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# PROCEEDINGS

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# AN OPEN DISTRIBUTED FIRE DETECTION SYSTEM

**Abstract**: This paper introduces an open distributed fire detection system. This system consists of three layers: base layer, middle layer and upper layer. The base layer connecting the detectors to control unit uses a special digitized bus. In order to have reliable and effective data transport, the digital bus protocol should make requirements to the physical layer, the link layer, the network layer and the transport layer. The middle layer which links the control units to one another adopts LONWORKS as its internal bus, implementing real distributed control between the control units. The upper layer, providing the interfaces between the fire detection system and other control systems, adopts standard network variables conformed to LONMARK protocol completely. The characteristic of the open system makes the integration between the fire alarm system and other control systems come true.

## 1 Epigraph

The devices of fire alarm system can be divided into three types according to topological structure. The first one concerns the field devices including various fire detectors, manual call points, special indicators and execution units of fire fighting system. The second one is usually composed of the control units, which are connected with the field devices, providing the interface of man-machine conversation for monitoring and testing. The third one is the center of the whole system, monitoring the alarms, sending off control signals, providing interfaces to security systems, building automation systems and city fire alarm network systems.

With the developing of microelectronics and network communication technology, the fire alarm system demands more adoption of these technologies.

Many new methods are adopted in fire detection in consequence of the progressing of sensor technology. The fire detectors become more stable because of multi fire detection technology. More information can be transmitted through the internal network with high speed.

Because of the advanced network technology, the large-scale and super large-scale fire alarm systems have been widely used. In order to insure the stability of the systems, the control units must have the characteristic of independence in case of failure of the internal network.

Now integration is a tendency of the control systems within buildings. So a fire alarm system needs the open characteristic to fit the demand.

## 2 Introduction

The fire alarm system introduced by this paper is a kind of new and distributed monitoring system developed by GST. The system is a typical one composed of three layers. The first layer is the base layer using special digitized bus protocol and being connected to the control unit and field devices. The network topological structure can be ring type, ‘T’ type, or mixed type of both. The second layer is the control layer conforming to LON bus protocol and being connected to various units of the system, such as display unit, control unit, communication unit and printer unit etc. The third layer is the interconnection layer satisfied by the requirement of LonTalk protocol, accomplishing the integration with other control systems.

# 3 Network Formation

## 3.1 Special Digitized Bus

The special digitized bus uses the self-defining bus protocol to suit the data transporting between control unit and field devices. In order to have reliable and effective data transport, the digital bus protocol should make requirements to the physical layer, the link layer, the network layer and the transport layer, which can be introduced respectively as follows:

I. The physical layer: An ordinary twisted pair or an optical fiber link is used for the electric connection. If a twisted pair is used, a direct connection is all right. If an optical fiber is used, a fiber-optic transceiver is needed. The fiber-optic transceiver is specially designed for data conversion purpose.

II. The link layer: The balance code is used with CRC calibration and sum calibration. The signal bus supplies power to detectors when it transports signals. The transmission rate is 16 kbps. Fig 3-1 shows the basic structure of the balance coding. The coding is symmetrical and self-calibrating. It has no special requirement to the wave-shaped edge and has the features of high resistance to disturbance, long transporting time and high reliability.

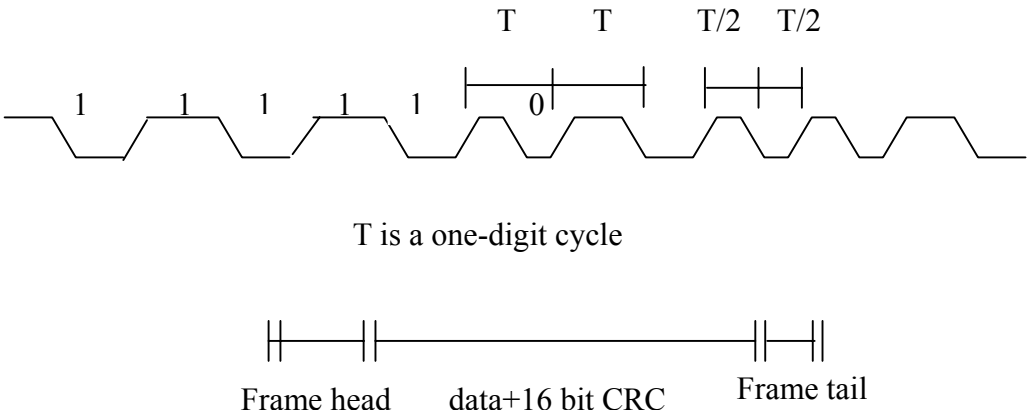


Fig3-1 Coding structure of special digital bus

III. The network layer: An independent addressing is used and the node coding is not restricted by the protocol.

IV. The transport layer: It provides acknowledged messages, and the calibration can be CRC calibration or sum calibration according to the degree of data importance and the spectrum of transport so that the communication is more reliable and effective.

The network between control units and detectors is a kind of master-slave, low speed, ring-type network. It has a characteristic of collision detection. Using twisted pair to transit signals and power, each control unit can be connected with 128 field devices. The network uses a kind of special digitized protocol, which includes network management, field device static signal transmission, and fire data pre-treatment.

Network management protocol regulates the manner of automatic distribution about logical addresses of the field devices. Each field device has only one number. During the period of network installation, the number is the only identifier of a detector by means of which the system can do double addresses tests and the logical addresses re-distribution.

Field devices static signal transmission protocol regulates the static signals exchange mode between control units and detectors. The static signals include production date, batch number, history and fire sensitivity etc.

Fire data pre-treatment protocol regulates the dynamic data exchange mode between control units and detectors. The protocol of the data transmission mode is based on interrupt, insuring that the signals can be transmitted rapidly and efficiently when needed. The data can be fire alarm signals or field signals pretreated by detectors.

ASIC with the firmware of special digitized bus protocol will be used in field devices. The matched circuits are also used in control unit. The data exchange is accomplished by coordination of the firmware. The custom design insures the stability and speed of the data transfer.

The protocol conforms to the requirement of the network in this layer and is also applicable for various security systems.

## 3.2 Control Unit Management Network

Fire alarm systems are usually composed of several kinds of units, such as central management unit, field devices control unit, repeater control unit, remote communication control unit, and remote printer unit etc. Various units have separate functions. More than one identical unit might be in the same fire alarm system. The network interconnects the units to accomplish a complete task.

The internal network of the system is LonWorks, a kind of field bus network based on LonTalk protocol promoted by ECHELON USA in 1993. LonTalk protocol follows ISO OSI reference model for network protocol and operates as national standard of ANSI/EIA709.1. The protocol has been integrated in the Neuron Chip named Neuron 3120, 3150 Chip. The nodes using Neuron Chip for controlling can communicate with the other nodes on the same network via the network variables. For the integrality of the network protocol, the internal network communication is simplified.

The structure of the fire alarm system is very flexible. The topological structure of the network can be changed according to the structure of protected area. The network structure can be compacted mode, distributed mode, or mixed mode of both.

The control units in the system can be connected directly with twisted pair when the compacted mode is adopted, and the transmission rate is 78kbps. Network communication can be realized using various transceivers through various media, such as twisted pair, power line, optical fiber, when the distributed mode is adopted. A router is necessary in order to connect the compacted part with the distributed part when the mixed

mode is adopted.

Many management units might be in the same network when the distributed mode is adopted. The functions of the management units can be set by software. Users can get custom designs for their fire alarm systems.

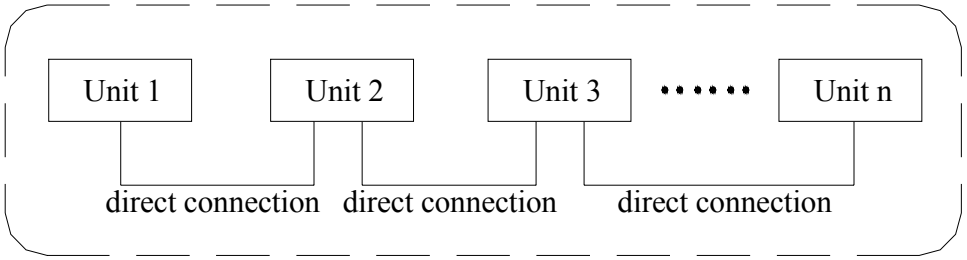


Fig3-2(a) The second layer network topological structure-the compacted mode

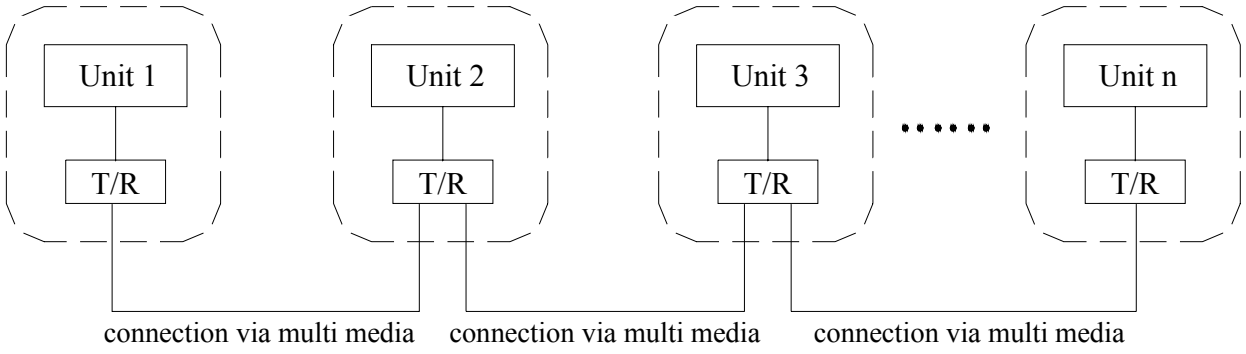


Fig3-2(b) The second layer network topological structure-the distributed mode

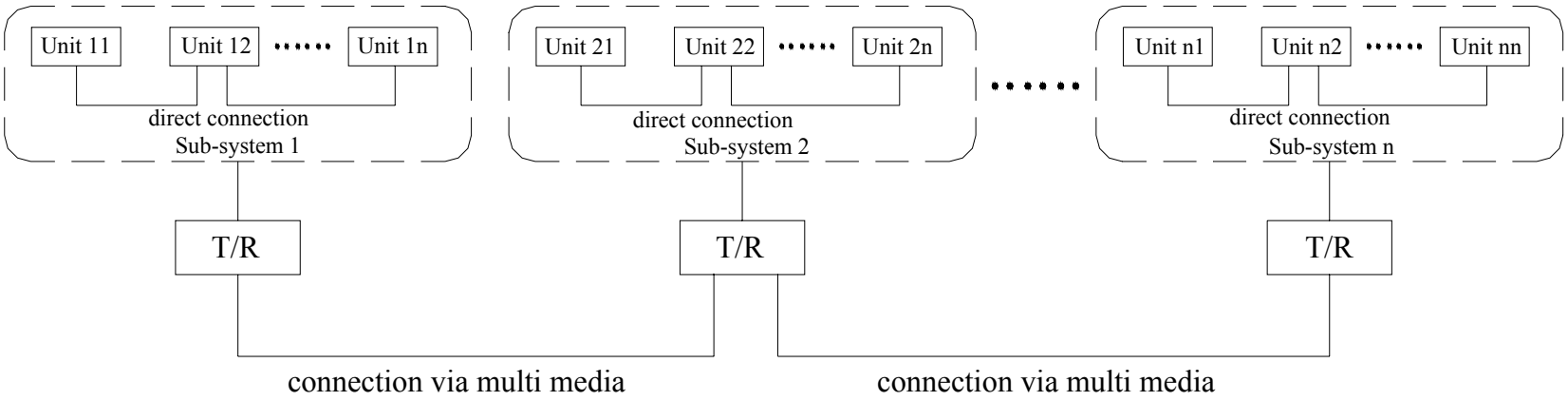


Fig3-2(c) The second layer network topological structure-the mixed mode

### 3.3 Open Data Interface

The diversity and open characteristic of LonWorks makes this system be widely used in the area of building automation and industry control.

The signals of the fire alarm system can be divided into private type and shared type. The shared type signals are presented by network variables meeting LONMARK standard. The standard network variables are approved and managed by LONMARK organization specially. Because LONMARK standard is an open standard, the systems approved by LONMARK organization can communicate with each other directly.

The interfaces have been designed for various media, such as twisted pair, optical fiber to fulfill the needs of users. The fire alarm system can directly connect to the other control systems meeting LONMARK standard via these interfaces.

## 4 Application Sample

We have designed an application system for Guangzhou subway using this fire alarm system. The subway system has 20 stations, 2 transformer stations, 1 vehicle center, and 1 control center.

The network system consists of two LonWorks ring-type networks, one is a twisted pair ring type network connected with the main control computer, standby control computer and a fire alarm control unit. The other is a fiber-optic ring type network connected with fire alarm control units of the stations. These two parts are connected with a router.

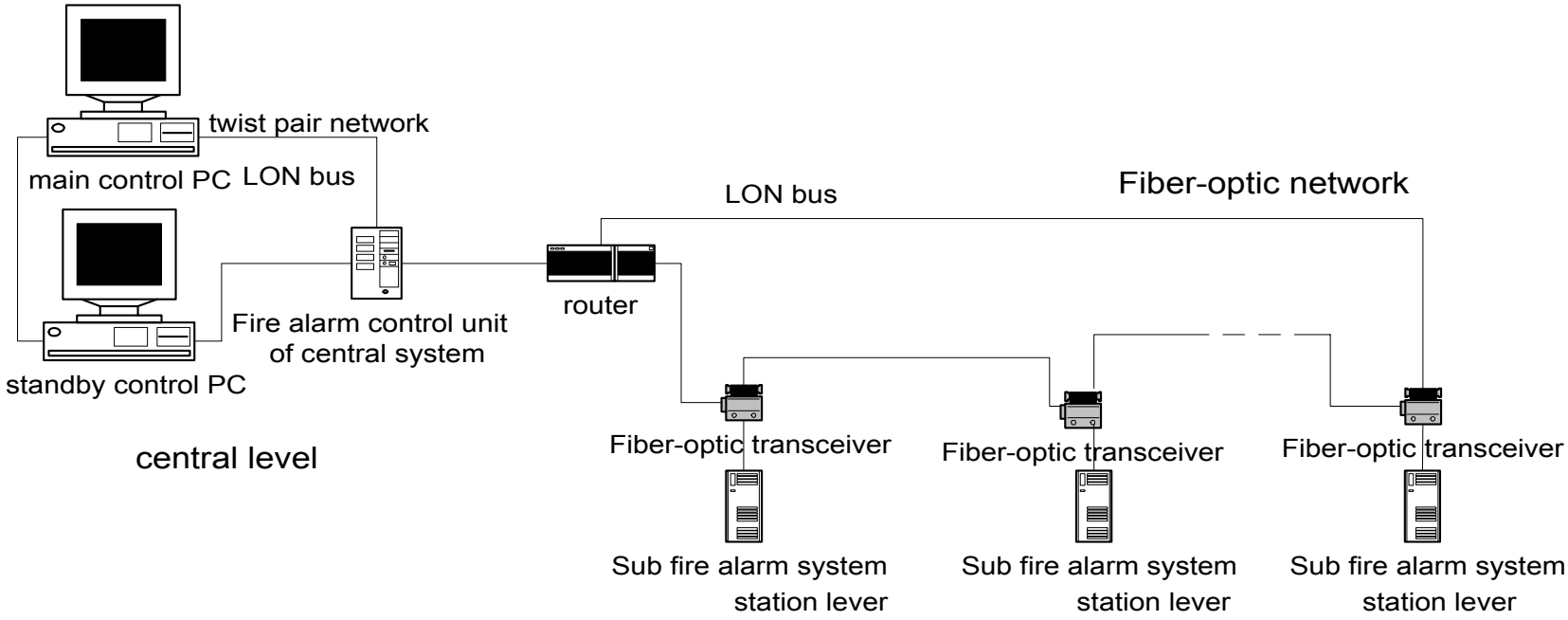


Fig4-1 Chart of the fire alarm system

The system is a distributed network system. The control unit of the station is a compacted mode fire alarm system. Each control unit is composed of a central management unit, field devices control unit and a repeater control unit. The control units are interconnected by the fiber-optic transceiver. Each node of the system can communicate with other nodes by peer to peer mode. The control center can get all the information within the network and save it to the system database and sends commands to the control units. The fire alarm control unit can work in network mode, performing the orders of the control center, and it also can work independently when the network failed. With the authorization the control units can also upgrade to a control center of part of the network or the whole network when needed.

## 5 Review

This paper introduces a new kind of fire alarm control system. The flexibility of the system makes it suitable for all kinds of fire alarm systems, especially the large distributed fire alarm control systems.

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