

Tasks of Decentralized SpaceWire-Plug-and-Play Algorithm

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Abstract—The decentralized algorithm differs from centralized by number of managers and tasks and complexity of algorithms interacting with each other. In the centralized algorithm a task of division a network into regions, supporting managers or manager protocol communication is not existed. But decentralized algorithm is more reliable and flexible then centralized. Two protocols of decentralized Plug and Play are provided in this paper (Plug and Play protocol offered by Dundee and Space Plug and Play Architecture SpaceWire adaptation). The main part is review tasks which appeared by development the decentralized SpaceWire-Plug-and-Play algorithm.

I. INTRODUCTION

The onboard system consists of a large number of different devices which are responsible both for mission execution and for network service. The task of functioning and service is decided by the Plug and Play algorithms. The purpose of Plug and Play technology is in device setup, support of control of network elements, timely response to change a network structure and determination of errors. Plug and Play shall be able to quickly and correctly process any network situation which can lead to defective system operation.

Execution of Plug and Play completely lies down on special control devices – network managers. Decentralized Plug and Play means that in network some network managers exist. Decentralized algorithm is more reliable from the point of view of maintenance of operability of a network. But for the decentralized algorithm it is necessary to solve several tasks.

The Plug-and-Play technology starts developing actively that leads to different decisions and protocols, increases distinction in the hardware opportunities.

But there are general moments in the Plug and Play technology:

- 1) Deleting the person from administration and monitoring processes;
- 2) Division technology into stages/services;
- 3) Division technology on centralized and decentralized type;
- 4) Attempts to make the universal algorithm.

A. SpaceWire – PnP protocol Definition offered by Dundee university

This protocol is intended for support the interacting mechanisms for execution of the key functions concerned with SpaceWire networks.

The main goal of SpaceWire PnP is functional compatibility on network layer. SpaceWire PnP provides services for research, identification and configuring of the SpaceWire network. Also this protocol includes support number opportunities correspond to the most widespread cases of SpaceWire application. The protocol doesn't demand from devices to support something except SpaceWire.

Devices can support one of the SpaceWire PnP types – levels. Level of support SpaceWire PnP defines a level of openness a network.

In a network of any level there are initiators and targets. The initiator is a source of PnP commands (read or write). Target is a device to which PnP packet is addressed. The node shall be the initiator; the target can be any device (node or router). Not all nodes have opportunity to be initiators (active node). Those nodes which can't executive these functions are passive.

The PnP network of the first level is defined that there are not an active nodes supporting the second level. The PnP devices of first level are simpler then the same device on the second level. This simplicity is reached because developers ensure functioning only one active node at any moment in network that means that the device competition when configuring within one network is disappeared. Network of the first level are called Management networks.

For PnP of the second level it is required devices supported a small set of opportunities and existence of the active nodes of the second level because the implementable algorithms are more difficult. These algorithms decide competition between several active nodes in a network. Therefore networks of the second level can cope with the added devices including new active nodes. The PnP networks of the second level are called Open networks.

All devices in completely discovered second level network have the owner. The owner is responsible for control of the device and provides all services to devices through a proxy. The proxy is a copy of all device parameters located in memory of the owner and provides to other nodes the interface for

configuration a slave device. When the active node wants to setup a device which doesn't own it directs a read or write command on a proxy in the same way as on real device. The owner of device has an opportunity to study a command and approve it (send the same command to real device) or to change a command, or cancel command [1].

For device memory access the RMAP protocol is used.

B. Space Plug-and-Play architecture SpaceWire adaptation

The central concept of SPA is that the components register the opportunities in Lookup Service when they are added to network. As soon as this information arrives, any component can address to Lookup Service and receive information about available node with required applications. Briefly the central concept can be described: registration, search and access.

1) Registration. Research of network topology is the first action of SPA system. Registration is executed at a topology discovering stage and registering of each component. Discovering happens for all SPA compatible networks and allows system to execute research of components. Process of components research after network topology discovering. Lookup SPA Services discovers network components to finish registration process.

2) Search. The set of SPA messages supports possibility of query to desired data, command sources and to services. Three opportunities for request are provided:

- Possibility of request an element on his name or a qualifier;
- Possibility of request meta-data on a certain variable;
- Possibility to receive all xTEDS.

3) Access. SPA supports the active and passive monitoring of devices and their operation for notification about problems of failures in a network. With the active monitoring Lookup SPA Service sends messages to each component and waits for the answer for some time. Passive monitoring requires a master device for a configuration of components for sending periodic messages to the master.

There is adaptation of SPA standard for the SpaceWire standard. In SPA subnet manager organizes association to protocol besides that that initially supported in case of SPA message exchange. SPA supports its own packet format and protocol addressing which is independent of low level networks in which they are transmitted. For services of SPA addressing, the data manager and other subnetwork managers to get access to SpaceWire subnetwork, there shall be a broker who allows to make research of components and message exchange to communication functions in spite of the fact that they initially aren't supported; thus is the role of subnetwork manager (SM-s) of SPA SpaceWire.

Fundamental roles of subnetwork managers (SM-s) SPA SpaceWire are described in the following items:

- 1) Research of all nodes in a network and binding SPA components;
- 2) Execution of any process required for a configuration network infrastructure for addressing support;

- 3) Registration component request from Lookup SPA Service in SPA network;
- 4) Comparison to the required addresses, probe of other managers in a subnetwork for their total number and request units of addresses to meet needs. Storage of the appropriated logical addresses for the subnetwork SPA components and possible division of the provided unit of addresses and assignment to their other managers.
- 5) Distribution of information (if it is necessary) to allow all subnetwork endpoints direct messages to any other subnetwork endpoint;
- 6) Direction a SPA message received by the manager of a SPA SpaceWire subnetwork (SM-s) from SPA-L to endpoint in a subnetwork;
- 7) Transfer of the messages arriving from subnetwork to SPA-L for local routing [2].

II. TASKS OF DECENTRALIZED SPACEWIRE-PLUG-AND-PLAY

The decentralized algorithm implies presence of several managers in one network and they function at the same time: discover, configure, store data and monitor network. Network breaks into regions (subnetworks), just one manager is responsible for each region. The region has the logical address (the regional address). As any terminal node shall have opportunity to address to any other device in a network, it is very important to setup correctly routing tables of routers (logical and regional addressing).

The decentralized algorithm should be applied to big scalable networks where one SpaceWire manager would become a bottleneck and couldn't execute quickly and correctly the functions for all devices in a network.

Creation of decentralized SpaceWire-Plug-and-Play algorithm is very labor-intensive process requiring the accounting of many tasks.

The tasks considered below are necessary for the decision in case of creation the universal SpaceWire-Plug-and-Play algorithm which would contain solutions of different tasks and approached the greatest possible number of devices and structures of network. The algorithms described above are given as an example of decentralized Plug-and-Play doesn't describe the solution of some tasks important in case of implementation of Plug-and-Play.

A. Algorithm of placement of network managers

For reduction inquiry and configure time of network the manager should be situated at some "center" of a network, in case of the centralized administration. The network manager is separate device connected to a network on which SpaceWire-Plug-and-Play will be executed.

If in the network some managers are situated it is necessary to find some such "centers" (for each region) where connect them for administration, configuration and monitoring of the network.

Depending on the selected topology and structure of a network the place of connection will differ.

The manager is connected to the distributed network structure via the router because terminal nodes are not broadcasting device, otherwise any packet accepted by them won't be sent further to a network, the packet will be accepted.

B. Data storage for managers

Solution of this task depends on onboard system in which administration will be carried out but generally it is possible to provide two candidate solutions.

The first variant is local data storage. Advantages are obvious – the special protocol use to the memory service isn't required, there is no bottleneck and critical area, protocols of access and demarcation of charges.

The second variant is the general data store. Disadvantages consist in additional complexity and need of creation for systems of a secure storage location. The recovery of information, in case of loss, consists only in request to all managers with command of repeated creation a database on the region. But for some systems such type of storage can be more acceptable than local.

C. The managers memory size and data format of storage

The format of storage is important and for general database but it is considered in the context of local storage introduces restrictions in other tasks.

Therefore it is necessary to pay attention to local information storage as in case of failure of one manager adjacent shall pick up its devices but in case of local storage there is a restriction on memory in each manager. In this task the following questions are: how quickly the critical condition of a network will be reached with different sizes of managers memory, in case of different number of them in a network and others.

D. Protocol of manager communication in a network

Owing to that managers shall support functioning of a network as it is possible more long and to envelop the greatest possible number of devices in case of failure of one manager adjacent shall pick up its devices. It results in need of creation of a protocol of communication of managers with each other, otherwise, the status exchange protocol.

If during an exchange of status messages it is defined that one of managers failed, it will be necessary to take vote among the remained operable managers for determination who will take the responsibility for functioning of the region or there shall be a division of the region which remained without manager.

E. Algorithm of network managers support

In a network the situation when one of several managers can fail for many reasons isn't excluded, in this case it is necessary to prevent formation of the network areas which aren't supervised by anybody. For the solution of this task it is offered to create algorithms of managers support in other words supports of capacity and administration of a network despite managers' failures.

The task and estimated decisions at current stage is considered in other abstract [3].

F. Algorithms of adaptive group routing and routing table setup

This task is important as the correctness of delivery data or any other type of packets in a network depends on it in case of failure the main path.

The task within one region looks not difficult, but if imagine that the packet shall pass through three regions the task of setup alternative ways becomes difficult and ambiguous in the decision.

In case of this task solution it is taken into account that the network operates in the standard mode. Otherwise, in a network messages are passing and to freeze there is no opportunity.

G. Algorithms of new or earlier switch-off device registration

Owing to that switches and terminal nodes often don't possess functions of generation of packets on events, detection new or failure of the working can happen only in case of inquiry by the manager of the region.

It is worth logically sharing registration algorithms of connection and switch-off of devices. In case of switch-off of the device or group of devices data aren't erased and unique parameters won't be used for setup of others.

Division of algorithm should be made by quantity and type of devices as it will entail different responses.

The algorithm of connection has more difficult structure, which not the group of devices, but the whole new region with own manager can be connected.

H. Task of network monitoring

Monitoring is executed by each manager within the region over devices. In other words the manager checks only devices of its subnetwork.

Monitoring of an onboard network can include tests of memory, links or simply test reading any available register and waiting of the response, or check of the set parameters that is also not deprived of sense if the device rebooted and its working parameters are dropped.

I. Algorithm of network administration

Devices are setup in process of study of a network. The study of a network occurs in the parallel mode, it means that the manager works with several devices at the same time, but it has restriction on number of such devices.

Upon completion of this stage, the network topology will become known, ways to each device to networks will be known, as well as from the device to the manager.

The main algorithm of operation of the manager concerns setup of devices parallel to study of a network. As a result the tuned network will turn out and it shall be ready to state functioning.

III. CONCLUSION

The Plug-and-Play technology is the necessary tool for creation, testing, check and administration of an onboard network. It allows to setup and maintain the greatest possible operability of

system doesn't dependent on the changing structure of a network, failure of parameters and network topology.

In other words, the Plug-and-Play solves important problems for start, setup and the subsequent functioning of a network.

The tasks described above will allow designing the decentralized, flexible and reliable SpaceWire-Plug-and-Play technology.

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