DetNet
Backhaul Networks

draft-wang-detnet-backhaul-architecture-00
draft-wang-detnet-joint-scheduling-00

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Motivation and Background

• Describes
  • Industrial backhaul network
  • IPv6 technology
  • WIA-PA standard
  • SDN

• Goal
  • Provide an SDN-based WIA-PA field network/IPv6 backhaul network joint scheduling method.
  • Enable the end-to-end joint scheduling of the cross-network data streams.
  • Enable the recognition of different types of cross-network data streams.
  • Enable the bandwidth guarantee specific to different types of cross-network end-to-end data.
  • Enable the acceleration of cross-network business deployment and reduce the management cost for network operation and maintenance.
Overview

• Joint Scheduling Architecture.
• Requirements.
• Method.
• Next steps
Network Structure

• A typical deterministic industrial field networks - backhaul networks structure.
• End-to-end joint scheduling of the cross-network data streams
Joint Scheduling Architecture

• Control Plane
  • There are many network controllers in the network, which together constitute the control plane for the whole industrial network.

• No uniform standard
  • There is not a unified standard of joint architecture of multiple controllers in the industry at present.

• The main frameworks
  • Distributed architecture.
  • Centralized architecture.
Joint Scheduling Architecture

• Distributed Architecture
  • East-West architecture.
  • The status of all network controller is equal.

• Disadvantages
  • Need to extend the east-west interface;
  • Maintain a global network topology in each controller.
Joint Scheduling Architecture

• Centralized Architecture
  • Vertical multi-level architecture;
  • One is the basic control plane composed of a variety of network controllers;
  • Another part is a network controller composed of the main controller.

• Disadvantages
  • The scale of the network is not very large;
  • A single SDN controller is sufficient to meet the control demands of industrial backhaul network.
Joint Scheduling Architecture

• Control plane
  • WIA-PA System Manager, SDN controller.
  • Joint scheduler is integrated into the SDN controller in the form of plugin.
  • Establishing a connection with the SDN controller.
  • Directly calling the corresponding module of SDN controller.

• Joint Scheduling Architecture
  • Deterministic networks and deterministic Ethernet-based networks are jointly scheduling.
  • Control and scheduling for the entire industrial network by joint scheduler, so as to provide a real-time protection for each data stream.
Joint Scheduling Requirements

• Determinacy
  • The data of Industrial field network-backhaul network directly related to the monitoring and control of industrial production process.

• Time Synchronization
  • The industrial field/backhaul network is a converged network and need some scheduling methods to ensure deterministic data stream. So it requires high time synchronization accuracy between devices in the network.

• Compatibility
  • Some mechanisms, interfaces, etc. will be necessary when conducting joint scheduling to be compatibility with industrial field/backhaul network.

• Scalability
  • Data scalability should be ensured during joint scheduling process.
Joint Scheduling Method

Solution

- A joint controller, WIA-PA network managers, gateways and field devices;
- The joint controller consists of an SDN controller and a joint scheduling plugin,
- WIA-PA networks are uniformly managed by the joint controller;
- The joint controller assigns a network identifier (PAN_ID) to each network manager connected thereto for identifying different WIA-PA networks;

A schematic diagram showing joint scheduling.
Joint Scheduling Method

• Establish backhaul network
  • S1: establishing a connection with the joint controller actively by the network managers;
  • S2: collecting information of the WIA-PA networks periodically;
  • S3: receiving and analyzing a business establishing request by the joint controller;
  • S4: looking up the PAN_ID of a source node and a destination node according to analyzed information;
  • S5: looking up the information of the corresponding networks and nodes and assigning paths and resources;
  • S6: sending a path and resource configuration request;
  • S7: sending a mapping table of WIA-PA network addresses and IP addresses to the gateways;
  • S8: configuring the controlled IPv6 backhaul network.
Joint Scheduling Method

• The network access of a network manager
  • Step 1: establishing a connection with the joint controller and reporting network manager information;
  • Step 2: assigning one PAN_ID to the WIA-PA network and establishing a mapping relation;
  • Step 3: sending a request for getting topology information and node information;
  • Step 4: replying with the topology information and node information;
  • Step 5: sending a configuration completion to end a network access process.

The network access of a network manager.
Joint Scheduling Method

- WIA-PA Network Joint Scheduling Scheme
  - Path deployment and resource allocation for WIA-PA network are performed by calling the WIA-PA network system manager API interface.
  - System manager query the corresponding information of the field device in the network
  - Then return the received information to the united scheduler.
  - Configure communication resources for the corresponding gateway device, routing equipment and field equipment.
  - Send a successful reply to the united scheduler after receiving a successful response.
Joint Scheduling Method

• Gateway protocol conversion
  • Step 1: receiving a data packet and judging whether the data packet is management data by a gateway;
  • Step2: If so, forwarding the data packet to the network manager, otherwise looking up a VCR;
  • Step3: looking up an IPv6 address according to Route_ID by the gateway;
  • Step 4: encapsulating the WIA-PA data packet in an IPv6 format by the gateway.
Joint Scheduling Method

- Bandwidth guarantee of the IPv6 backhaul network
  - Step 1: calculating path information and network resource assignment;
  - Step 2: verifying whether a bandwidth in the path is sufficient for meeting a business;
  - Step 3: if so, deploying a flow table through the SDN controller;
  - Step 4: if not, recalculating the path information and resource assignment and selecting other secondary paths.

The bandwidth guarantee for an IPv6 backhaul network
Joint Scheduling Method

• Consider Industrial Backhaul Network as a Black Box
  • Only consider its delay impacts and ignore its internal details.
  • The approximate delay of packets caused by the industrial backhaul network.
  • Implementing a few of scheduling paths of different priority.
  • Then the data stream goes through the black box, and it will cause uncertain delay which is in a numerical range.
• When the data stream comes out the backhaul network.
  (the deadline is missed / there is time left)
Next steps

• Ignore the Delay of Industrial Backhaul Network
• Build Delay Model of Industrial Backhaul Network
Thanks!

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