INVITED TALKS

Technical Session: Algorithms, techniques, and architectures for Big-Data-Analytics-as-a-Service

Traceability, Trust, and Privacy in Big Data Analytics: Issues and Enforcement

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Data marketplaces and Big Data analytics-as-a-Service platforms aim at processing large volumes of data from multiple external sources.
The result of this processing serves as input of decisional systems, e.g. fraud management systems or intelligent transportation systems, which are often critical or sensitive.
By providing additional information and knowledge, the integration of external sources of data can be very valuable for the decision making. However this can generate risks if these sources of data are not reliable or, worse, compromised by a malicious agent.
To overcome this issue, notions such as trust, reputation, accountability and traceability have emerged as key enablers for external source integration in analytical processes.
Reciprocally, from the data provider point of view, sharing its data with third parties is not risk-free if the further life of the data is not traced and controlled. This can indeed lead to unexpected usage or misusage of this data, leakage of sensitive data, privacy breaches, etc.
In this keynote, we will review and discuss questions related to the integration of external sources of data in Big Data Analytics platforms and processes, with a special emphasis on trust, traceability, and privacy; then we will focus on candidate approaches and technologies to address these issues, notably provenance, reputation, and accountability.

Technical Session: Biologically inspired models for innovation in Medicine

Neurophysiological indices of brain plasticity from EEG-based modeling of brain networks

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Modeling functional brain circuits during specific tasks, or even at rest, can provide important information about the neural mechanisms at the basis of many motor and cognitive functions. In particular, tracking changes in brain networks can inform about their modifications due to pathological conditions, and their reorganization due to spontaneous recovery or to a specific treatment. In this paper we will discuss the role of EEG-based connectivity studies in supporting the diagnosis of specific motor and cognitive deficits and in defining neurophysiological outcome measures of different rehabilitation interventions.

Special Technical Session: Computational Intelligence Applications in Health and Smart Cities

Computational Intelligence, Precision Medicine and Comorbidity

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Precision medicine (PM) relevance is destined to grow with the development of computational intelligence methods and Electronic Health Records data mining. One priority is to find synergies between phenotypes and markers of diseases and comorbidities. PM somehow represents an arrival point. The previous era of P4 medicine has established a shift of paradigm in the medical field. In this talk, I will focus on data synergies leading to the integration of heterogeneous sources of information, the definition of deep phenotyping and markers re-modulation; the establishment of clinical decision support systems. Currently, some problems remain to be solved, involving geo-differentiation and ethnic balance, protocols for sharing of digital information, interoperability between different record types (structured and non) to optimize the process of decision making in an actionable way. The link between "precision" and "big data" with respect to computational intelligence, will be the key point of our understanding of

complex diseases and management of comorbidities affecting an increasing amount of people in the most advanced societies.

The quest for a bionic hand: recent achievements and future perspectives

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Replacing a missing upper limb with a functional one is an ancient need and desire. Historically, humans have replaced a missing limb with a prosthesis for many reasons, be it cosmetic, vocational, or for personal autonomy. The hand is a powerful tool and its loss causes severe physical and often mental debilitation. The need for a versatile prosthetic limb with intuitive motor control and realistic sensory feedback is huge and its development is absolutely necessary for the near future.

Among the possible solutions to achieve this goal, interfaces with the peripheral nervous system, and in particular intraneural electrodes, are a very promising choice. In this presentation, the results achieved so far by using thin-film transversal intraneural electrodes (TIMEs) for sensory feedback are summarized.

First, we are going to show the results achieved during a short-term implant of TIMEs in a trans-radial amputee to restore sensory feedback. With the first subject, it was possible to restore several component of the sense of touch such as contact events, grasping force, object shape and stiffness. We also showed that texture discrimination can be restored by implementing a neuromorphic algorithm reproducing the firing dynamics of nerve fibers connected to mechanoreceptors. Recent results achieved of the first long-term implant in another amputee confirm and extend previous results.

Finally, the next steps to achieve a fully implantable devices will be briefly summarized.

These findings show that these interfaces are a valuable solution for delivering sensory feedback to subjects with transradial amputation. Further experiments are necessary to better understand the potentials of this approach during chronic experiments.

Technical Session: Cultural Heritage, Smart City, and Participatory Process

Designing Tangible Interactions for Participation and Dialogue in Heritage

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In this talk, I will draw from my 20 years of experience working with cultural heritage technologies and institutions in Europe, and particularly from the current EU-funded research program meSch - material encounters with digital cultural heritage. I will argue how heritage technologies must be seen through a conceptualisation of heritage presented and interpreted in a participative and dialogical way, rather than simply as ways to deliver digital content. I will discuss the challenges of merging the design of rich, tangible and embodied experiences with the open-ended and active participation of visitors encountering heritage, as well as reflecting on the need to empower heritage staff to actively adapt technologies to their needs and audiences.

Technical Session: Enabling technologies for measurement challenges in dual-use scenarios

Development of explosive traces sensors for a dual civilian and military use

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The goal of this work is to develop nanostructured sensors that permit to lower the detection limit of explosive vapors. To reach this objective we designed silicon micrometric cantilevers as transducers. Indeed the adsorption of explosives or pollutants molecules on a cantilever modifies its resonant frequency. So the detection is possible by studying the resonant frequency shift or the bending of cantilevers. In order to enhance the cantilevers sensitivity, their surfaces were nanostructured with metal oxide nanotubes or nanorods arrays. This nanostructuration increases the cantilevers surface area and consequently improves their explosives capture probability. As these sensors are

highly sensitive, really small, and as they have a short reaction time, they can be used for both civilian (in airports, trains,...) and military applications.

The NS3E laboratory, in collaboration with the ICPEES laboratory, has developed and optimized several metal oxide nanorods and nanotubes syntheses (TiO2, CuO,...). These nanostructures were first grown on cantilevers having an optical readout and in a second time the syntheses were adapted to piezoresitive cantilevers in order to avoid all problems link with the use of a laser. The objective is to determine the optimal size (length and diameter) of the nanostructures in order to decrease the explosives detection threshold down to unprecedent values. That's why different sizes of each metal oxide were obtained by tuning the reaction time, the temperature, the sample position in the reactor and the concentration of the reagents. These nanostructured sensors are able to detect several explosives (TNT, RDX, PETN,...) with very high sensitivities. Indeed, these sensors are able to detect a concentration of 1 ppt of TNT. The field of application of these nanostructured sensors can still be increased in the future to the detection of air pollutants.

Co-authors of this work:
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Air-space applications in Italian air force: the experience of flight test wing

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The Aero-Space System Engineering Group (GIAS) is a new group of Flight Test Wing born with the twofold aim to improve the space support of satellite systems to Italian Air Force (ItAF) operations as well as to extend the air domain up to the 330.000 feet, the Karman line that conventionally represents the space's lower boundary.
Under the supervision of ItAF Air Staff, several activities have been developed during the initial technical activities of GIAS, some of them will be described in this speech.

First, an experimental activity for 3D coordinates mensuration from COSMO-SkyMed SAR data through radargrammetry have been conducted. COSMO-SkyMed (CSK) is a constellation of four satellites in sun-synchronous orbit,

equipped with a Synthetic Aperture Radar (SAR) payload. In the framework of a CSK Operational Test & Evaluation (OT&E) activity, aimed at assessing the system potential to support the ItAF operational capabilities, a campaign was set up by GIAS, with the support of the Joint Center for Satellite Remote Sensing and the Aeronautical Geo-topographic Information Center, in order to assess the accuracy of CSK system for 3D coordinates mensuration.

Also, an academic study related to RPAS application has been recently completed by GIAS in collaboration with the Joint Center for Satellite Remote Sensing. A near future scenario will be characterized by a systemic integration of existing manned aircraft infrastructures with satellites and unmanned systems. One of the most challenging task will be the capability to fly safely in Beyond Radio Line Of Sight (BRLOS) conditions and in particular to transmit high data rate video streaming. A typical Intelligence, Surveillance, Reconnaissance (ISR) scenario composed by a RPAS integrated with Earth Observation and Telecommunication satellites has been analyzed, developing ad hoc Modelling & Simulation tools.

Finally, the ItAF recognizes the relevance of a sensor architecture for a Space Surveillance & Tracking (SST) capability to protect its own space and satellite assets and infrastructure against the damage or destruction from collision with other space debris in orbit. In 2011, the Italian Government has delegated the ItAF, with collaboration of Italian Space Agency (ASI) and National Institute for Astrophysics (INAF), to study the feasibility of a national architecture using already existent assets and processing capabilities for SST. It was started a survey at national level and an experimentation using radar sensors, property of ItAF and INAF, both in monostatic and bistatic configuration. In 2014, the European Commission established an European SST framework, to promote the use of national assets and processing capabilities of Members State. Those national capabilities have to guarantee an initial European Architecture to provide an SST Services with the huge challenge of gradually becoming self-sufficient and independent in producing an integrated European space surveillance network. Collected data from networked sensors will be sent to a national integration centre in order to analyze it and make the orbit determination of the detected space debris using specific software tools. The potential capabilities of these sensors and the results of preliminary tests carried out separately with a monostatic long range radar and an optical telescope managed by ItAF will be presented for the detection of a subset of space objects in LEO orbit.

Technical Session: IoT and Big Data: Efficient Management of Sensor/Cloud Integration

Consorzio Interuniversitario Nazionale per l'Informatica (CINI): Research and Technologies for Society and Industry via the Experience of the CINI Labs

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The talk will rapidly present the structure of CINI and its organization into national labs, which offer significant opportunities of involvement in impactful initiatives for society and industry over different thematic areas, from assistive technologies to big data, from cyber security to smart cities and communities. Then, the focus will be on the most relevant ongoing projects and initiatives, in order to further disseminate results of industrial interest and to increase the awareness of current research and innovation opportunities for the national community of academic/industrial researchers in the field.

The CINI Lab for Cyber Security: Ongoing Projects and Opportunities

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The Cyber Security National Lab is gaining relevant visibility by valuing the Italian research in this field thanks to an organization based on working groups, which aim to promote and improve their activities on a national level, also by creating new chances of multidisciplinary research. Sub-fields with ongoing research and innovation activities include, for example, critical infrastructure protection, biometrics, protection of cyber-physical and smart complex systems, security/privacy/dependability in the cloud, and risk analysis. The talk will also overview the most relevant ongoing projects and initiatives of the lab, as examples of industry-relevant results and of opportunities for the academic/industrial researchers in the area.

Beyond Digital Footprint: technology and community management to improve local searchability

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Imola Informatica SpA, CEO

Search engines for the Web (and more in general for any resource with Internet connectivity) typically exploit search algorithms that work on different types of digital traces. But, in order to achieve maximum searchability of any resource, also with no/limited local digital traces, which kind of change and extension do we need? The talk will focus on practical and visionary examples of integration among technologies, "physical" relationships, and community management in order to enable the shift from "searching over the Internet" towards "searching through the Internet".

Technical Session: Nanoelectronics and Nanoelectromagnetics for a Smarter Technology in Everyday Life

Nanopackaging for a Smarter Life

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We live in an Information Age driven by the astonishing progression of solid state electronics over the past 70 years since the invention of the transistor, and especially by the relentless march forward driven by industrial roadmaps based on faith in the infallibility of Moore's Law. But even as Moore's Law falters in the face of the challenges of nanoscale device manufacturing, new applications are opening up, e.g. flexible electronics, wearables, Internet of Things, etc. As IC chips became bigger and on-chip devices became smaller, electronics packaging, which has provided the chip with mechanical support, environmental protection, thermal dissipation, signal and power integrity, and system reliability from mainframe computers and PCs to smart phones, has kept pace through comparable innovations. Electronics packaging areas are becoming more specialized in meeting new environmental challenges, e.g. biomedical, oil well, space, aeronautics, and of that information center formerly known as an automobile! The current "grand challenges" for electronics packaging are 3D system integration by chip-stacking, embedded passives to provide more board real estate for active silicon, and the continuing battle against increasing power dissipation.

Nanotechnologies offer a variety of materials options for reliability improvements in microelectronics packaging, primarily in the applications of nanocomposites, or in the exploitation of the superior properties of carbon nanotubes and graphene. Nanoparticle composite materials are studied for resistors, high-k dielectrics, electrically conductive adhesives, conductive "inks," underfill fillers, and solder enhancements, while nanowires, CNTs and graphene may also find thermal, interconnect, and shielding applications. The presentation will focus on these materials technologies, as outlined below.

(1) Introduction to Electronics Packaging and context to the "Smarter Life"
(2) Nanoparticle properties: melting point depression, coulomb block, sintering, mechanical strength, etc.
(3) Nanoparticle fabrication
(4) Nanoparticles for inductors, capacitors and resistors for embedded passives
(5) Nanoparticles in electrically conductive adhesives,
(6) Nanoparticles in conductive inks for SMT interconnect and vias
(7) Nanoparticles added to lead-free solders and flip-chip underfills
(8) CNTs: fabrication, characterization, and properties
(9) CNT effects in solders
(10) CNTs for thermal management and electromagnetic shielding
(11) Graphene for thermal management
(12) Nanowires and nanoscale spring interconnects
(13) Current commercial applications of nanopackaging
(14) Summary

This talk is partially sponsored by the IEEE Nanotechnology Council under its Distinguished Lecturer program. The level will be introductory and accessible to students and graduates in electrical, mechanical, and materials engineering or the physical sciences. The talk will be beneficial to anyone with an interest in electronic device design, fabrication, assembly, or application.

Technical Session: New Frontiers in Adaptive Computing Systems

Dynamic circuit specialisation as a step towards more efficient hardware design of the future

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When the end of Moore's Law will prevent our future hardware from automatically being smaller, faster, more functional, and cheaper, we will have to find other ways to design future hardware systems more efficiently. Instead of

optimizing different application parts separately and placing them on a chip next to each other, we can use dynamic circuit specialization (DCS). In DCS, parts of our implementation are individually optimized but placed on the same FPGA hardware area one after the other. Changing between optimized implementation parts happens through dynamic FPGA reconfiguration. In this presentation, the possibilities of dynamic circuit specialisation will be highlighted, what it can mean for future hardware design and how run time reconfiguration can be automatically performed on current FPGAs.

Technical Session: New Materials and applications in magnetics

Progress in Magneto-Optical Kerr Microscopy

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A review will be given on the possibilities and recent developments of magnetic domain imaging by wide-field magneto-optical microscopy with emphasize on soft magnetic materials. This includes vectorial imaging, quantitative Kerr microscopy of complete magnetization processes, high-resolution domain wall studies, and time-resolved microscopy. By using magneto-optic indicator films (MOIF) with perpendicular anisotropy, the domains and magnetization processes of grain-oriented electrical steel can be conveniently imaged, even in the presence of insulating layers and in a single-shot time-resolved way up to power frequencies. MOIF films also provide the potential to investigate the role of grain boundaries for flux propagation in such material.

Modeling Dynamic Hysteresis through Fully Connected Cascade Neural Networks

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Modeling magnetic hysteresis is critical for a correct representation of magnetic devices and is a task often faced in industrial design. Unfortunately, magnetic hysteresis is a phenomenon that still lacks a deep and complete physical interpretation of the underlying mechanisms that regulates it. The majority of the models known in literature for the representation of magnetic hysteresis are phenomenological, and there is no physical interpretation of the model parameters with respect to the material under study. This has several disadvantages, of which the most important one is the uncertainty of the

existence of a unique model for the material. Moreover, the elevated computational costs associated to the models makes them too expensive for applications such as real time estimation of the field, or finite element simulations of complex and articulated devices.
A possible solution to model this phenomenon reducing considerably the computational costs involved is to use Neural Networks. Indeed, Neural Networks offers a black-box approach in modeling, with computational costs, accuracy and generalization capabilities finely tunable according to the architectures and the techniques used for the training. This comes to the cost of losing completely any physical interpretation of the model, but for application specific scenarios, the advantages introduced by this technique greatly overweight its drawbacks.
The neural approach is a known and affirmed technique for magnetic hysteresis modeling, and several authors proposed different methods to overcome the most difficult obstacle in this approach: representing the dynamic memory-based behavior of magnetic materials with the simplest neural architectures available.
This presentation will be focused on the application of particular approaches for efficiently representing magnetic hysteresis using Neural Networks. An advanced methodology able to generalize the neural approach to non-static excitations, i.e. taking into account material losses, will be analyzed. Moreover, a general extension of such method to the vector form of hysteresis will be discussed. The outline of the presentation is the following:

1) Introduction to the modelling problem of magnetic hysteresis
2) The limits of the models found in literature
3) Neural approach to modeling a phenomenon
4) The difficulties in modeling magnetic hysteresis: possible solutions
5) Non-static generalization of the problem
6) Vector generalization of the problem
7) Conclusions

The aim of the presentation is to give a general understanding of the topic, and will be understandable by students and graduates in engineering with interest in magnetic hysteresis modeling, and in general, neural network based black box modeling.

A Passive Clutch based on MagnetoRheological Fluids and Eddy Currents

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Magnetorheological fluids (MRFs) are smart materials that exhibit (rapid, reversible and tunable) changes in their rheological properties when a magnetic field is applied. These non-colloidal suspensions of micron-sized magnetisable particles respond to a magnetic field turning near-solid in few milliseconds. This phenomenon is reversible and fluids can return to their liquid state in a very short time (approx. 10 ms) by removing the magnetic field. Typical MRF

applications are found in devices used to absorb mechanical shocks and vibrations (e.g. in the automotive or aerospace industry) or in the high precision processes of polishing or finishing complex-shaped surfaces (optical lens, waveguides, hard disk, ...). Moreover, the MRFs have also been used to develop "haptic interfaces" in virtual environments.

Due to their viscoplastic behavior the MRFs are also used in clutches and brakes. In this field many papers and patents were presented. However the majority of the proposed MRF-based devices uses electrical coils as the source of magnetic field to excite the MR fluid. Although the electrical coils are a very simple and suitable solution to provide the precise and reliable control of the output torque, they cannot guarantee a fail-safe operation in the case of electrical failure. When the fail-safe requirements are mandatory specifications, the use of permanent magnets as the source of magnetic field could be a viable solution.

Furthermore, considering that in such kind of devices relative speed exists between different parts, a rotating magnetic field produced by the permanent magnets can be exploited to induce eddy currents on a copper sheet, strategically placed around the MRF. The interaction between these currents and the magnetic flux density of the exciting system allows to obtain an electromagnetic torque. This torque is added to that of the MRF, helping the clutch engagement especially during the start up phase, when an extra torque could be necessary to overcome possible static frictions. Once the two shafts have reached the same speed, the electrodynamic effects vanish and the torque transmission is assured by the MRF only.

The presentation will focus on this technology, as outlined below.

(1) Introduction to the Magnetorheological Fluids;
(2) Typical application examples: electromechanical devices and haptic interfaces;
(3) A fail-safe Magnetorheological clutch excited by permanent magnets;
(4) The electrodynamic effects as an extra torque generator;
(5) Magnetic FEM design;
(6) The prototypes and the experimental measurements;
(7) Summary.

This work was developed and funded within a framework of a project supported by Pierburg Pump Technology and Tuscany Region, P.O.R., C.R.e.O., F.E.S.R. 2007-2013.

The Already Possible Factory Of The... Present!

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Within the so called Industry 4.0 stream, factory of the future is such a used keyword that sounds like a mantra.

In Italy, the National Research Council runs one of the very few Flagship projects on it.

Within one of the best not just Italian technical universities, Politecnico di Milano, our Chairmen and coworkers pay a special attention to the ergonomic context of the operator interfacing the mechatronic plant, caring for both: their interaction, in principle a cooperation, may loosely obey to a kind of prey (jobs), predator (workers), super predator (robots) extension of the famous Lotka-Volterra model for the prey-predator interaction, as per the bright intuition of Dr Fantini

Less considered are still at least 3 technologies already ready in other fields, of which the factory could benefiting the near future development:

- brain computer interfacing [Urbano et al. Computers and Biomedical research, 2000] in order to at least partially control the plant without limb interaction, like Stephen Hawkings its workstation
- hearth rate variability in order to detect the psychophysiologic stress [Malliani et al., Circulation 1991, 283 citations according to scholar] and monitor the comfort of the operator
- active noise compensation [Liberati & Lorito, internal report], producing the same measured noise at the operator ear in phase opposition in order to cancel it via optimum forecasting and for instance Kalman-like filtering

The above are examples of mature technologies in other fields, useful in the present context, thus paradigmatic of the concept that trying to blindly apply just consolidated technologies is over: the present real world, internet of things as another mantra says, offers challenges to which it is often possible to answer by importing, adapting, composing, co-designing and re-designing existing technologies in other fields, besides developing on purpose if needed.

Technical Session: Smart Grid and Smart Mobility for Smart Cities

Efficient integration of electric vehicles in distribution networks with high share of renewable energy sources

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The mass deployment of renewable energy sources (RES) and plug-in Electric Vehicles (EV) raise several operational concerns to distribution network operators, leading to conservative RES and EV deployment strategies. The development and implementation of advanced EV management schemes that enable the synergy between the EV charging and RES production can offer several operational benefits to the distribution system operators. The objectives of such EV/RES management schemes can be: i) the allocation of the charging demand of the controlled EV fleet during hours with high RES production or among valley hours, ii) the exploitation of the EV batteries as distributed storage for shaving the network peak demand iii) the increase of the maximum EV/RES deployment level of a distribution network without upgrading the existing grid infrastructure. Qualitative and quantitative results from the implementation of EV/RES coordination in realistic simulation models of Greek MV distribution networks will be presented and discussed.

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A system view in-situ demonstration project for urban Smartgrids

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The presentation will deal with urban SmartGrids demonstration project involving large and small cities in France. The focus will be mainly on different SmartGrids with a system view perspective: from generation sources (mainly DG) to real life customer involvement. As such, specific results covering testing of a variety of innovative solutions ranging from the integration of Distributed Generation and EV into city grid, information and communication system, smart distribution substation, self-healing capability of distribution grid, TSO/DSO interfacing, advanced DMS functions, innovative demand response strategies and

services, will be summarized. It has to be noted that for such real life testing, about 500 customers are involved in the experiment particularly for testing different pricing mechanisms with respect to load control.

The presentation will detail the full scope of the urban SmartGrids while considering the various involved stakeholders from the whole energy chain and the feedback experience from the real implementation of the SmartGrids technologies on 2 cities in France.

Technical Session: Wireless Power Transfer: modeling and applications

Inductive Power Transfer in the ISM bands

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Inductive power transfer is commonplace at lower power for charging phones and, whilst not common, is known and demonstrated at several kW for charging electric vehicles. The general trade-off is that as power increases, frequency decreases. However, in power electronics, the general rule that high frequency operation allows higher power density as the passive components shrink, also holds in wireless power transfer. In this talk, I will review some fundamentals, highlight the challenges of high frequency (i.e. multi-MHz) operation in the ISM bands, discuss some of the solutions to enable highly efficiency power electronics on the transmitter and receiver side with functionality to build a system robust to changes in reflected load.