain. In this seminar, these concepts will be clarified using practical examples of Analog Signal Processing (ASP) techniques implemented with original leaky-wave antennas and circuits, which perform broadband instantaneous processing in the convoluted space, frequency and time domains which define our perception of reality and related physical phenomena. Practical cases of a WPT leaky-wave device for light-drone wireless empowering, and a simple coaxial smart-cable to detect intruders, will be described to exemplify these concepts, all of them based on the intrinsic ASP properties of leaky-wave antennas.

Intentional Wireless Power Transmission via Time-modulated Arrays

Instructor : Diego Masotti

Authors: D. Masotti, A. Costanzo

The use of time as an additional optimization parameter in the design of highly reconfigurable antenna arrays has a great potential: in particular time-modulation of nonlinear switches driving the antennas is exploited by Time-Modulated Arrays (TMAs).This talk proposes a potential application of TMAs in a smart wireless power transmission (WPT) method, based on a two-step procedure, exploiting real-time beaming of time-modulated arrays. The sideband radiation phenomenon, which is usually a drawback of these radiating systems, is favorably used for intentional WPT: in a first step to precisely localize the tag to be powered and in the second one to perform directive WPT. The approach is first theoretically discussed, then the numerical procedure, which integrates full-wave analysis of the antenna array with nonlinear simulation of the modulated nonlinear feeding network, is used to validate the principle of operation and to include nonlinearities and electromagnetic couplings affecting the whole system performance. The procedure allows a flexible design of the TMA -based WPT system, taking into account the impact of different array elements layout and spacing on localization and power transmission performance

Registration

Training school on: "Electromagnetics and emerging technologies for pervasive applications: Internet of Things, Health and Safety"

- **School fees:**
  - Regular Registration: 300 €
  - Student Registration: 125 €
- **Grants for students are available:**
  - Application deadline: March 15th, 2016
  - Supporting travelling expenses, school fee
  - Notification of Grant Recognition: March 20th, 2016

NOTE: 1 extra grant is recognized to a *female attendee* that applies for WOMEN WPT within March 15th,2016

Details @ http://www.cost-ic1301.org/?page=women-in-wpt-award

Please, pre-register for the Spring School in this web-site:

http://goo.gl/forms/e317hU14pN

Info at: http://www.cost-ic1301.org

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Hotel Arrangement

BEST WESTERN City Hotel

http://www.cityhotelbologna.it/

***Address*:**
Via Ambrogio Magenta, 10,
40128 Bologna, Italy

Arranged Prices for School Attendees:
Double Room (for single use) – 70€
Double Room – 40€/person
Twin Room – 40€/person

- Shuttle Service Included -

Form, info and details @
https://drive.google.com/file/d/0B1ArfLRmDbZbU1hBQWZOQ0JNLTg/view?usp=sharing