

ARC-IT, THE NATIONAL ITS ARCHITECTURE, AND CVRIA

The Architecture Reference for Cooperative and Intelligent Transportation (ARC-IT) is a major upgrade to the National ITS Architecture that covers all of the scope and content from both National ITS Architecture Version 7.1 and the Connected Vehicle Reference ITS Architecture (CVRIA) Version 2.2. ARC-IT provides a unifying framework that covers all of ITS, including all of the Connected Vehicle applications. Since ARC-IT merges and upgrades the content of both the National ITS Architecture and CVRIA, “What’s New” depends on your perspective:

- [What’s New in ARC-IT From the National ITS Architecture Perspective](#)
- [What’s New in ARC-IT From the CVRIA Perspective](#)

WHAT’S NEW - NATIONAL ITS ARCHITECTURE PERSPECTIVE

This section will help you understand how the concepts and features that were a familiar part of earlier versions of the National ITS Architecture have translated into ARC-IT. It presents an overview of how the original high-level National ITS Architecture concepts translate to ARC-IT concepts and also provides links that allow you to drill down into some of the nuts-and-bolts differences between V7.1 and ARC-IT in more detail.

At first glance, ARC-IT may appear to be a completely different product than previous versions of the National ITS Architecture, and the differences are indeed substantial. On closer examination though, many of the concepts and features that were in National ITS Architecture Version 7.1 are still there, but the terminology has been updated for consistency with current best practices and the scope and content has been updated to represent the latest thinking in Intelligent Transportation Systems. ARC-IT is the latest version of the National ITS Architecture that covers all of ITS as currently envisioned. Let’s walk through each of the pieces of earlier versions of the National ITS Architecture and see how they translate to ARC-IT.

Service Packages Are Still the “Front Door” to the Architecture

Service Packages have always served as the primary entry point to the National ITS Architecture and they continue in that role in ARC-IT. The number of service packages has increased substantially from 97 (V7.1) to 139 (V8.1) because ARC-IT covers all of the National ITS Architecture service packages and all of the connected vehicle applications that were defined in CVRIA. As the National ITS Architecture service packages were merged with the CVRIA applications, there was some consolidation and reorganization to the overall list. The eight service areas that were used to organize service packages in the National ITS Architecture became twelve service areas in ARC-IT as the organization was upgraded to accommodate the expanded list. As shown in the following table, all of the original service areas carry forward, often with more concise terminology. The new ‘Support’ and ‘Sustainable Travel’ service areas include Service Packages from CVRIA that will be mostly new to National ITS Architecture users.

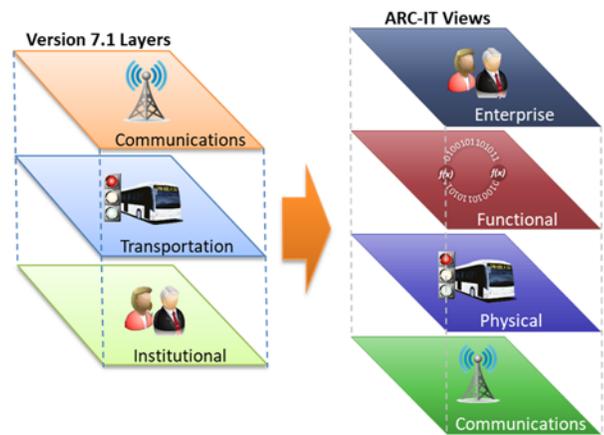
V7.1 Service Area	ARC-IT Service Area
Advanced Traffic Management Systems (ATMS)	Traffic Management (TM)
Advanced Traveler Information Systems (ATIS)	Traveler Information (TI)
Advanced Public Transportation Systems (APTS)	Public Transportation (PT)
Emergency Management (EM)	Public Safety (PS)
Commercial Vehicle Operations (CVO)	Commercial Vehicle Operations (CVO)
Maintenance and Construction (MC)	Maintenance and Construction (MC)
Archived Data (AD)	Data Management (DM)
Advanced Vehicle Safety Systems (AVSS)	Vehicle Safety (VS)
	Support (SU)
	Sustainable Travel (ST)
(Previously included in ATMS)	Parking Management (PM)
(Previously included in MC)	Weather (WX)

Visit the [National ITS Architecture Service Package Heritage Page](#) to see more precisely how each National ITS Architecture Version 7.1 service package relates to service packages in ARC-IT. Don't

worry too much about translation between National ITS Architecture and ARC-IT Service Packages because you won't have to do it yourself. The ARC-IT software tools, RAD-IT and SET-IT, will convert your National ITS Architecture service packages to ARC-IT service packages automatically.

'Layers' Are Now 'Views'

ARC-IT includes four 'Views' that are directly related to the three 'Layers' that comprised previous versions of the National ITS Architecture. The 'Institutional Layer' became the 'Enterprise View' in ARC-IT as the name was updated to reflect current terminology. This view was also moved from the basement (or foundation as we used to call it) to the penthouse in the ARC-IT representation.

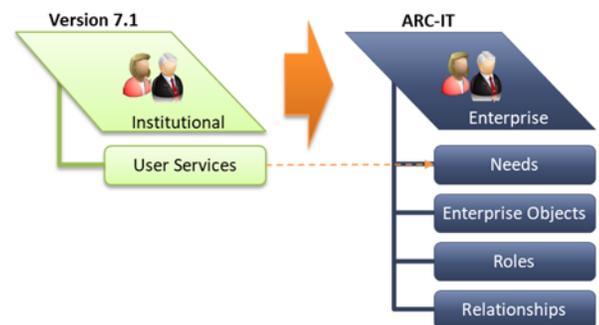


The 'Communications' Layer became the 'Communications' view and moved from the top to the bottom of the stack. The 'Transportation' Layer, which contained both the 'Physical Architecture' and the 'Logical Architecture' in the National ITS Architecture split into two views in ARC-IT. The Physical View is equivalent to the 'Physical Architecture' and the Functional View is equivalent to the 'Logical Architecture' in previous versions. So while 'Views' were not defined in previous versions of the National ITS Architecture, they neatly correspond to the National ITS Architecture layers and the physical and logical architectures in previous versions of the National ITS Architecture.

The following sections walk through each view and describe what is new in ARC-IT and what to look for in upcoming releases.

What's New in Enterprise View

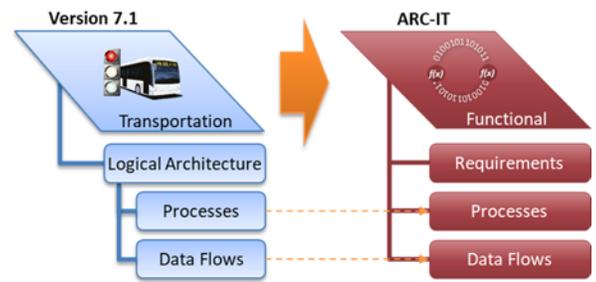
The User Services and User Service Requirements were the guiding documents for the National ITS Architecture through Version 7.1. ARC-IT required a broader statement of user needs that also covered connected vehicle concepts shown in the CVRIA applications. As a result, a new set of high-level needs was defined for each service package in ARC-IT, augmenting the user services and user service requirements. The user services were used to support the development of the ARC-IT user needs and the documents are available for reference on the web site. Beyond the user services and other source documents, the Institutional Layer did not include



detailed definitions. ARC-IT defines enterprise objects that represent stakeholder organizations and identifies roles and relationships between enterprise objects.

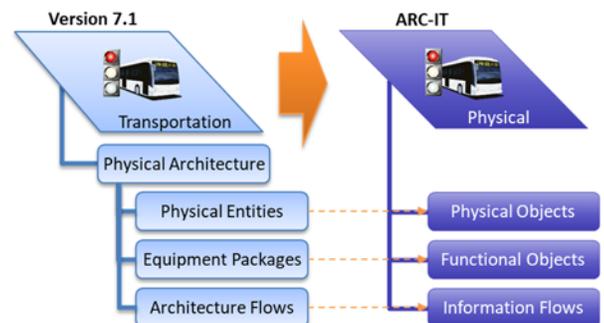
What's New in Functional View

The ARC-IT Functional View closely corresponds with the Logical Architecture in Version 7.1. ARC-IT includes a similar hierarchical set of processes and data flows that are analogous to, and based on, the processes and data flows that were included in previous versions of the National ITS Architecture. The processes and data flows were extended as the structured analysis that underlies the functional view was expanded to cover all ARC-IT service packages and needs. The requirements shown in the Functional View do not have a direct analog in the Logical Architecture, but they directly correspond to the functional requirements that were defined for each Equipment Package in previous versions of the National ITS Architecture. For ARC-IT, all of the functional requirements are directly traceable to one or more Needs in the Enterprise View. All of the functional requirements are allocated to Functional Objects in ARC-IT, the ARC-IT equivalent of Equipment Packages in previous National ITS Architecture versions. As the name implies, 'Functional Objects' are a key component that bridges the gap between the Functional View and Physical View.



What's New in Physical View

The names have changed, the scope has expanded to include all connected vehicle applications, and the presentation has been revised and enhanced, but the Physical Architecture from previous versions of the National ITS Architecture continues as the 'Physical View' in ARC-IT.



'Physical Entities' are now 'Physical Objects'. ARC-IT still differentiates between 'Subsystems' (physical objects that have defined functionality) and 'Terminators' (physical objects at the periphery of ITS that have defined interfaces, but no defined ITS functionality). Due to the additional scope, there are 139 physical objects in ARC-IT Version 8.1, a substantial increase from the 98 physical entities that were in Version 7.1. The new physical objects support specific representation of connected vehicle equipment (e.g., the new 'Connected Vehicle Roadside Equipment' (RSE) physical

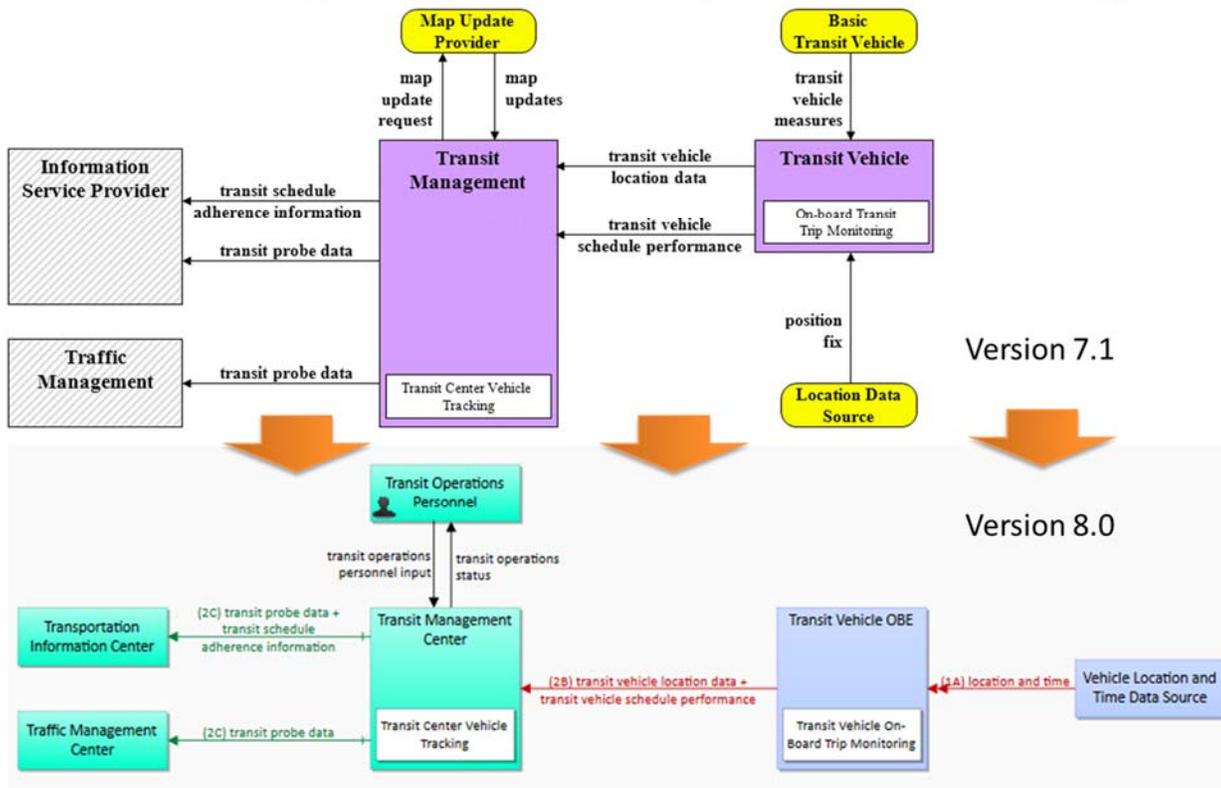
object) and new-for-V8 services, particularly new support service packages that drove identification of new physical objects to support general capabilities like credentials management and data distribution. You will also note that the physical object names have changed a bit to make them slightly more 'physical'. For example, the 'Traffic Management Subsystem' has become the 'Traffic Management Center' in ARC-IT. Although the names are a bit more physical, ARC-IT is as flexible as ever and still allows each user to define how many centers they have in their region and what each center does, mixing and matching physical objects as necessary, just as in previous versions. As with the other architecture components, don't worry too much about translation between National ITS Architecture and ARC-IT physical objects because you won't have to do it yourself. The ARC-IT software tools, RAD-IT and SET-IT, will convert your National ITS Architecture physical entities to ARC-IT physical objects automatically.

'Equipment Packages' in Version 7.1 are now 'Functional Objects' in ARC-IT. The new name much better reflects the role of these objects in connecting the Functional and Physical Views. Despite the name change, most of the equipment packages from Version 7.1 carry forward as Functional Objects in ARC-IT with minor name changes and description enhancements.

Similarly, 'architecture flows' in Version 7.1 are now 'information flows' in ARC-IT. Just as in Version 7.1, these flows define the flow of information between physical objects. Most of the architecture flows from Version 7.1 carry forward as information flows in Version 8.0, but ARC-IT includes many new flows to support connected vehicle applications. ARC-IT also uses the short-hand term 'Triple' to refer to a: 1) Source Physical Object, 2) Information Flow, and 3) Destination Physical Object – the three components that define the transfer of information between a source and a destination. This concept has always been included in the National ITS Architecture; we just use a concise term consistently to refer to this combination of three pieces of information in ARC-IT Version 8.0.

The presentation of the physical view (physical architecture in previous versions) has also been enhanced. The following figure shows a Version 7.1 and an ARC-IT physical view diagram for the same 'Transit Vehicle Tracking' service package.

Service Package Diagram Evolution (Transit Vehicle Tracking)

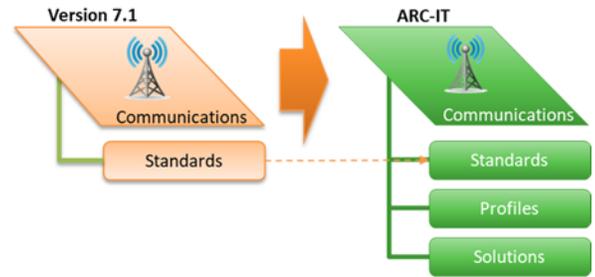


At first glance, the diagrams look very different, but they actually show the same basic information. Using ARC-IT terminology, both show physical objects (as colored boxes), functional objects (smaller white boxes), and information flows that are included in the service package. The most obvious difference is physical object shape and coloring. In ARC-IT, physical objects are color-coded based on 'Class' (Center, Field, Support, Vehicle, Traveler), while in previous versions they were color coded to indicate whether they were a subsystem, a terminator, or a subsystem that didn't include functionality in the service package. In ARC-IT, the information flows are also color coded based on security characteristics and a prefix like '(2C)' is used to encode spatial and time context for the flow. As with all of the service packages, there are also content changes related to redistribution of functionality between service packages. For example, the 'Map Update Provider' interface shown in the version 7.1 diagram has been consolidated into a new "Map Management" service package in ARC-IT, so the map update interface is not included in the ARC-IT version of the diagram.

What's New in Communications View

In previous versions of the National ITS Architecture, the Communications Layer defined the standards that are required to support the transfer of information defined in the Physical Architecture (now Physical View in ARC-IT).

This continues to be the focus of the Communications View in ARC-IT, but ARC-IT now does a more complete job in that it not only identifies standards, just like in Version 7.1, but now it organizes those standards into 'Profiles' that identify standards at each layer of the ISO communications stack and specifically includes standards that will support secure ITS communications. The combination of a profile that identifies the communications stack along with ITS information layer message and data dictionary standards are assembled into a communications 'Solution' for each information flow triple in the physical view. Through these enhancements, the Communications View in ARC-IT provides much more detail to support implementation than earlier versions of the National ITS Architecture.



Security

The same basic security classification scheme used in previous versions of the National ITS Architecture that considered confidentiality, integrity, and availability requirements for each information flow and physical object continues, but has been substantially upgraded and revised for ARC-IT. Every information flow triple in ARC-IT now includes security classification ratings for confidentiality, integrity, and availability and those ratings are used to provide device classification requirements for the physical objects that send and receive the information flows. Also, previous versions of the National ITS Architecture were largely silent on actual security implementation, but ARC-IT explicitly supports security credentials management and references specific communications security standards.

WHAT'S NEW - CVRIA PERSPECTIVE

This section will help you understand how the concepts and features that were included in the Connected Vehicle Reference Implementation Architecture (CVRIA) are represented in ARC-IT. It presents an overview of how high-level CVRIA concepts translate to ARC-IT concepts and also provides links that allow you to drill down into some of the nuts-and-bolts differences between CVRIA and ARC-IT in more detail.

The good news for CVRIA users is that the ARC-IT concepts and architecture structure will be familiar because most of it is inherited from CVRIA. The most notable change is the scope of ARC-IT is much broader, since it covers all of ITS, while CVRIA only included Connected Vehicle applications. Let's walk through each piece of CVRIA and see how it translates to ARC-IT.

Applications are Now 'Service Packages'

The CVRIA development was centered on defining an architecture reference model that supported a list of Connected Vehicle applications. CVRIA Version 2.2 supports 99 distinct connected vehicle applications. The applications are also the best way to access CVRIA, whether you are looking at the website or using the SET-IT software tool. In ARC-IT, 'Service Packages' are the equivalent of CVRIA applications. They serve the same dual purpose of being the basis for ARC-IT development and the best place to start to find the parts of ARC-IT that you need. The number of service packages has increased substantially from 99 CVRIA applications to 139 ARC-IT service packages because ARC-IT also covers the broad list of National ITS Architecture service packages.

In many cases, you will find familiar CVRIA application names in the ARC-IT service packages list. For example, the CVRIA 'Curve Speed Warning' application became the ARC-IT 'Curve Speed Warning' Service Package. About 2/3 (67 of 99) of the CVRIA applications translate to exactly one service package in ARC-IT, though the names are sometimes changed to better differentiate from other service packages. In other cases, CVRIA applications that were architecturally very similar were distilled and combined into fewer service packages to keep the overall list of service packages manageable. For example, 11 different CVRIA V2V applications were all distilled into a single 'V2V Basic Safety' service package in ARC-IT. No CVRIA application was left behind; every CVRIA Version 2.2 application is supported by at least one ARC-IT Service Package. Visit the [CVRIA Service Package Heritage Page](#) to see more precisely how each CVRIA application relates to service packages in ARC-IT. Don't worry too much about translation between CVRIA and ARC-IT Service

Packages because you won't have to do it yourself. The SET-IT software tool will convert your CVRIA applications to ARC-IT service packages automatically.

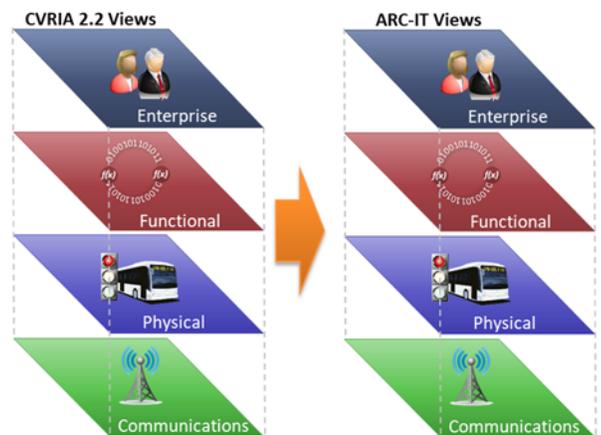
With 139 service packages to organize, ARC-IT includes a couple of new features that make it easier to find the service packages you need and reference them concisely. ARC-IT includes 'Service Areas' that are used to organize service packages and every ARC-IT service package includes a short name that reflects its service area. For example, the short name for "Curve Speed Warning" is "VS05" where "VS" indicates the "Vehicle Safety" service area. The "05" simply indicates this is the fifth service package in the list for the Vehicle Safety service area. In general, service packages are numbered within a service area so that more basic service packages are at the beginning of the list and more advanced service packages are at the end. "VS05" conveys that "Curve Speed Warning" is a bit more complex from a system architecture perspective than VS01 and VS02 that cover autonomous vehicles and basic V2V safety respectively, but less advanced than Infrastructure Assisted Cooperative Adaptive Cruise Control and Automated Vehicle Operations that appear much further down the list. The service areas are a bit higher level than the 'groups' that were used to organize applications in CVRIA, but they are quite similar as shown in the following table. Group and Type sorts of the service packages are also still available in ARC-IT, so you can view service packages in ARC-IT much as you viewed applications in CVRIA.

ARC-IT Service Area	CVRIA Application Group(s)
Commercial Vehicle Operations (CVO)	Commercial Vehicle Fleet Operations, Commercial Vehicle Roadside Operations, Freight Advanced Traveler Information Systems
Commercial Vehicle Operations	Freight
Data Management (DM)	Planning and Performance Monitoring
Maintenance and Construction (MC)	Maintenance and Construction
Parking Management (PM)	Parking Management
Public Safety (PS)	Incident Management, Public Safety
Public Transportation	Electronic Payment, Transit, Transit Safety
Support	Communications, Core Services, Security
Sustainable Travel	AERIS / Sustainable Travel
Traffic Management	Border Management, Traffic Management, Traffic Network, Traffic Signals

ARC-IT Service Area	CVRIA Application Group(s)
Traveler Information	Traveler Information
Vehicle Safety	V2I Safety, V2V Safety, Vehicle Safety
Weather	Road Weather

CVRIA and ARC-IT Contain the Same Views

ARC-IT includes the same four ‘Views’ that were defined in CVRIA since the structure of CVRIA was used as the starting point for ARC-IT. While the views match exactly, the content of each view is broader in ARC-IT because ARC-IT covers all of ITS, not just connected vehicle applications. Also, ARC-IT Version 8.0 did not include the equivalent of all of the CVRIA components for every view; these gaps have been filled in ARC-IT Version 8.1.

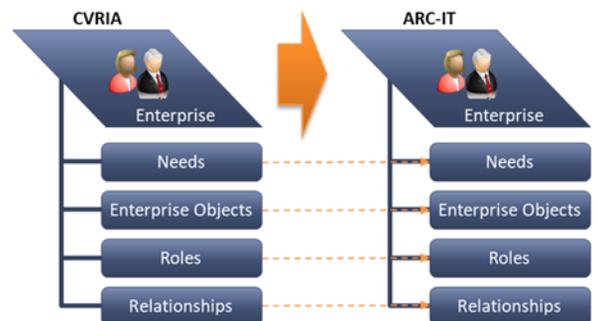


The following sections walk through each view and describe what is new in ARC-IT 8.0 and what to look for in upcoming releases.

What’s New in Enterprise View

Every application in CVRIA included a set of needs. ARC-IT also includes needs for each service package. While the concepts are the same, the ARC-IT needs have been substantially rewritten to ensure they are well-formatted user needs that clearly identify the stakeholder

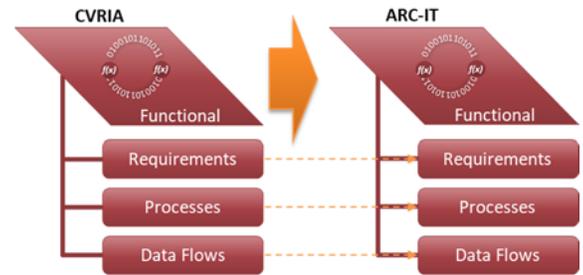
organization and succinctly state the need from that user perspective. CVRIA includes ‘Enterprise Objects’ that identify the enterprises involved in connected vehicle applications and resources that closely correspond with CVRIA physical objects. A similar, but materially improved, set of Enterprise Objects is included in ARC-IT. Enterprise Objects have defined relationships in CVRIA. Similar relationships are defined in ARC-IT, but these relationships have been revised to improve consistency and correct issues in the CVRIA model. Finally, Enterprise Objects play different roles



(operate, maintain, etc.) with respect to resources/physical objects and these roles are defined in CVRIA. An expanded set of roles are defined in ARC-IT that includes all of the CVRIA roles.

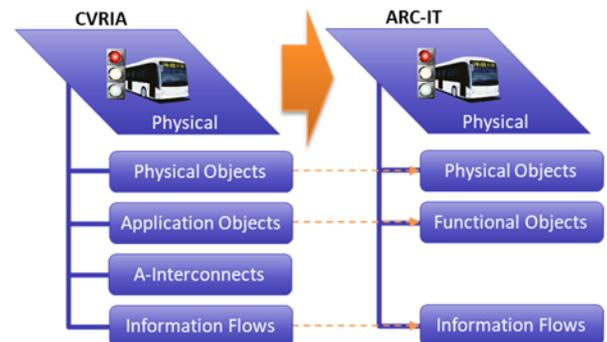
What's New in Functional View

Although not explicitly included in functional view, CVRIA includes a set of requirements for each application that are directly traceable to CVRIA needs. ARC-IT also includes requirements that trace to needs, but ARC-IT requirements are grouped by functional object and have been rewritten to improve quality. The requirements upgrade was substantial, so the ARC-IT requirements should be viewed as essentially all new, with no specific traceability back to CVRIA requirements. ARC-IT Version 8.1 includes a hierarchical set of processes and data flows that are analogous to, and based on, the processes and data flows that were defined in CVRIA. The processes and data flows were extended in ARC-IT as the structured analysis that underlies the functional view was expanded to cover all ARC-IT service packages and needs.



What's New in Physical View

If you are familiar with the Physical View in CVRIA, you won't have a problem with Physical View in ARC-IT since they are very similar. Physical objects are mostly the same in CVRIA and ARC-IT, although ARC-IT has more of them to support all of ITS. In ARC-IT, we distinguish between 'Subsystems' (physical objects that have defined functionality) and 'Terminators' (physical objects at the periphery of ITS that have defined interfaces, but no defined ITS functionality). Although many of the physical object names have not changed in ARC-IT, a few have been renamed so they fit better in an ITS-wide list of physical objects. For example, the 'Roadside Equipment' (RSE) physical object in CVRIA has become the 'Connected Vehicle Roadside Equipment' in ARC-IT since there are many different kinds of roadside equipment in ITS. As with the other architecture components, don't worry too much about translation between CVRIA and ARC-IT physical objects because you won't have to do it yourself. SET-IT will convert your CVRIA physical objects to ARC-IT physical objects automatically.



'Application Objects' in CVRIA are now 'Functional Objects' in ARC-IT. The new name much better reflects the role of these objects in connecting the Functional and Physical Views. Despite the name change, most of the application objects from CVRIA carry forward as Functional Objects in ARC-IT with minor name changes, description enhancements, and some consolidation to remove redundancy and overlap.

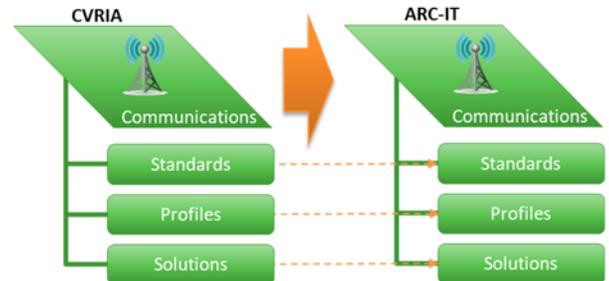
'Application Interconnects', which defined the information transfers between application objects per service package in CVRIA, are not included in ARC-IT. Through experience in CVRIA, we found that the A-Interconnects value to users did not justify the resources required to create and then maintain them as part of ARC-IT.

'Information flows' in Version 7.1 continue as 'information flows' in ARC-IT. Just as in CVRIA, these flows define the flow of information between physical objects. Most of the information flows from CVRIA carry forward as information flows in ARC-IT, but ARC-IT includes many new flows to support other ITS service packages. In all, the number of flow triples (source physical object-information flow-destination physical object) has increased from 1117 triples in CVRIA 2.2 to 1722 triples in ARC-IT Version 8.1.

What's New in Communications View

As shown, the CVRIA communications view concepts – standards, profiles, and communications solutions, all carry forward to ARC-IT. The communications view in ARC-IT is much larger, since communications solutions

must be assigned to 50% more flow triples than in CVRIA, but the constructs and overall architecture design is unchanged in ARC-IT. ARC-IT includes modestly updated standards definitions to reflect version updates and other recent SDO activity. It also includes several new communications profiles, including profiles that support passive Bluetooth and Wi-Fi monitoring, new profiles that support vehicle clustering, where vehicles act as a network nodes to support information sharing, and legacy profiles that define current ITS communications for common applications like toll collection.



Security

The same security classification scheme used in CVRIA that considered confidentiality, integrity, and availability requirements for each information flow and physical object continues, but a complete security analysis of every information flow triple and physical object is included in ARC-IT. Every

information flow triple in ARC-IT now includes security classification ratings for confidentiality, integrity, and availability and those ratings are used to provide device classification requirements for the physical objects that send and receive the information flows.