Smart grids enabled by edge computing

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Abstract

A smart grid is the nervous system of the power generation, transmission, and distribution systems that makes a great use of the information and communications technologies (ICTs). The ICT enables the smart grid to timely detect, monitor, and react to local changes in usage and in the event of electrical faults of various types. The smart grid is the nexus of distributed electrical sensors, smart energy meters, smart appliances often deployed in customer premises, transducers, network interfaces, remote terminals, servers, and a multiplexed communication system which transmits data and commands between parts installed across the entire power grid system components. The main power grid components include the power generation station, high-voltage transmission system, distribution systems, and customer premises. The sensors that can be interconnected to one another using various network architectures and computing paradigms are the eyes and ears of the smart grid which provide information vital for efficient and timely fault detection, monitoring, and controlling the entire power grid system. Hence, the smart grid is derived from the general-purpose network architecture and computing models in a manner as to fit the purposes of the electrical grid system. The main thing that distinguishes a smart grid from the general-purpose computer network is that it is one specific application of it. The most striking characteristic of computer networks is their generality. They are not optimized for a specific application like the smart grid. They are built principally from general-purpose programmable hardware capable of carrying and supporting many different types of data, and a wide spectrum of ever growing applications. Just like the general-purpose computer network, the smart grid could be deployed in

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client-server, peer-to-peer, or distributed architecture. In a similar fashion, the computational paradigm of the smart grid could be cloud, fog, or edge based. But the smart grid is typically the embodiment of the Internet of Things (IoT) or cyber-physical systems; hence, the most suitable computing paradigm is one that brings the computation and data storage closer to the point where data are created and garnered. Thus, this chapter looks at the typical ways how the edge computing paradigm is applied to improve reliability, the load forecasting capability, security and privacy of the smart grid. To put it another way, this chapter focuses on four things. It, first, lays down the foundations and background knowledge about the power grid, smart grid, and edge computing paradigm. Second, it explains the factors that affect the reliability of the smart grid and explains the ways how the edge computing techniques can improve the reliability of the smart grid. Third, it explores the requirements and ways how power consumption prediction could be accurately performed at the edge using artificial intelligence (AI), machine learning (ML), and deep learning (DL) methods coupled with advanced electrical signal processing techniques. Finally, it presents how the security and privacy issues of a smart grid enabled by edge computing could be addressed.
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Inspec keywords: client-server systems; network interfaces; cyber-physical systems; power engineering computing; power transmission reliability; load forecasting; power generation faults; power transmission faults; power distribution faults; power consumption; power distribution reliability; fault diagnosis; smart power grids; power generation reliability; power system security; learning (artificial intelligence); power meters; Internet of Things
Other keywords: distributed electrical sensors; smart energy meters; electrical faults; network architectures;

of the Internet of simulation has emerged to utilise the technologies of cloud, edge, fog computing, and high-performance computing for design and analysis of complex cyber-physical systems using simulation. These technologies although being applied to the domains of big data and deep learning are not adequate to cope with the scale and complexity of emerging connected, smart, and autonomous systems. This study explores the existing state-of-the-art in automating, augmenting, and integrating systems across the domains of smart cities, autonomous vehicles, energy efficiency, smart manufacturing in Industry 4.0, and healthcare. This is expanded to look at existing computational infrastructure and how it can be used to support these applications. A detailed review is presented of advances in approaches providing and supporting intelligence as a service. Finally, some of the remaining challenges due to the explosion of data streams; issues of safety and security; and others related to big data, a model of reality, augmentation of systems, and computation are examined.

Providing effective Internet services in the MMDS, LMDS MVDS environment

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- Delivering wireless Internet over MMDS, LMDS and MMDS offers revenue-enhancing and competitive opportunities for operators. This paper discusses some of the requirements for providing wireless Internet services. We discuss the architectural view as well as the interfaces and required equipment to provide wireless Internet. Implementation, security, and capacity issues are discussed briefly to provide the service provider with an understanding of their options when implementing wireless Internet system.

fault detection; edge computing; electrical signal processing techniques; power generation station; deep learning methods; high-voltage transmission system; load forecasting; distributed architecture; general-purpose programmable hardware; power grid system components; smart grid reliability; Internet of Things; ICT; power consumption prediction; cyber-physical systems; edge computing paradigm; electrical grid system; network interfaces; computer network; computing paradigms; information and communications technologies; distribution system; client-server system; machine learning; multiplexed communication system; artificial intelligence

Subjects: Distribution networks; Power system measurement and metering; Network interfaces; Computer communications; Knowledge engineering techniques; Power engineering computing; Reliability; Computer networks and techniques; Power system control; Power system planning and layout

The interconnection of local area networks using ATM over satellite

- N. Linge ; E. Ball ; J. Ashworth
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- This paper details the work undertaken at the University of Salford in both the design and development of an interface subsystem for attaching either CSMA/CD or FDDI LANs onto the ATM based satellite service. An in depth investigation into the design of both the hardware and software of this subsystem is presented together with actual performance results obtained from the demonstrator trials using Catalyst to interconnect remote networks located in Nanterre (France), Aveiro (Portugal) and Basel (Switzerland). These trials used a variety of data types from basic file transfer through to video based applications.

The IEEE 1394 bus

- A. Paskins
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- The IEEE 1394 interface originated from work in the late 1980s in an attempt to provide a standard for desktop computer applications. Initially the development was largely undertaken by Apple Computer under their tradename of the “FireWire” bus. The 1394 Trade Association was formed in September 1994 to promote and develop the interface. The Trade Association has members from both the computer and consumer electronics industries and is still actively developing the 1394 interface. The interface was standardised by the IEEE in 1995. The IEEE 1394 interface currently has 3 speeds defined, 100, 200, and 400 Mbit/s. Equipment working at a given speed will also work at all the lower speeds and so equipment of different speeds can be used on the same bus. Also, it is possible to have two items of equipment exchanging data at the highest speed on a bus; with other lower speed equipment also on the same bus. (6 pages)

Remote trading by satellite - ATM by satellite implementation issues in the scope of the THESEUS project

- F. Dachert ; M.N. Sauvayre ; F. Capobianco
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- The objective of the ACTS project THESEUS (terminal at high speed for European stock exchange users) is to develop a terminal that will be a key component of an open ATM system able to meet the telecommunications requirements of the future European capital market. That will be achieved by means of a combination of theoretical studies, prototype development and validation tests. The development of the HW and SW for a specific terminal will necessarily be compliant with future available broadband telecommunication infrastructures: therefore the baseline for THESEUS is the development of a fully standard ATM interface. The validation tests will be carried out taking advantage of the available broad-band experimental networks. Taking into account that the availability of ATM connections will not be capillary across Europe, at least in the medium future, the project foresees the possibility of connecting remote users (broker) to the stock exchanges by using satellite links. In that regard it is clear that the satellite links will be based on an ATM interface in order to allow a direct interconnection with the THESEUS terminal. This digest, which addresses essentially the satellite aspect of the trials, starts with a description of the network which will support the exchanges between the THESEUS terminals, then the THESEUS terminal is outlined, finally the satellite trials and their implementation issues are detailed. (6 pages)

WSDL-based ICS proforma and generation method

- Xiaodong Zhai ; Wenjing Li ; Yinghui Chen ; Yichang Liu ; Rui Dong
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- The management information model conformance testing is carried out according to the corresponding implementation conformance statement (ICS) proforma. Each kind of information model should have its own ICS proforma. In this paper, WSDL-based ICS proforma is proposed based on ITU-T methodology for ICS proforma and the grammar rule of WSDL. It provides interface implementers and suppliers a standard format for them to state their implementation of a management information model. Also it can meet all the requirements of information model conformance testing for Web service-based network management interface. At last, it gives an automatic generating method and implements an automatic generating system for WSDL-based ICS proforma. Now, the system has been applied to conformance testing for WebService interface.