U.P.B. Sci. Bull., Series C, Vol. 69, No. 3, 2007 ISSN 1454-234x

INTERSTRUCTURE - A SOLUTION FOR IMPROVEMENT OF TRANSPORTATION TELECOMMUNICATION APPROACH

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Având în vedere tranziția comunicațiilor spre medii fizice cât mai performante şi mai stabile din punct de vedere al standardizării dispozitivelor implicate, vom arăta că noua generație de echipamente de comunicații şi noile modele de management al serviciilor oferite utilizatorilor în domeniul transporturilor pot fi gândite ca ***interstructură****. Ceea ce aduce nou acest concept de* ***interstructură*** *este diferențierea telecomunicațiilor de infrastructură şi suprastructură şi înglobarea acestora (a telecomunicațiilor aplicate în transporturi) într-un termen ce le poate deosebi în practică. Cu alte cuvinte, atunci când vorbim de mentenanța* ***interstructurii*** *excludem din start ideea că se acționează asupra unui element din infrastructura locului respectiv sau asupra suprastructurii existente în acel loc. Vom aborda subiectul din punctul de vedere al transporturilor, deoarece în acest domeniu există studii specifice şi o delimitare mai clară a conceptelor de infrastructură şi suprastructură. Elementul inedit este acela al abordării noului concept prin delimitarea zonei de mijloc dintre infrastructură şi suprastructură prin* ***interstructură,*** *acesta venind în sprijinul administratorilor de rețele ITS (Intelligent Transportation Systems) şi poate pe viitor al administratorilor de echipamente de telecomunicații care, de exemplu, proiectează un suport de comunicație pentru o instituție utilizând infrastructura şi suprastructura acesteia pentru a obține propria* ***interstructură*** *pe care să o administreze într-un regim de independență față de primele două.*

Based on communication transition toward much more performance for physical media and a better stability from device standardization point of view involved, we shown that the new generation of telecommunication equipments and new management models from transportation area could be merged in ***interstructure****. What is new about this concept* ***interstructure*** *is that it separate transportation telecommunication area from infrastructure and superstructure and involve this one in a single term so that make it easier to distinguish in practice. In other words, when we discuss about* ***interstructure*** *maintenance we exclude from the outset that we operate on the infrastructure component that is placed in a specific area or on the superstructure existing in that particular site. We tackle this subject from the transportation point of view, because in this domain there are specific studies and the differences between infrastructure and superstructure are clearly delimited. The novelty is that the concept are analyzed through delimit a middle area between infrastructure and superstructure and call it* ***interstructure****, this concept line up behind ITS administrators and in the future could help*

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telecommunication equipment administrators which, for example, design a communication support of a institution using it infrastructure and superstructure for obtain their ***interstructure*** *who they can administrate as an independent entity against the first two.*

Keywords: interstructure, Ethernet, transportation, traffic, infrastructure, protocol, communication, standard, network, framework

1. Introduction

We can affirm that is the first time when this subject of ***interstructure*** is discussed and this word doesn't exist at this moment in any dictionary. There are no other studies about this type of approach, so the research will start with this study.

If we start with the necessity of integrated communication infrastructures and add the needs of management services, we will see that these services become very important for developing new ideas and add new possibilities to improve public services in transportation area. This new concept introduces the separation of all software and hardware equipments from what we call infrastructure or superstructure of a specific area of interest for population. We will try to define ***interstructure*** concept and refer primarily at transportation telecommunications then we will show the utility of concept.

2. The definition of a new concept for transportation communication

The new concept is defined as:

In·ter·struc·ture *(ĭnˈterə-strŭkˈchər) n.*

1. *All components that assure simultaneously, directly or indirectly maintenance for a construction and for any entity that use it.*

2. *All equipments that assure a good functionality for infrastructure and superstructure through interworking of maintenance elements.*

This concept is the entity which ties the infrastructure with the superstructure – and is placed on the boundary between them (see fig. 1). The purpose of this concept is to protect both structures and assure that will be no misunderstanding when people refer to equipments that are placed on the ***interstructure*** *level. The term refers especially to all communications and new technologies that merge with transportation area in the first place. Techniques* *like monitoring networks and implementing media (fiber optic, UTP- Unshielded Twisted Pair, router[2], switch[3] etc) can be part of this concept.*

This definition relies on three fundamental concepts:

In·fra·struc·ture (ĭnˈfrə-strŭkˌchər) *n.*

1. An underlying base or foundation especially for an organization or system.

2. The basic facilities, services, and installations needed for the functioning of a community or society, such as transportation and communications systems, water and power lines, and public institutions including schools, post offices, and prisons.

inˌfra·strucˈtur·al *adj.*

Usage Note: The term *infrastructure* has been used since 1927 to refer collectively to the roads, bridges, rail lines, and similar public works that are required for an industrial economy, or a portion of it, to function. The term also has had specific application to the permanent military installations necessary for the defense of a country. Perhaps because of the word's technical sound, people now use *infrastructure* to refer to any substructure or underlying system. Big corporations are said to have their own financial infrastructure of smaller businesses, for example, and political organizations to have their infrastructure of groups, committees, and admirers. The latter sense may have originated during the Vietnam War in the use of the word by military intelligence officers, whose task it was to delineate the structure of the enemy's shadowy organizations. Today we may hear that conservatism has an infrastructure of think tanks and research foundations or those terrorist organizations have an infrastructure of people sympathetic to their cause [1].

Su·per·struc·ture (so͞oˈpər-strŭkˌchər) *n.*

1. A physical or conceptual structure extended or developed from a basic form.

2. The part of a building or other structure above the foundation.

3. The parts of a ship's structure above the main deck.

4. The rails, sleepers, and other parts of a railway [2].

Sub·struc·ture (sŭbˈstrŭkˌchər) *n.*

1. The supporting part of a structure; the foundation.

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[2] Router – A device that forwards data packets along networks. A router is connected to at least two networks, commonly two LANs or WANs or a LAN and its ISP's network. Routers are located at gateways, the places where two or more networks connect. http://www.webopedia.com/TERM/r/router.html .

[3] http://www.webopedia.com/TERM/s/switch.html

2. The earth bank or bed supporting railroad tracks [3].

Analyzing the above definitions we can frame ***interstructure*** between those known concepts as belong to each one into equal parts and in the same time to have their own roles. We call it Xstructure and will try to make a correspondence with OSI levels (from computers approach) and NTCIP (from transportation approach) in the next paragraphs. The ***interstructure*** can show the ITS manager how the signals and commands for remote devices are transported.

If we think one type of transport like a sum of equipments and define: i_k = infrastructure; s_k = superstructure and substructure; ξ_k = interstructure, A_k = the vehicles - mathematical approach will be:

$$\sum_{1}^{n} i_k + \sum_{1}^{m} s_k + \sum_{1}^{n} \xi_k + \sum_{1}^{n} A_k = T$$

Where k,n $\in$ N and T = an transportation area that is full functioning.

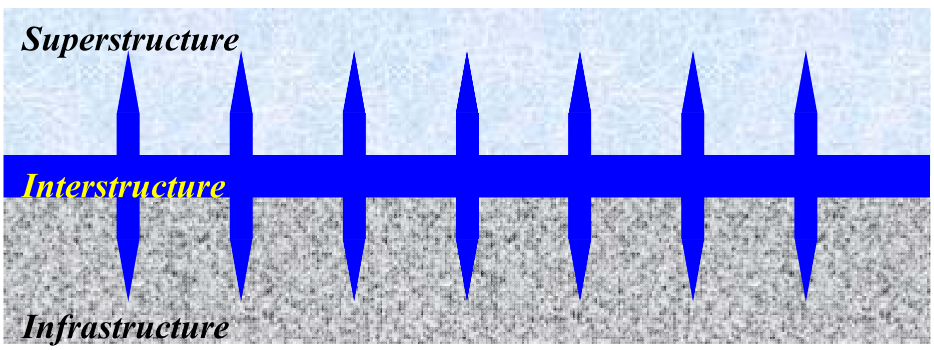

Fig. 1. **Interstructure** affiliation zone– conceptual representation (X**structure**)

3. Arguments for *interstructure*

A transportation telematic system could not exist without data and/or voice communication. The development of communications especially in transportation area depends on good architecture and implementation of research projects [4]. If the communication architecture will be plan using the ***interstructure*** concept, then the standardized layers who give access to the information will be more accurately delimited.

Let's go back now to the definition of ***interstructure***: when we say *"all components that assure the concomitant, directly or indirectly maintenance for a construction and for any entity that use it",* we can consider an example from transportation area. If we think a video camera for surveillance of traffic as equipment dedicated to observe a specific area from a road, we can use this equipment for observing the carriageable, if there are splits in the road and we can interfere for redress the infrastructure or the superstructure. So, "video camera for traffic surveillance" is a part of ***interstructure.*** In this moment all ITS administrators are aware of difference between the superstructure of a specific location and the video camera that is not a part of that superstructure and is part of his level of action – ***interstructure***.

According to the most recently studies[4], important classification have been realized regarding to intelligent transport systems. In this studies appear intelligent infrastructure and intelligent vehicles as new terms. We include the following systems: traffic control systems, parking management systems, variable message signs, highway advisory radio etc., in ***interstructure***, so any equipment that offers better services for transportation using telecommunications can be included in our concept.

The Internet is changing every aspect of our lives — education, research and more. Behind all this success is the underlying fabric of the Internet: the Internet Protocol (IP). IP was designed to provide best-effort service for delivery of data packets and to run across virtually any network transmission media and system platform. The increasing popularity of IP has shifted the paradigm from "IP over everything," to "everything over IP". In order to manage the multitude of applications such as streaming video, voice over IP, e-commerce, and others, a network requires quality of service (QoS - Quality of Service) in addition to best-effort service. Different applications have varying needs for delay, delay variation (jitter[5]), bandwidth, packet loss, and availability. These parameters form the basis of QoS. The IP network should be designed to provide the requisite QoS to applications. On the other hand, a file transfer application, based on ftp, doesn't suffer from jitter, while packet loss will be highly detrimental to the throughput [5]. These new and advanced technologies will become normally technologies and will be used by anyone for day to day information. This part of communication technologies can be included too in the ***interstructure*** for tomorrow.

If we refer to the second definition of ***interstructure***, we can think at ITS device servers that are facilitators of *telematics,* the new wave of technology for the transportation industry, this concept is a ***interstructure*** concept. Telematics is defined as data communications between systems and devices. It incorporates networked products in a vehicle, so a person can download information onto the central computer system, on board systems and sensors for driver protections etc. For example, a tire company can analyze tire performance for pressure, safety and environmental data. Data is collected on a pressure sensor mounted to the tire and

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[4] Information is from www.benefits.its.dov.gov

[5] Jitter is the deviation in or displacement of some aspect of the pulses in a high-frequency digital signal. As the name suggests, jitter can be thought of as shaky pulses. The deviation can be in terms of amplitude, phase timing, or the width of the signal pulse.

submitted to the telematics module. All equipment that are not only a part of the vehicles but can connect with infrastructure and superstructure thought wireless or radio communication, or even Ethernet can be ***interstructure*** [6].

On the basis of all applications transition toward IP we can accept that all telecommunication equipments must use this technology to be improved functional parameters. For example, a good decision in the future will be that all RS 232 interfaces descend to Ethernet medium. This is possible by adding networking equipment that enable remote access of semaphore, video camera and other monitoring equipment. A conclusive example of how information could be collected from traffic is represented in Fig. 2 [7].

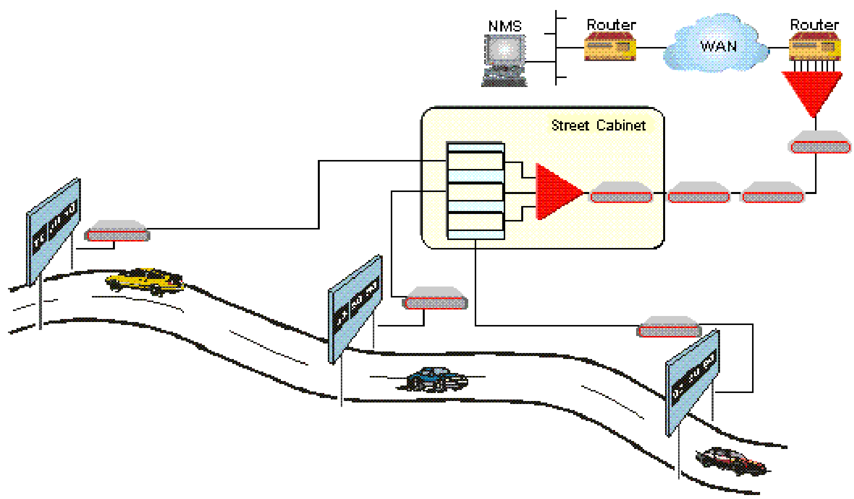

Fig. 2. Collecting data from traffic[6]

Building Ethernet connectivity into a product is no simple task. It requires a significant investment in hardware and software integration – often in areas outside of core competencies. Device networking starts with a device server. These solutions enable most any device with serial capability (TTL- Transistor-Transistor Logic) to become a fully functional member of an Ethernet network. Device servers include all of the elements needed to network-enable equipments – a processor, real-time operating system, a robust TCP/IP stack, a web server, and a network connection. All the connected product additionally needs is a header, providing connections to a power source and to a TTL serial port.

The IP attributing to every serial device in transportation field to collect and offer information to traffic monitoring department and also to all agencies and persons involved in traffic will be an inherent advantage. Serial interfacing could

[6] From http://www.rad.com/Article/0,6583,13601,00.html , NMS – Network management system, WAN – Wide area network

be accomplished via a TTL connector, and for Ethernet access, an RJ 45 (10/100 Base -T) must be available [8].

Rehearse this possible services sustain by IP and the most widely used medium as Ethernet we notice there are many details and aspects who can be included in ***interstructure*** concept: equipments that can accept a serial port and dynamic participates at the telecommunications process, networking devices (router, switch, repeater, fiber optic, etc) that could not be considered infrastructure or superstructure. If we think and look at this communications field as an ***interstructure*** we can develop this area of transportation telecommunications more easy and for better understanding of this new domain we must understand NTCIP - The National Transportation Communications for ITS Protocol.

4. The National Transportation Communications for ITS Protocol (NTCIP) as a part of *interstructure*.

NTCIP family of standards defines protocols and profiles that are open, consensus-based data communications standards. When used for the remote control of roadside and other transportation management devices, the NTCIP-based devices and software can help achieve interoperability and interchangeability. NTCIP allows agencies to exchange information and (with authorization) basic commands that enable any agency to monitor conditions in other agencies' systems, and to implement coordinated responses to incidents and other changes in field conditions when needed. Such data exchange and coordinated response can be implemented either manually or automatically. One agency can monitor, and issue basic commands, if authorized, to field devices operated by another agency, even though those devices may be from a different manufacturer than those used by the monitoring agency.

NTCIP allows a management system to communicate with a mixture of device types on the same communications channel. For example, with the addition of appropriate application software in the system computer, a dynamic message sign could be installed near a signalized intersection, and the computer could communicate with the sign controller using the communications line or channel already in place for the traffic signal controller, if certain aspects of the communications protocols, that is, the Data Link and Physical layer protocols are the same[9].

NTCIP defines a family of general-purpose communications protocols and transportation specific data dictionaries/message sets that support most types of computer systems and field devices used in transportation management. Applications for NTCIP are generally divided into two categories: C2F (center to field) and C2C (center to center) – this communications could be ***interstructure*** flows. The former, normally involves devices at the roadside, communicating with management software on a central computer. C2C applications usually involve computer-to-computer communications where the computers can be in the same room, in management centers operated by adjacent agencies, or across the country.

If every connection between center to center and center to field are considered as the ***interstructure*** between to points of a management system will be easier to discuss about traffic monitoring and management centers. The NTCIP communications levels can be sublevels of ***interstructure.***

NTCIP uses a layered or modular approach to communications standards, similar to the layering approach adopted by the Internet and the International Organization of Standards (ISO). In general, data communications between two computers or other electronic devices can be considered to involve the following primary layers, called "levels" in NTCIP, to distinguish them from those defined by ISO and the Internet. The NTCIP standards publication numbers are grouped in number ranges to indicate the standard type and the *level* where the standard goes.

Information Level – contains standards for the data elements, objects and messages to be transmitted, for example, TCIP, NTCIP 1200 series Standards publications.

Application Level – in this area we can include standards for the data packet structure and session management. for example, SNMP, STMP, FTP.

Transport Level – at this level we can find standards for data packet subdivision, packet reassembly and routing when needed, for example, TCP, UDP, IP.

Subnetwork Level – this level contains standards for the physical interface, for example, modem, network interface card, CSU/DSU, and the data packet transmission method, for example, HDLC, PPP, Ethernet, ATM.

Plant Level – consists of the physical transmission media used for communications, for example, copper wire, coaxial cable, fiber optic cable, wireless. It should be noted that the plant level is an infrastructure choice and not a standards election choice. However, the plant level selection will have an impact on the subnetwork level selection to which it must interface.

The information level standards used in ITS are unique to the transportation industry. The National ITS Architecture and much of the on-going standards development effort for ITS involve identification of required data elements and the definition of their use for all the different domains and functions within ITS, for example, traffic, transit, traveler information, emergency management.

When options are available with layered or modular protocols, the options can be diagramed in a "framework." Exhibit Fig. 3 illustrates the framework for

NTCIP. The diagram shows the different protocols that can be chosen at each level (the boxes) and which ones are compatible (the lines connecting boxes). However, not all compatible configurations make sense, and there are mutually exclusive choices. For example, running SNMP over TCP/IP is not typically done in the Information Technology industry.

A particular message transmission can use at least one protocol from each level of the NTCIP framework. The series of protocols used in the message transmission is called a "protocol stack." We think ***interstructure*** as a concept that relies on these new studies too (NTCIP studies) and emphasis the importance of standardization in telematics.

This new standard can be a **primary standard** applies directly and specifically to the device or component subsystem being implemented. For example, the Standard 1203, 1204 and several others are primary NTCIP standards. Or a **supporting standard** applies in general to more than one specific device or component subsystem implementation. For example, the NTCIP Standard 1201 Global Objects standard applies to all devices and component subsystem implementations that use or require features such as: identification and location of equipment, global time, and event detection or scheduling. And finally, a **base standard and protocol** applies to the application, transport and sub-network levels. These standards define NTCIP unique capabilities for protocol and data transport choices to complete the design of an operational deployment.

The levels shown in the framework are somewhat different from communication stack layers defined by the ISO's Open Systems Interconnect seven-layer reference model and other standards developing organizations. The levels and terminology used in NTCIP were chosen for simplicity and ease of understanding by lay readers, and relevance to typical applications in the transportation industry. The OSI layers and terminology are often referenced in later technical sections of this publication and in many of the standards defined by NTCIP."

We showed that at each level of NTCIP model more detail is added. More detail means more computational effort, and more effort to find the require parameters. Yet, these details can have major impact on the performance of the communication link [10].

So, if OSI is split in 7 levels, NTCIP is split in 5 levels then Xstructure is split in 3 levels and all public administration from transportation community, or any transportation company could decide at with level must interfere to eliminate a problem. If they take a action on the transportation telecommunication level then we can think that this is a action on the ***interstructure*** level.

The knowledge is more important then information; information itself is not sufficient [11]. Based on this affirmation we can conclude that in our case it is good to exists a boundary – ***interstructure*** – for all transportation communication and then we can cram the concept with all devices, sub-concepts, standardization etc.

6. Conclusions

In this paper, a slaty representation of general concepts of infrastructure and superstructure are introduced and in the first part is introduced ***interstructure*** as a new concept. I have shown that a new layered model that consists in infrastructure, ***interstructure*** and superstructure could optimize the management of infrastructure and superstructure and like the last two can offer a new level of how to look at some devices or how to think when it start a standardization process for telematic industry. So, when we think at ***interstructure*** we see all telecommunications devices that are use for traffic control, optimization of transportation process, access to the Internet and make this global network to be useful for devices maintenance etc [12].

To make easy monitoring and manage the device servers, including all the elements needed, we must implement network-enable equipments and add IP to each device that has a serial port. Demand for bandwidth makes Ethernet the preferred protocol. This multitude of devices, new technologies and standards for transportation telecommunications we try to put in a single word ***interstructure***.

As against infrastructure and superstructure we could not say that ***interstructure*** is a concept for direct use, but we believe that it will help for delimitation of traffic management equipments, (for example all devices that are enumerate in this paper) and standards that are design for transportation systems. We will go further and try to include in this concept all electronic data traffic that help transportation management centers to function at a high level [13].

We try to make a comparison via OSI – NTCIP – Xstructure levels. We call it virtually Xstructure all levels from infra**structure** – inter**structure** – super**structure,** if OSI has 7 levels, NTCIP has 5 levels then Xstructure has 3 levels and all public administration from transportation community, or any transportation company could decide at with level must interfere to eliminate a problem.

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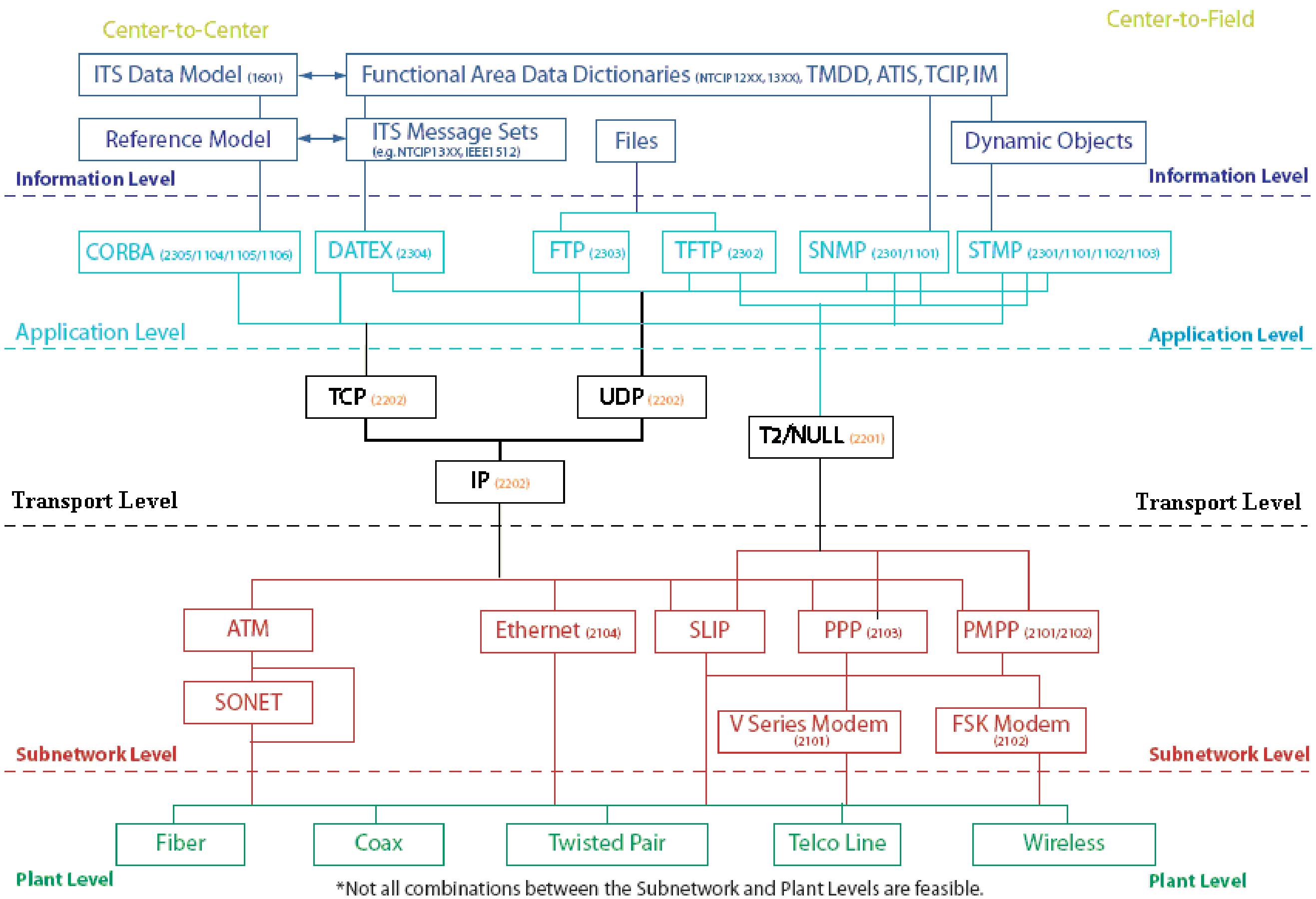

Fig. 3. NTCIP Standards Framework (from National Transportation Communications for ITS Protocol – The NTCIP Guide