Available online at www.sciencedirect.com
ScienceDirect
AKCE International Journal of Graphs and Combinatorics ▮ (▮▮▮▮) ▮▮▮–▮▮▮
AKCE International Journal of Graphs and Combinatorics
www.elsevier.com/locate/akcej

Techniques for selecting topology and implementing the distributed control system network for maritime platforms

Chernyi Sergei

Admiral Makarov State University of Maritime and Inland Shipping, Saint-Petersburg, Dvinskaya st., 5/7, 198035, Russia

Received 26 May 2017; received in revised form 9 September 2017; accepted 11 September 2017
Available online xxxxx

Abstract

Currently, there is an increased interest in the tools and methods of active control of generation and consumption of the inactive energy flows. Particularly, the task is relevant for autonomous electric power systems operating on a non-linear load. At the same time, the inactive energy flows is required to be controlled according to the specified law in order to impart the desired properties to autonomous systems. In general, with a high degree of automation on board the ships of the world fleet, the task of improving the efficiency of the automatic control of electricity quality remains urgent to them. This issue has arisen due to the fact that the semiconductor converters of electricity are becoming more widely used in the ship's autonomous power systems. A scheme has been developed on the Ethernet platform for optimizing system performance of maritime platforms. The research was focused on the offshore platforms that operate in the Black Sea.

Keywords: Ethernet; Static error; Control systems; Oil and gas industry

1. Introduction

Automation of technological processes made possible to achieve the enhanced quality and increased profits in the various spheres of the industry where it was implemented. Success in this sphere allows accomplishing efficiently the most complicated tasks, namely: to explore most boreholes, drilling and exploitation of which are technically impossible or non-profitable now [1,2]. At the same time, automation enables both to explore technically sophisticated field deposits, to reduce a preparatory stage before extraction, to enlarge economic expediency of a number of projects, and to enlarge labor safety and nature protection efficiency.

Furthermore, specialists know that oil and gas industry greatly falls behind the other industries in the sphere of automation implementation in the drilling installations, because drilling automation is a very complicated process. For the sake of convenience, it is often divided into more easily controllable modules, which may be used separately, or in combination, creating in theory an intellectual system, being capable drilling the holes in the autonomous mode.

Peer review under responsibility of Kalasalingam University.
E-mail address: sergiiblack@gmail.com.

https://doi.org/10.1016/j.akcej.2017.09.005

Please cite this article in press as: C. Sergei, Techniques for selecting topology and implementing the distributed control system network for maritime platforms, AKCE International Journal of Graphs and Combinatorics (2017), https://doi.org/10.1016/j.akcej.2017.09.005.

Moreover, it is important to note that the solutions for a certain configuration of the equipment or geophysical condition and not suitable for other installations, that is localized solutions, are economically expensive and require human intervention and control. In this connection, development of a new technology for data exchange under conditions above shows promise and high demand. Otherwise, it is necessary to consider the possibility to use solutions applied in other industries for oil and gas extraction. In any case, problems of their standardization, certification, compatibility and capability to operate in the real-time mode and to back-up data, data protection and transfer for analysis and storage of databases in the remote objects step forward.

Drilling service companies, operators, equipment manufacturers, etc. use as a rule various standards for data transfer.

Development of the hardware–software complex for the drilling platforms allows carrying out comprehensive monitoring, controllability and programmability of the complete drilling installation and the drilling process and consequently the capability of the autonomous control. As an ultimate goal, it makes possible to improve the technological process of drilling on its own, to solve the problem of maintaining the boreholes at the best quality level, minimize the emergencies, to prolong useful operation time for the equipment, to optimize the rate of penetration as well as to improve overall performance.

2. Description of the structure of the electric power system at an offshore drilling installation

Consider the main stages in the development of the system for optimizing the operation of the offshore platform, are several stages. Elements of the electrical system on the drilling rig require reliable and accurate operation of the automated control systems of the complexes [3,4]:

- Automatic start and stop of diesel-generator units due to the operation mode of the electric power plant;
- Control over the state of diesel units;
- Automatic accurate synchronization of generators and outage from paralleling;
- Distribution of active and reactive powers;
- Automatic start and stop of diesel-generator units due to the consumed power and availability of the required reserve;
- Control of the increased consumed power;
- Short-circuit protection;
- Provision of spare capacity for starting powerful consumers;
- Control of the voltage frequency;
- Operation under the certain program due to the operation mode.

Function of startup and stop of diesel-generators may be done automatically or manually. Automated synchronization is achieved by a special system of synchronization, which regulates parameters of an operational generator and a generators being switched on, and forms the signal for closing automatic breaker. It usually takes not more 45 s for forming the signal for diesel-generator start until its running in parallel. Control system for the power reserve provides startup and stop of diesel-generators due to the load on the power plant. In case if the power reserve is absent to start the powerful consumer as well as if the load on generators exceeds their nominal value or if generator current is much than the threshold limit for the long period of time, the diesel-generator is started up [5].

If there is no voltage in main switchboard busbars, all available diesel-generator units are started up automatically. The generator, which was started the first and at which busbars voltage appeared, is connected to busbars of the main switchboard. Then the other generators start operating in the shunt mode as far as they are ready.

The structure described does not take into account one more system closely connected with the electric power system of the drilling installation — namely, system of the filter compensating devices. Low-controllable compensators, designed for building up the power factor and elimination of the first higher-order harmonics, are installed at the modern drilling rigs. However, if to use the recent developments in this sphere at the drilling rigs [6], such a system becomes controllable in wide ranges and with coordinated control together with other elements of the electric power system, it may greatly increase efficiency, profitability and reliability of the autonomous drilling installations.

The upcoming trends in development of the information support for the autonomous electric power systems in the drilling rigs are as follows:

Please cite this article in press as: C. Sergei, Techniques for selecting topology and implementing the distributed control system network for maritime platforms, AKCE International Journal of Graphs and Combinatorics (2017), https://doi.org/10.1016/j.akcej.2017.09.005.