

APCO Project 25 RCP in Project54

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This document describes the use of the standard APCO Project 25 digital radio RCP (Radio Control Protocol) in the Project54 system.

RCP is an abbreviation for *Radio Control Protocol*, and represents a good idea which was incompletely executed in the standard. It provides no useful radio “control” and only some of the status information needed to use the wireless data link at maximum efficiency. This document refers specifically to RCP as implemented in Motorola Astro radios, which are the only APCO Project 25 compliant data capable radios that have been tested as of the date of writing. Also, the document contains only that information about RCP which is useful for writing code for the Project54 system. The APCO Project 25 RCP standard is described in detail in the TIA document:

IS102.BAEE, Radio Control Protocol, January 1998

RCP Basics

The data mode of Project 25 digital radios is based on IP packets in input and output serial streams. For the rest of this document, “outbound” IP packets will be defined as packets delivered by the computer to the radio, while “inbound” IP packets will be defined as packets directed to the computer from the radio. RCP provides a mechanism for obtaining status information from the radio within the IP based framework. The radio reserves a single IP address and port to be used for RCP. All outbound IP packets which are addressed to the RCP address and port are interpreted by the radio as RCP commands, rather than being sent out over the RF connection. Similarly, all inbound RCP feedback information is received by the computer in the form of IP packets from the radio’s RCP address and port.

When the radio is first powered up, all inbound RCP packets are addressed to the broadcast IP address. However, the radio remembers the source IP address and port of the most recent outbound RCP packet, and all subsequent inbound RCP packets are directed to that address and port.

Inbound RCP packets are either “reports” or “responses”. RCP “reports” are unsolicited packets occurring when the radio status changes. RCP “responses” are direct replies to outbound RCP “requests” from the computer. There are two types of RCP requests: “information” requests and “configuration” requests (which generate information responses or configuration responses, respectively). The responses to these requests contain essentially no useful information (in the Motorola Astro implementation at least). However, RCP requests do perform two useful functions. First, sending an RCP request

establishes a specific return IP address/port for subsequent RCP responses and reports. Second, making an RCP request and is a good way to check the data path to the radio. If no response is received within a few seconds, either the radio is turned off or the data path to the radio is not functioning.

RCP reports contain incomplete but useful information about the radio status, as described in a later section of this document.

RCP in Project54

In the Project54 system, IP data to and from the radio is coordinated by the Project25IP service (Project25IP.exe). This service performs the necessary serial encoding/decoding of the IP packets, forming a buffer between the generic Windows 2000 network stack and the physical connection to the radio. The Project25IP service also modifies the behavior of RCP as seen by applications.

The most important impact of the Project25IP service on RCP is to support multiple RCP clients. As mentioned above, the radio supports only a single RCP client, directing all incoming RCP responses and reports to the single IP address/port which sent the most recent outgoing RCP request. However, the Project25IP service maintains a list of all RCP clients (the source address/ports of all prior outgoing RCP requests). The service then intercepts all inbound RCP response and report packets and forwards each one to all RCP clients. Thus multiple applications can utilize RCP to monitor the radio status without interference.

The Project25IP service also fabricates a non standard RCP report. Motorola Astro radios return a "Network Unreachable" ICMP packet whenever an outgoing data packet can not successfully be delivered to the base station. The Project25IP service translates each incoming ICMP packet into a RCP report packet of type "PACKET_LOSS" (RCP report code 0xef, which is not defined in the Project 25 standard) which is delivered to all RCP clients.

An application which needs to monitor radio status via RCP can obtain the radio's RCP address and port from the registry entries:

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.\Project25\Network\RcpIP  
.\Project25\Network\RcpPort
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An application should use INADDR_ANY and a unique port number as the source IP address and port for communicating with RCP.

RCP Requests in Project54

The most useful functions of RCP requests are to establish a RCP feedback "connection" with the Project25IP service and to detect whether the radio is turned on (to "ping" the

radio). The contents of the request response are not useful and thus are not discussed in this document.

An application can “ping” the radio by sending either of the following two 8-byte packets to the RCP address/port discussed above:

RCPInfoRequest: {0x43, 0x00, 0x02, 0x00, 0x01, 0x00, 0x47, 0x43}
RCPConfigRequest: {0x43, 0x00, 0x02, 0x00, 0x02, 0x00, 0x33, 0x39}

If an answering packet is received within 4 seconds the radio is turned on and the complete data path is valid. If an answering packet is not received within 4 seconds the radio is turned off (or some other part of the data path is not working correctly).

RCP Reports in Project54

RCP reports are received asynchronously from the radio (via the Project25IP service) when the radio status changes. The five RCP report packet types currently supported are discussed below.

POWER_UP {0x45, 0x00, 0x01, 0xff, 0xff, 0x00, 0x50}

The POWER_UP packet is returned shortly after the radio is turned on, indicating that it is ready to receive data from clients.

NOT_REGISTERED {0x45, 0x00, 0x01, 0xff, 0xff, 0x00, 0x4e}

The NOT_REGISTERED packet indicates that the radio has failed to register with the base station for data operations. This typically occurs when the mobile radio is out of radio range with the nearest VHF repeater, but may also mean that the radio itself is not correctly “programmed”, or that base station equipment is not functioning.

PACKET_LOSS {0x45, 0x00, 0x01, 0xff, 0xff, 0x00, 0xef}

The PACKET_LOSS packet indicates that the radio tried to send a data packet to the base station but was not able to do so successfully (data packet delivery is normally confirmed by a transparent handshake between the mobile and base station radios). This typically occurs when the mobile radio is out of radio range with the nearest VHF repeater, but may also mean that the base station equipment is not functioning.

SVC_NOT_AVAIL {0x45, 0x00, 0x02, 0xff, 0xff, 0x00, 0x44, 0x30}

The SVC_NOT_AVAIL packet occurs when the radio is switched to a voice-only channel.

SVC_AVAIL {0x45, 0x00, 0x02, 0xff, 0xff, 0x00, 0x44, 0x31}

The SVC_ AVAIL packet occurs when the radio is switched to a data capable channel.

RCP feedback only occurs when the radio state changes. Since it is impossible to determine the state of the radio *before* an application is executed, applications should use a “no news is good news” approach to using RCP to monitor radio status. For example, applications should not assume initially that the radio is on a voice-only channel, and thus can’t handle data until SVC_ AVAIL is subsequently received. Rather, applications should assume initially that the radio is on a data capable channel, and thus can handle data unless SVC_ NOT_ AVAIL is subsequently received.

For the purpose of writing “robust” software, some details of the RCP report packet structure should be noted. All RCP report packets have a six byte “header” and one or more bytes of “information”. All RCP report packets have the value 0x45 as the first byte of the header. When checking a RCP report packet, only the first byte and the “information” bytes should be checked. The other bytes of the header might differ between radio manufacturers. Thus, POWER_ UP should be detected by receiving a 7 byte packet with 0x45 in the first byte, 0x01 in the third byte, and 0x50 in the seventh byte. Similarly, SVC_ AVAIL should be detected by receiving an 8 byte packet with 0x45 in the first byte, 0x02 in the third byte, 0x44 in the seventh byte, and 0x31 in the eighth byte. The other bytes in the packet headers should be ignored.