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6. AUTHOR(S)

Daniel S. Skelley Sidney R. Jones

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

Naval Air Warfare Center Aircraft Division
22347 Cedar Point Road, Unit #6
Patuxent River, Maryland 20670-1161

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

Naval Air Systems Command
47123 Buse Road, Unit IPT
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There are several Office of Secretary of Defense (OSD) funded programs and Range Commander's Council (RCC) tasks that are looking at the use of packetized data in an environment traditionally dominated by pulse Code Modulation (PCM). This paper examines where these efforts are leading and what the next step is.

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# You Can Move Packets ...Now What?

**Daniel S. Skelley**
**Naval Air Warfare Center Aircraft division**

**Sidney R. Jones**
**Naval Air Warfare Center Aircraft Division**

## Abstract

There are several Office of Secretary of Defense (OSD) funded programs and Range Commander's Council (RCC) tasks that are looking at the use of packetized data in an environment traditionally dominated by Pulse Code Modulation (PCM). This paper examines where these efforts are leading and what the next step is.

**Keywords**
Instrumentation, data acquisition, networks, protocols, standards.

# Introduction

Early instrumentation system designs were centralized. These systems used components that had to be placed in close proximity to one another. Transducer outputs from throughout the test article were individually routed back to the instrumentation system. The centralized instrumentation system would sample the data at its inputs and generate a composite output for recording and/or transmitting. As instrumentation system designs matured, the distributed system was introduced. These systems had instrumentation busses connecting a central system controller to remote data acquisition units throughout the test article. The transducers were wired to a remote data acquisition unit near the transducer. The system controller sent data requests, via the instrumentation bus, to the various remote units. The remote units responded and the composite output was generated as the data was received. We are now on the leading edge of a third design shift – the data acquisition network.

Data acquisition networks are a variant of a distributed data acquisition system. Similar to a distributed data acquisition system, a data acquisition network consists of data acquisition units that are remotely placed around the test article. However, the communications protocols used are significantly different. The data acquisition network uses a packet switched bus as opposed to the time division multiplex bus used by the data acquisition system. Data acquisition networks operate similar to traditional computer networks and data is moved between system components in packets. While this difference may appear to be minor, the impact of using packetized data is far reaching.

# Current Efforts

The Telemetry Group of the Range Commanders Council (RCC) is the primary standards group within the telemetry community. The RCC and several Office of Secretary of Defense (OSD) projects, have come to the conclusion that packetized standards need to be addressed. As a result, there are three separate areas that are being addressed with regards to packetized data: recorders, telemetry, and data acquisition (instrumentation bus). The first two set out with the idea of accommodating packetized data sources on the test vehicle. The third set out to find a fast, capable, and commercial bus only to discover they were all packet based. It was then the concept of transforming the instrumentation system into a data acquisition network was considered. However, some instrumentation designers were one step ahead of us.

The trend toward data acquisition networks was made clear by a Navy Small Business Innovative Research (SBIR) program. As the solution to a Navy requirement for a wireless data acquisition unit capability, the development contractor proposed a wireless local area network between the controller and the data acquisition units. Out of this effort a true wireless data acquisition network is being created. The RCC efforts, industry interest, and OSD funded programs like the Next Generation Instrumentation Bus

(NexGenBus) and Advanced Range Telemetry (ARTM) are clearly leading toward the use and creation of data acquisition networks. The combination of these efforts and programs will create a delivery system for packetized data from the point of origin in the vehicular data acquisition network to the remote user. This is illustrated by the system shown in Figure 1.

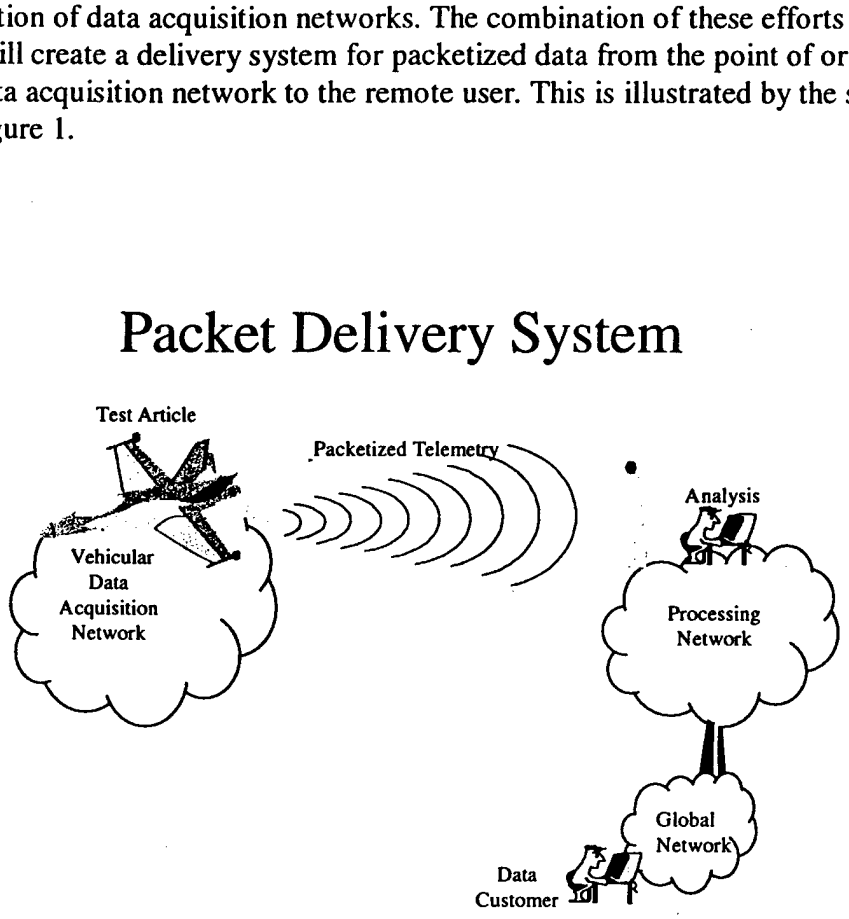


Figure 1

In such a system, data is collected, formatted into packets, stored, displayed and/or transmitted by the vehicular data acquisition network. The data is transmitted to the processing network, via a packetized telemetry link. Data packets are received and placed on the processing network for analysis, distribution, and display. A properly designed system, such as the one illustrated in figure 1, has numerous advantages. These include:

- The data is directly compatible with commonly used packet communication networks (i.e. Internet). It can be sent to worldwide customers with ease.
- It leverages off the significant investment in standards development, hardware, and software. The Defense community can no longer afford the cost and technology lag associated with creating and using its own proprietary standards.
- Full network connectivity of the components of the vehicular data acquisition network opens up numerous possibilities. Each component of the data acquisition

network can communicate directly with any other unit. As an example, data driven acquisition strategies are easily implemented.

(This material is from Reference #3 which contains a much more detailed treatment of the advantages and disadvantages of data acquisition networks.)

The creation of a standard for the delivery system of packetized data in a test and evaluation environment is a significant milestone. It will certainly facilitate the use of the systems as shown in Figure 1. Considering the trends in the commercial sector, the RCC tasks, and the OSD funded programs, there is substantial reason to believe that data acquisition networks and packetized telemetry is on the near horizon.

The virtual inevitability of this new technology does not imply that the implementation is without significant challenges. The challenges are indeed significant. Latency variance, delivery order of data, time correlation, and the inherent bandwidth inefficiencies of packetized telemetry are just some of the issues that must be dealt with. Significant as these technology challenges are, current indications are that they will be overcome. However, to achieve the full promise of data acquisition networks and packetized telemetry, one more step is required.

## The Next Step

There are many questions that must be answered for a telemetry system to perform properly. One of the more prominent ones is: *"What is the nature of the delivered data?"* The end user needs to know a considerable amount of information about the delivered data in order to effectively use it. This required information might include data structure, time tag information, engineering unit's conversion information, point of origin, encoding method, and a multitude of other things. Without this information, the delivered data is of little or no value to the end user. In a traditional Time Division Multiplex (TDM) telemetry system, the user relies on the data structure imposed by IRIG 106 Chapter 4 and the telemetry attribute descriptions provided in accordance with IRIG 106 chapter 9. Given compliance with chapter 4 and a descriptor provided in accordance with Chapter 9, the end user can effectively and easily use the TDM data. TDM data that is not formatted per chapter 4 and does not have a Chapter 9 descriptor file is still usable. However, it is difficult, requires specific knowledge, and the user must have very flexible equipment. The widespread use and interoperability of TDM systems is primarily due to standardization imposed by these two crucial chapters in IRIG 106.

In a similar manner to a non-chapter 4 TDM stream without a Chapter 9 attribute file, the data from data acquisition networks will be difficult to handle. There currently is no standard to define a structure for the data packet utilized within the data acquisition network. There is also no standard for an attributes transfer file like chapter 9 that would describe to a user the information required to process the data. The user must understand how that particular vendor has formatted their data packets and somehow gain all the necessary descriptor information (engineering units conversion, etc.) to use the data.

Until we get standards that cover data structures and attributes transfer information for data packets the use of data acquisition networks will be cumbersome.

In recognition of this, the Telemetry Group of the RCC has proposed the creation of an adhoc committee. This adhoc committee will investigate issues concerning data packet structure and attributes information transfer as it applies across the entire system shown in figure 1.

## Conclusion:

With successful outcome from the RCC adhoc committee, the picture will be complete, data structures, delivery systems, and attribute transfer schemes will be defined allowing the data acquisition network to reach its full potential. However, without widespread vendor and user support of the standards being developed, the use and acceptance of this promising new technology will be limited.

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