Research on Transformation method of URIs Domain name system based on ETB

Jiachen Liu, Yi Qiao, Yang Li, Shunde Wang

Institute of Electrical and Information Engineering, Dalian Jiaotong University, Dalian 116028, China

Abstract

With the application of Ethernet in high speed EMU, ETB (Ethernet Train backbone) will become the main trend of train communication network in the future. For the domain name system of train communication network, a domain name system based on IEC61375-2-3 is proposed to map the host name to IP address.

Keywords

IEC61375-2-3, ETB, DNS, URI.

1. Introduction

Server addressing is an important part of communication system, which determines the endpoint and communication partner of communication relationship. Communication or addressing associated with this can be defined between physical entities, such as physical devices or people, or between more abstract objects, such as applications or system functions. In IEC 61375-2-5, a train-level addressing mode for physical entities is defined. The standard defines a scheme for addressing the TCwhole vehicle range on a train. At the functional level, a more abstract addressing scheme based on N domain name is defined, which is equivalent to the domain name system of the Internet. IP address The main reasons for the introduction of an additional addressing scheme based on：

(1)Can be used to resolve abstract functions rather than device-related IP addresses. For example, the same functionality can be accessed through different IP addresses in different combinations, but these combinations all have the same name;

(2)You can change the IP address without affecting the domain name;

(3)Can better understand and explain domain name. This will become even more important when you use IPv6 addresses in the future.

Functional addressing is related to logical functions. The source of information may be a function within a vehicle or group, the destination address of the information may be a function within a vehicle or group, or it may be a function between multiple or all marshalling, A function can be implemented by one or more terminal devices in a group.

2. TCN domain name system

The TCN Domain name system (TCN DNS) defines a hierarchical, domain-based naming scheme that relies on a distributed database system to implement the naming scheme. Its main purpose is to map host names to IP addresses.

2.1 **TCN Domain name Space and region**

The communication entity (source and destination) should be defined by the standard TCN domain name.TCN domain name space derived from the TCN domain name space by the tree structure with the local train as the root. The next level in the root directory is defined by the closed train subdomain,

the closed train subdomain is composed of the marshalling subdomain and the vehicle subdomain that ends in the host, and the host is managed. Equipment for logical functions. For land communication, the entire TCN DNS domain name space can be mapped to a superior intranet owned by a train operator or a maintainer. In this case, the mapped TCN DNS namespace can be identified by the operator's specific root name to identify.T CN DNS domain space is divided into multiple zones, each zone is managed by an authoritative DNS name server. One possibility is to define a sub-domain as a zone, and an authoritative DNS domain name server is responsible for the zone. In the case of several networks the marshalling subdomains in several zones are subdivided and the DNS domain name server delegates these zones to the DNS name server.

2.2 Unified source identifier structure

The unified source identifier (TCN URI) schema syntax is defined by RFC 3986 using Backus Naur Form (BNF) notation. It is defined by the basic elements of some syntax, which are listed in the following table. The definition of this architecture is different from that of RFC 1035:

Limit to a maximum of 15 characters (RFC 1035: 63 characters allowed);

The first character cannot be a number (RFC1035 allows digits).

Table 1 Basic syntax of TCN URI

label	alpha 1[uchar]13 alphanum
uchar	Alphanum mark
alphanum	Alpha digit
alpha	‘a’-‘z’,‘A’-‘Z’
digit	‘0’-‘9’
mark	‘-’

The TCN URI identifier is used to identify the source function / device and the target function / device of the information. The following table defines the general schema for the TCN URI.

Table 2 General structural syntax

TCN URI	[scheme‘:’‘//’]user‘@’host
scheme	‘trn’
user	usr
host	fctdev‘.’vehicle‘.’consist‘.’[cltrain‘.’]train‘.’

According to this definition, the TCN URI definition can be written as:

trn:usr@fctdev.vehicle.consist.cltrain.train

The host portion of the TCN URI can be resolved to an IP address by the TCN DNS service. The tag "fctdev" is used to identify the logical device that is implementing the addressing service function, which can be a single or more physical devices.

In a communication relationship, the source and destination of the information are identified by the TCN URI. The range of specific TCN URIs is different from that of source-dependent or destination dependent. TCN URIs, and their syntax rules are different. Usr parts can be used to apply configuration files to distinguish different functions and instances located on the same physical device.

2.3 Mapping TCN URIs to IP addresses

The resolution of mapping TCN URIs to IP address URIs is usually managed by TCN DNS service .IEC 61375-2-5 to assign IP address range 239.192.0.0 / 14 for train grade IP MC groups. In order to combine this address range with the defined TCN URI structure, especially for auxiliary groups limited to a marshalling, the decomposition of the address range of an assigned IP MC group must be defined. General decomposition is defined as11101111.110000rr.zzzzzzzz.zzzzzzzz, where the fields are shown in Table 3.

Table 3 General decomposition of the address of the IP MC group

Subnet digital part	
[r]	Definition range: ‘00’B = Vehicle range ‘01’B = ETB related marshalling ‘10’B = Finite composition formation ‘11’B = Indeterminate
[z]	Further decomposition

The whole train group is a group associated with different ETB in the train. The decomposition of all train groups is defined as:

11101111.11000000.gggggggg.gggggggg

The numerical range of [g] is 0-65535, in which 0-255 is defined in IEC 61375-2-5 and 256-65534 is reserved for user-defined user 65535.

A full train group containing IP MC groups from terminal devices operating networks and multimedia networks. If the FUNCTION_INFO parameter ETBID is set to 255, a full train group address should be assigned to that parameter. Because the whole train group may contain different ETB TopoCnt values for the ETDPs, the use of TRDP to communicate with the whole train group is problematic. ETB TopoCnt is included in the TRDP header. And is used by the target terminal device to verify the correctness of the received message if it contains The message will fail if the ETB TopoCnt value is associated with the ETB. Using gateways between ETBs to change the etbTopoCnt value may be a solution, but a complex.ETB-dependent group is defined as a group .ETB-related group that is a member of an ETB-related group:

11101111.11000000.bbgggggg.gggggggg

The subnet part [b] is the ETB identifier (ETBID) in the range of 0-3, an the host part [g] range is 0-16383;0 for all terminal devices; 1 for all ECSP (only ETB0); 2-16382 foruser definition;16383 is reserved .

An IP MC group containing only terminal devices from an operating network is an ETB related group. An IP MC group containing terminal devices from a multimedia network is another ETB related group. A finite grouping of ETB-related groups, all of which belong to one group. The decomposition of finite marshalling is defined as follows:

11101111.11000001.bbcccccc.gggggggg

The subnet part [b] is an ETB identifier (ETBID) with a range of 0-3;[c] is a train marshalling number, with a range of 1-63;0 is local marshalling.The host part [g] group number ranges from 0-254;0 is the terminal equipment of all networking connected to ETB;1 for all ECSP (ETB0 only) ;2-254 for the user definition;255 is reserved .

The group identifier must be unique in the group. The same 8-bit group identifier value range is used for vehicle restriction groups and marshalling qualified groups, so it must be shared. For example:the group defined at the marshalling level ("grpHMI.aVeh.lVeh") is different from the group defined at the vehicle level (e.g. "grpHMI.veh02.lCst"). Encode "all Ed" by setting all grp-id bits to 0 instead of 1. To avoid confusion, use this convention because the grp-id bit set to 1 can also represent all groups.

2.4 join IP multicast groups

In order to join the IP MC group, the whole train and ETB related groups have defined the IP MC address that will not change when the train composition changes, so it is feasible for the terminal equipment to join the group when the system starts. Finite marshalling is a dynamic IP multicast group with IP multicast group addresses that may change after each train starts. Because of its dynamic nature, all terminal devices joining such a group need to leave the group at the beginning of the new train and join with the new IP MC address again. Another recommended solution is to route

IP packets from ETB to ECN (ETBN) at the same time Time conversion IP MC address. DURIng this network address translation, the [c] bit representing the train number in the IP MC destination address may be replaced by 0 (local number). In this case, it is feasible for the terminal device to join a group at system startup. Terminal devices capable of receiving TRDP messages from limited marshalling and ETB-related or full train groups should be added to two IP MC groups. Some TCN URIs mapped to IP addresses are predefined and do not need to explicitly resolve URIs via TCN DNS.

Table 4 commonly used TCN URIs

TCN URI(Mainframe part)	Scope	IP	Describe
grpAll.aVeh.aCst.aClTrn.lTrn	D	239.193.0.0	Broadcast to all terminal devices associated with ETB0
grpAll.aVeh.lCst.lClTrn.lTrn	D	239.194.0.0	Broadcast to all terminal devices associated with ETB0 in the local marshalling
grpAll.aVeh.lCst.lClTrn.lTrn	D	239.255.0.0	If all terminal devices are connected to the same network (only one network is connected to ETB), all terminal devices broadcast to the local component are replaced. Note: this address is defined in IEC 61375-3-4.
lDev.lVeh.lCst.lClTrn.lTrn	S,D	127.0.0.1	This equipment (local closed loop)
grpECSP.anyVeh.aCst.aClTrn.lTrn	D	239.193.0.1	Broadcast to all ECSP

Each terminal device in the network subscribes to 239.194. 0. 0.ETBN uses the results of the ETB initial run to add rules to the MC routing table with its address 239.194.X. 0,Where X represents their own marshalling (X = trnCstNo+ (ETBID× 64).)All other addresses with a range of 239.194.X. 0 will not be routed to ECN.When routing from ETB to ECN, ETBN converts MC address 239.194.X.0 to 239.194.0.0.

Where there are more than one network in a group:Data packets with destination address 239.194.0.0 must be processed by ETBN in this group in order to transmit them to all networks. One solution is to route it from the source network to ETBs and translate the target address to 239.194.X. 0.Another solution is that the ETBN in the source network uses IP unicast to transmit packets to other ETBNs in the group, and then the target ETBN retransmits the packets to their network in multicast.The first method is easier to implement, but the packet will be sent to all ETBNs in the train. More support from ETBN is required, but packets will never leave the network.

3. TCN DNS server

The part of the TCN URI host is specified in RFC 1034 and RFC 1035 with the help of the defined TCN DNS resolution to the interaction between the IP address. DNS client and the local DNS server.

Each marshalling shall provide at least one authoritative DNS domain name server.Marshalling domains can be divided into zones, each of which has its own DNS name server.A special case is a grouping of separate operations and multimedia networks, in which two dedicated DNS name servers can be provided, one for operating the network and the other for the multimedia network.Marshalling DNS servers should be able to resolve the TCN URI host portion to the corresponding IP address.As shown in the following figure, a given train consisting of three formations has two train backbone networks: ETB0 (operational network "op") and ETB1 (multimedia network "MM"). For ETB0 and ETB1TCN reference directions are equal.

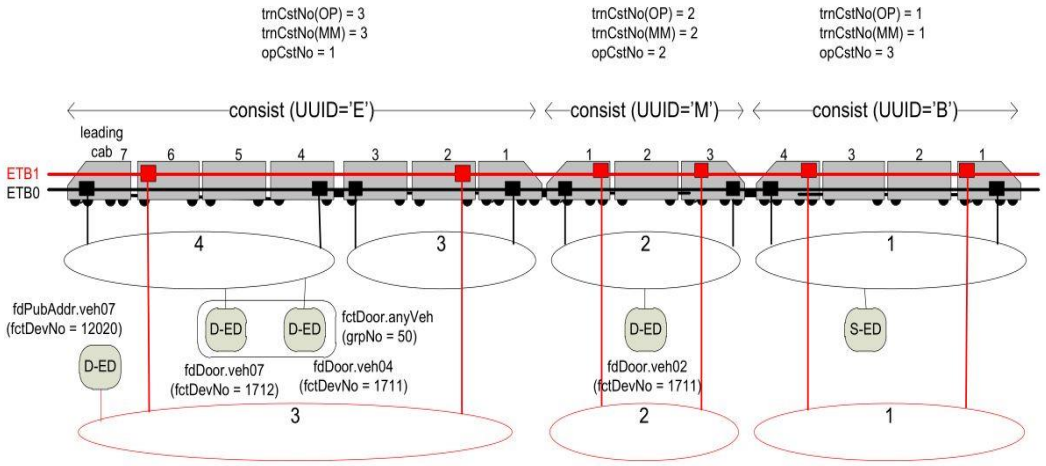

Fig. 2 TCN URI parsing

Due to the position of the head car, the operation number is opposite to the TCN number of ETB 0.The marshalling with a universal unique identifier of "E" contains two ECNs corresponding to ETB0 and an ECNs corresponding to ETB1. Each ETB in the other groups corresponds to only one ECN.In addition, suppose that there are two DNS name servers, one for operating the network and the other for the multimedia network, and the terminal device connected to either of the two networks uses the associated DNS name server for address resolution.Each ETB has a train topology database that shares partial information in accordance with the defined rules.

This task will target the source terminal device located in the marshaled universal unique identifier "B" and connect to the operating network to parse the TCN URIs of the two destination terminal devices shown:

The terminal device "doorCTRL@fdDoor.veh02.cst02.anyClTrn.lTrn" is in the marshalling of the universal unique identifier as "M";

The terminal device "public Announce@fdPubAddr.anyVeh.leadCst.anyClTrn.lTrn" is in the marshalling (header)of the universal unique identifier as "E"; In addition, in order to resolve the group address of the gate controller group for train grade marshalling and limited marshalling (shown in the figure as group "E"), as a train wide group and as a combination limiting group, the group "doorCTRL@fctDoor.anyVeh.aCst.aClTrn.lTrn" is in the train.Group "doorCTRL@ fctDoor.anyVeh.cst01.anyClTrn.lTrn" is in group E.In order to resolve the TCN URI "doorCTRL@ fdDoor.veh02.cst02.anyClTrn.lTrn" ETB0 DNS server must perform the steps listed in Table 5.

Table 5 TCN URI parsing

Step	Movement	Result
1	Isolate the TCN URI host portion and peel off the unwanted portion	= “fdDoor.veh02. cst02”
2	Find "cstUUID" labeled cstNot2 in the train directory in the local train topology database	= “M”
3	Search for "cstUUID" in the marshalling information list	CONSISTINFO record in number M
4	Search [fctName= "fdDoor"] and [cstVehNo = 02] in the array of functional information recorded by CONSISTINFO, and retrieve the values of the parameters fctIdtetbNo and cnNo.	fctId=1711 etbNo=0 cnNo=1
5	The value of "subnet id" can be derived from the directory of the train network associated with ETB0	subnet id=2
6	Calculation of IP address according to IEC 61375-2-5 from parameter values: etbNo,subnet id and fctId	IP=10.128.134.175

Group DNS name servers should implement DNS protocols as specified in RFC 1034 and RFC 1035 . Group DNS name servers should accept recursive client queries, as shown in the example of Figure 2 . The destination TCN URI within a local or remote group should be resolved within 1.0 seconds . Start measurement time from the query until the answer is sent to the client .

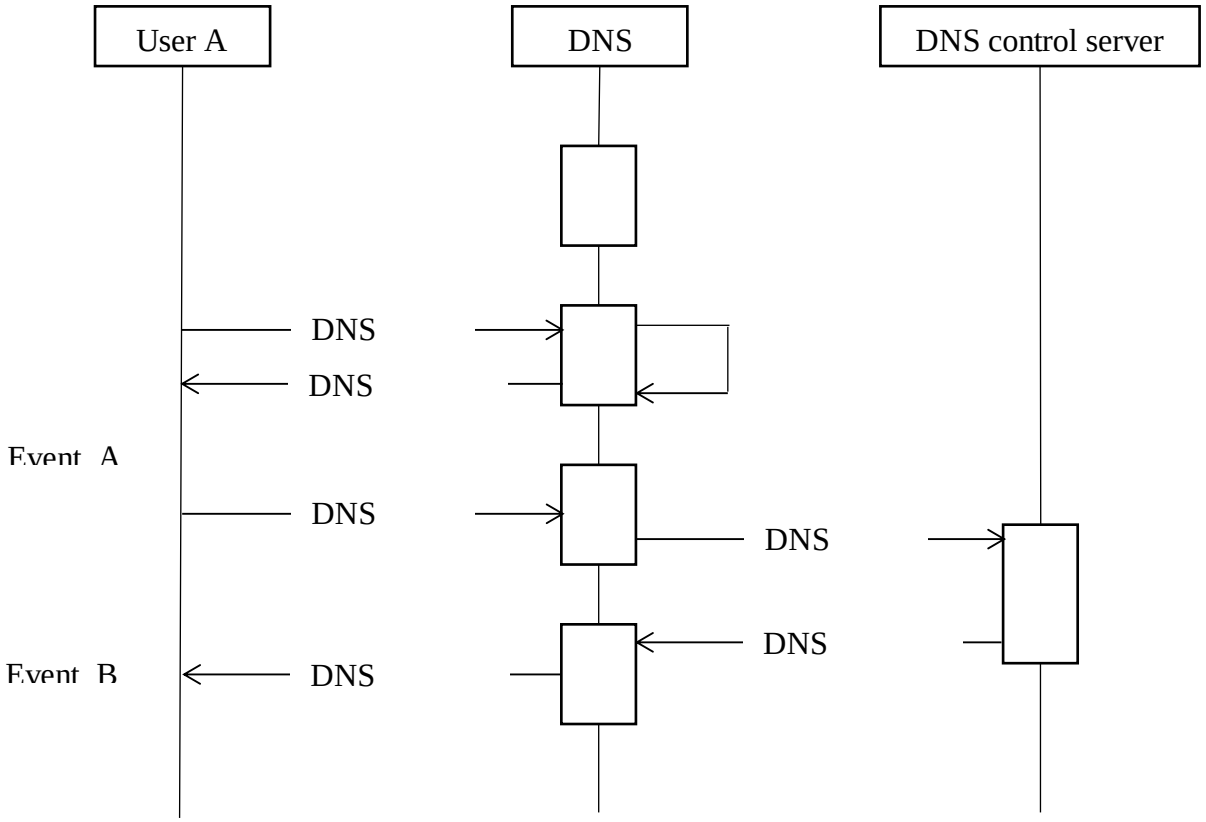

Fig. 2 DNS protocol

4. Conclusion

The mapping of CN URIs to IP addresses is ETB specific for inter-group communication because it depends on the train network directory of a particular ETB. Therefore, a TCN DNS server should be provided for each ETB.Each feature should use the TCN DNS server for TCN URI address resolution, which is related to the ETB that the feature wants to communicate with. Addressing in different marshals can result in different IP addresses, depending on the ETBs used for communication.Note that the return path for inter-group communication will use the same ETB, and the returned message will use the original sender's IP address as the destination address.

References

[1] IEC 61375-1: Part 1: Electronic railway equipment-Train communication network(TCN) - Part 1:Train Communication Network[S],1999.
[2] IEC 61375-2-3-2015: Electronic railway equipment - Train communication network(TCN) - Part 2-3: TCN communication profile[s],2015.
[3] IEC 61375-2-3-2015: Electronic railway equipment - Train communication network(TCN) - Part 2-5: ETB - Ethernet Train Backbone[s],2014.
[4] Shunde Wang, Ying Liu. Research on address Translation method of Train Network based on ETB [J]. Railway rolling stock, 2017 (6): 36-38.