Using the ROSE X.25 Packet Network

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Forward - RATS Open System Environment

The Radio Amateur Telecommunications Society (RATS) is dedicated to the improvement of communications systems in the Amateur Radio Service. This objective has been guided by individuals who are willing to develop software, operate, and use systems which push the current state of the art. Our packet switch, the ROSE X.25 Packet Switch, and communications server, ROSErver/PRMBS, have from their inception been ambitious projects providing increased functionality to the users and network management. These systems were developed to support communications using conventional packet radio equipment. Any AX.25 TNC user can access a network of ROSE switches, and likewise any WORLI-compatible packet bulletin board system can exchange mail with ROSErver/PRMBS.

The objective was not another home-grown packet switch or BBS, but to add features needed by the users and network management while also facilitating interoperability with (or through) other networks. The vehicle for this interoperability was the then emerging Open Systems Interconnection Reference Model (OSI-RM) developed jointly by IS0 (the International Organization for Standardization) and the CCITT (the International Consultive Committee on Telephone and Telegraph). Adherence to the model has provided a modular framework in which protocols could be tested, used, and replaced as new solutions (software and hardware) became available.

We chose to base our systems on OSI because it is a blueprint for communications not bound to the design methodologies or marketing objectives of private companies like IBM or DEC, or of governmental agencies such as the U.S. Dept of Defense. Instead, these protocols have been developed and agreed upon by both user groups and telecommunications carriers. This blueprint defines the various aspects of communications in terms of a seven-level stack. For example, the switch provides all required network services needed to interconnect remote users.

These include:

Connection - creating a data path through a network

Data - transfer of data between users will be free of: Most bit-errors; Sequencing errors; Undetected packet loss Undetected packet duplication

Clearing - the orderly termination of communications.

The OSI reference model is the blueprint that was applied to facilitate the evolution of the ROSErver/PRMBS Message Handling System. This system began its development as a packet bulletin board system (or PBBS), but has outgrown this label by adding interoperability support for CCITT X.400 Message Handling System and DoD Internet RFC822 message headers, providing for remote file and database requests, and remote execution of applications for a user. The system is progressing toward support for Directory Services, CCITT X.500 and Management Information Services, IS0 95%.

The progress of OSI-based development has been fraught with difficulties, including apathy, "Why Change?"; limited resources of developers; the collection of dialogues that became known as the "protocol wars". Many of these problems occurred because we recognized the impact of OSI very early and as such were faced with no base of software or expertise from which to build and many of the required standards were not yet defined, or were defined poorly. These difficulties have been overcome, since the momentum of the interest in OSI protocols to support multimedia electronic mail (X.400), directory services (X.500), and other applications in the marketplace today has helped to fuel our efforts now that a larger community exists for the exchange of ideas and problem resolutions.

In any communications environment there are always real and artificial boundaries where special handling is needed for communications to occur. In amateur radio we have local, regional and area nets for traffic handling, while these are geographically based boundaries they are artificial, since a moderately equipped HF station can easily cross those boundaries. In the commercial land-line based communications systems these boundaries also occur, and in fact are encouraged in order to facilitate management of the equipment involved such as modems, telephone lines, microwave stations, etc. The term Domain is one term that is used to describe a large collection of systems that interoperate in a cooperative manner.

A domain name or identifier is assigned to specific collection of communications systems to identify the political or management group responsible for proper operation of the systems. In order to keep the size of the list of Domain Identifiers to a minimum the identifiers are based upon a tree-like structure, "njit-eies.mailnet.edu" is an example of a system name where "edu" is the domain name for the educational/university communications networks and "mailnet" is a domain within the "edu" domain, or a sub-domain. There can be many levels of domains. The management group responsible for the top level domain can add sub-domains as needed without having to notify the groups managing the other top level or global domains. This allows flexibility that is especially important to dynamic and fast growing networks, such as networks found in the Amateur Radio Service.

In order to fully integrate the worldwide Amateur Radio Service into the global OSI community we needed a unique domain identifier for OSI-based Amateur Radio systems. This identifier had to account for national identity in order to provide the basis for recognition by the regulatory bodies in each nation. This objective had one serious logical caveat: we did not want to request a piece of the global domain name space from each country with an Amateur Radio activity. To do so would have been a nightmare of paperwork and expense. What was needed was a global Domain Identifier for the Amateur Radio Service. IS0 and CCITT recognized needs of certain activities and organizations such as Amateur Radio when they devised the global domain name scheme. Under IS0 is a place for "Identified Organizations" (IS0 6523). Since the Amateur Radio Service is recognized as a global service by the International Telecommunications Union (ITU), the International Consultive

Committee for Radio (CCIR) and the International Amateur Radio Union (IARU), we approached IS0 for a global domain assignment. After some discussion the International Code Designator (ICD) identifying the Amateur Radio Service was issued. With the Amateur Radio ICD, OSI-based Amateur Radio systems will be known by, and accepted by, non-Amateur systems operating throughout the world,

RATS will continue the development of user applications to support and expand the needs of the Amateur Radio community. We will continue to work with other individuals and groups to cooperatively develop new and innovative applications and support systems.

Introduction to the ROSE X.25 Packet Switch

The ROSE X.25 Packet Switch is a connection-oriented, Open Systems Interconnection packet switch which conforms to the CCITT Recommendation X.25 and provides the user with a functionally rich network interface. The user interface to the ROSE X.25 Packet Switch has been designed with the average user in mind. Current users who are familiar with networking using digipeaters (C CALLSIGN VIA DIGI, DIGI) will find that we have continued this basic concept in the ROSE X.25 Switch user interface.

The network will accept data from you and will notify you if there is a possibility that data has been lost. The network is 100% reliable unless you are otherwise notified.

Users no longer need to know each step through the network to get to the desired destination. The network will handle all routing of connections as defined by the routing tables that the network manager has set up.

The only two things you need to know to make calls using the ROSE X.25 Packet Switch are the call sign of the switch local to you, and the network address (Area Code/Exchange in USA), of the point you want to exit the network. It's like knowing where the telephone is in your house and knowing the phone number (Telephone Network Address) of the person you are calling.

Future applications will provide directory information, similar to 555-1212, and other applications that the system manager may choose to upload, such as Clusters or Conferencing/Round-Tables.

System Overview and Features

Written in the C language by Thomas A. Moulton, W2VY, the ROSE X.25 Packet Switch is based on the popular AX.25 Link protocol and the CCITT X.25 Packet protocol. The use of the C language allows rapid "porting" of the software to other hardware.

ROSE X.25 Packet Switch offers the following features:

* Support for AX.25 Level 2 Users - Any standard TNC.

* Support for X.25 Level 3 Users - BBS can directly interface with network; allows more efficient support for multiple simultaneous users on one BBS.

* Enhanced Digipeater Support - Higher throughput due to fewer retries through one switch.

* Faster Response Time - Switch is will retransmit information as needed using Hop-by-Hop Acknowledgements providing higher throughput.

* Online Information - Information/Help bulletin.

* FCC and foreign Government (PTT) acceptable AX.25 Level 2 SOURCE and DESTINATION Identification - the call signs of both the station of origination and termination appear at each end of the connection.

* Station Identification integrity maintained - Call signs traverse the network without ANY changes.

* Proper Transmitter Licensee Identification - Switch always identifies its transmissions with its own call sign, not the call sign of ANY user.

* Simple Addressing - Only need to know the address of the desired exit point of the network, not all the intermediate steps, true Implicit Addressing.

* State of the art addressing - Addressing is based on the universally accepted telecommunications numbering plan.

* Network Determined Routing - Network manager determines best path, eliminating need for broadcasting of routing information to other switches.

* Dynamic Route Selection - Network will automatically attempt alternative paths to remote switches.

* Predetermined Network Paths - Network manager tells each switch which paths to use, will not attempt impossible links because another switch was heard during a band opening.

* Easily Extendible Networking Plan - no need to re-learn how to connect to another station because of a new switch being added.

* Support for Emergency Operations - A switch can be added to the network to provide service from the afflicted area without modifications to the existing network.

* Security System for Remote Control - authentication of user who requests to view or modify configuration.

What ROSE Provides

The ROSE X.25 Packet Switch allows users to connect transparently through the Amateur Packet Network to a remote station without the worry of setting up connections on a step-by-step basis. All a user needs to do is connect through the local switch specifying the remote station's network address.

Before ROSE, you had to know the call sign of each digipeater/node in the path to reach the station.

To connect to a station with a ROSE X.25 Packet Switch you only need to know the call sign of your local switch and the network address (telephone area code and exchange) of the switch local to the station.

For example, to connect to W2VY from anywhere in the USA:

C W2VY via (call sign of Your local switch), 201478

It's as easy as dialing a telephone.

Disconnecting from a Station

Before we get into the various ways you can issue connect requests through a ROSE X.25 Network, it is always good to know how to get out! You just disconnect like you normally would, if you are using a BBS send the "BYE" command, if you are talking to another person hit Control-C and type "D" at the "cmd:" prompt. Don't worry about doing something wrong, it won't bother the switch, if you find something that does then I've got a bug to fix! Please tell me!

Information Bulletin

The switch contains a configurable information message which can be used for network information, meeting notices and any text that is desired by the network manager. To get this message you just need to connect to the switch and enter return. If your local switch is N2DSY-3 you would just type: "C N2DSY-3". When you get the *** CONNECTED message hit return. You will then receive a line indicating the version (release date) of the switch and the text that was loaded by the manager. The version is important to know when reporting any bugs. When all the text has been sent, the switch will automatically disconnect.

Local Digipeating

This mode of operation is straightforward and provides a familiar mode of operation to continue WITHIN the local network. The ROSE X.25 Packet Switch will only digipeat frames with just ONE call sign (its own) in the "via" field of the AX.25 frame. The digipeat call sign is usually the call sign of the switch with a "-2" suffix, and the switch call sign is generally the station call sign with a "-3" suffix. In any case the suffix of the digipeater will be one less than the suffix of the switch.

For the N2DSY-3 switch the following will work:

"C N2FWI V N2DSY-2"

But the following will be ignored:

"C N2FWI V N2DSY-2,KD6TH-5

Because of the extra digipeater field, you may need to use local switching and an exit digipeater, see below.

Networking with ROSE

There is only one new concept for users to learn in order to use the advanced networking capabilities of the ROSE X.25 Packet Switch. Each switch has a unique, local, six-digit "address." This address is the telephone area code and the exchange of the location the switch is serving. This address is used to indicate to the network where the station you want to communicate with is located.

Local switching

Instead of digipeating you may want to use the advanced functionality of the switch to reduce channel overhead and increase the overall throughput. If you want to connect to another station that uses the same switch (N2DSY-3, address 201744 in this case) that you use, you can do this as shown;

For example: "C N2FWI Via N2DSY-3,201744"
(where you want to connect to N2FWI)

In the preceding example you specified N2DSY-3 because that was where you entered the ROSE X.25 Network, and you specified 201744 because that was where you wanted to leave the ROSE X.25 Network. In this case both the entry and exit points were the same location, like a digipeater.

This initially looks like a two hop digipeater connection, but in reality the ROSE X.25 Packet Switch gets into the picture and makes the connection more reliable. The switch will receive the connect request from you, establish a connection with you, and then attempt to establish a connection with N2FWI. This arrangement provides less congestion within the network because the acknowledgements are only between adjacent stations.

Multi-switch networking

In order to connect to another station at a remote switch one must know the address for that switch. If KB7UV uses the switch "718956" a user would type: "C KB7UV V N2DSY-3,718956" to connect to him. In later versions the network will have support for directory services enabling you to use the actual telephone number of the Amateur as the address instead of being required to know their local switch address.

Entry and Exit Digipeaters

If the nearest ROSE X.25 Packet Switch is not local to you, you may need to include an extra digipeater address. For instance if K2MFF-2 is the digipeater you need to access the nearest switch (N2DSY-3), then you could use a connect command such as;

C WA6KJD Via K2MFF-2,N2DSY-3,619372

A digipeater may also be needed at the exit point of the network:

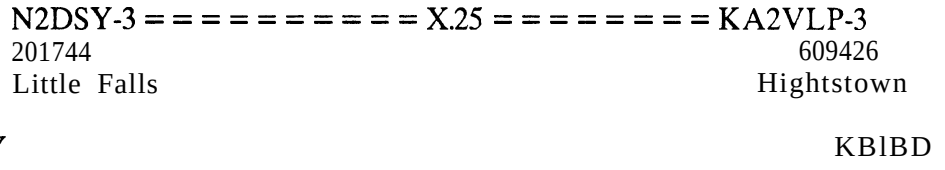
C WA6KJD Via N2DSY-3,619372,WA6KJD-2

As well as Both:

C WA6KJD Via K2MFF-2,N2DSY-3,619372,WA6KJD-2

Monitoring Transmissions

Let us first look at what happens when you set up a connection. For the purpose of example we will look at a network consisting of two switches.



When I want to connect to Bob, KBlBD, I type:

C KBlBD Via N2DSY-3,609426

Which will cause my TNC to transmit:

W2VY>KB1BD,N2DSY-3,609426 <C>

Where the <C> means that it is a Connection request.

At this point N2DSY-3 will accept the connect request by sending:

KB1BD>W2VY,609426,N2DSY-3* <UA>

Where the <UA> is an "Unnumbered Acknowledgement" confirming and accepting the Connection request.

Note that N2DSY-3 is marked (*) as the transmitting station.

At the other end the connect request will exit the network with KA2VLP-3 sending:

W2VY>KB1BD,201744,KA2VLP-3* <C>

Note that KA2VLP-3 is marked (*) as the transmitting station.

Assuming Bob's station is on the air and not busy, he will accept the connect request by sending:

KB1BD>W2VY,KA2VLP-3,201744 <UA>

And his TNC will print to the terminal:

*** CONNECTED TO W2VY VIA KA2VLP-3,201744

This indicates the correct path to W2VY for Bob.

How to determine where a connection originated

When monitoring a channel you will see the switch call sign preceded or followed by a six-digit number. This is the area code and exchange of a switch within a ROSE X.25 Network.

Example:

If you were to see a monitored frame such as:

WA6KJD>W2VY,619372,N2DSY-3* <I>:Carol says Hi!

Where the <I> indicated the transmission contains Information.

This would indicate that the N2DSY-3 switch was transmitting information to W2VY on behalf of WA6KJD who is at Switch address 619372.

And if you saw:

W2VY>WA6KJD,N2DSY-3,619372 <I>:Hi Dad, back on HF yet?

Would be a frame sent by W2VY going to WA6KJD@619372.

Connections with DX Stations look about the same but have an extra numeric field:

VE7APU>W2VY,3020,615423,N2DSY-3* <I>: Hi Tom.

Is a frame from Canada (Data Country Code 3020), Area Code 615-423. For a complete list of DCC's see Appendix B.

ROSE X.25 Packet Switch Messages

"*** Disconnect *** nnnn"

This message is sent when your connection to the other station is cleared. The four-digit number (nnnn) describes the reason for disconnection. For your convenience the following table is a list of the codes that are normally seen. The first two digits are only important to this table.

X.25 Name	Value	Explanation
DTE Originated	0000	The other station disconnected
Number Busy	0100	The other station is busy
Congestion	0500	Retry Count Exceeded
Out of Order	0900	Network link not operating
Not Obtainable	0D00	No known path for address specified
Ship Absent	3900	No response from station

In the future these will be replaced with phrases with more meaning,

Appendix A contains a complete list of codes used by the ROSE X.25 Packet Switch.

"*** Reset *** nnnn"

This message is sent when a RECONNECT command was issued or the link went through a level 2 "Link Reset", to notify you that there may have been some data lost. For the complete list of X.25 Cause and Diagnostic codes see Appendix A.

X.25 Name	Value	Explanation
DTE_Orig	0092	The other user issued a REConnect
Congestion	0792	A Network Link issued a REConnect

Tips and Tricks

Can't type full numeric digipeater field:

If you own a TNC from the vendor that does not allow numeric fields (TAPR TNC-1 based TNC's) you may exchange any l's for I's and/or O's for O's and the switch will translate it for you. Don't worry about incoming connect requests as they don't place the same limitation on received frames.

Appendix A

CCITT X.25 Cause Codes used by the ROSE X.25 Packet Switch

The clearing (disconnect) codes are comprised of two parts, the first two digits are the X.25 Cause, indicating the general reason for the failure and the second two digits are the X.25 Diagnostic to indicate the specific reason for the failure.

CCITT X.25 Name	Value	Explanation
DTE Originated	00	The other station disconnected
Number Busy	01	The other station is busy
Invalid Facility	03	internal error
Network Congestion	05	Retry Count Exceeded
Out of Order	09	Network link not operating
Access Barred	0B *	Not used
Not Obtainable	0D	No known path for address specified
Remote Procedure	11	internal error
Local Procedure	13	internal error
RPOA Out of Order	15 *	RPOA Not operational
Reverse Charge	19 *	Reverse Charging not subscribed to
Incompatible Dest.	21 *	Incompatible Destination
Fast Select	29 *	Fast Select Not subscribed to
Ship Absent	39	No response from station
Gateway Proc Error	Cl *	Gateway Detected Procedure Error
Gateway Congestion	C5 *	Gateway Congestion

* Currently not used, should not be seen.

Table 1 - X.25 Clearing Cause Values

CCITT X.25 Name	Value	Explanation
DTE Originated	00	The other station re-connected
Out of Order	01 *	
Remote Procedure	03 *	
Local Procedure	05 *	
Network Congestion	07	Link Reset on Network Trunk
Remote Operational	09 *	
Network Operational	OF *	
Incompatible Dest.	11 *	
Network OutofOrder	1D *	
Gateway Proc. Error	Cl *	
Gateway Congestion	C3 *	
Gateway Operational	C7 *	

* Currently not used, should not be seen.

Table 2 - X.25 Resetting Cause Values

Appendix A

CCITT X.25 Diagnostic Codes used by the ROSE X.25 Packet Switch

Value	Explanation
01 (01)	Invalid P(S) - Internal sequencing error
02 (02)	Invalid P(R) - Internal sequencing error
17 (11)	Invalid X.25 Packet for R1 State
19 (13)	Invalid X.25 Packet for R3 State
20 (14)	Invalid X.25 Packet for P1 State
21 (15)	Invalid X.25 Packet for P2 State
22 (16)	Invalid X.25 Packet for P3 State
23 (17)	Invalid X.25 Packet for P4 State
24 (18)	Invalid X.25 Packet for P5 State
25 (19)	Invalid X.25 Packet for P6 State
26 (1A)	Invalid X.25 Packet for P7 State
27 (1B)	Invalid X.25 Packet for D1 State
29 (1D)	Invalid X.25 Packet for D3 State
33 (21)	Unidentifiable Packet
36 (24)	Illegal Packet on unassigned logical channel
38 (26)	Packet too short
39 (27)	Packet too long
41 (29)	Restart packet on non-zero logical channel
43 (2B)	Unauthorized Interrupt Confirm Packet
44 (2C)	Unauthorized Interrupt Packet
71 (47)	No logical channel available
72 (48)	Call Collision
76 (4C)	Facility not provided when expected
120 (78)	Temporary Routing Problem
127 (7F)	Maintenance Action
146 (92)	Retry count exceeded for data packet transmission

Table 3 - X.25 Diagnostic Codes Used

Zone 2

DCC	Country or Area
202	Greece
204	Netherlands
206	Belgium
208	France
212	Monaco
213	Spain
216	Hungarian People's Republic
218	German Democratic Republic
220	Yugoslavia (Socialist Federated Republic of)
222	Italy
226	Romania (Socialist Republic of)
228	Switzerland (Confederation of)
230	Czechoslovak Socialist Republic
232	Austria
234	United Kingdom of Great Britain and Northern Ireland
238	Denmark
240	Sweden
242	Norway
244	Finland
250	Union of Soviet Socialist Republics
260	Poland
262	Federal Republic of Germany
266	Gibraltar
268	Portugal
270	Luxembourg
272	Ireland
274	Iceland
276	Albania
278	Malta (Republic of)
280	Cyprus (Republic of)
284	Bulgaria (People's Republic of)
286	Turkey

Zone 3

DCC	Country or Area
302	Canada
308	St. Pierre and Miquelon
310	United States of America
311	United States of America
312	United States of America
313	United States of America
314	United States of America
315	United States of America
316	United States of America
330	Puerto Rico
332	Virgin Islands (USA)
334	Mexico
338	Jamaica
340	French Antilles
342	Barbados
344	Antigua
346	Cayman Islands
348	British Virgin Islands
350	Bermuda
352	Grenada
354	Montserrat
356	St. Kitts
358	St. Lucia

Zone 3 (Cont.)

DCC	Country or Area
360	St. Vincent
362	Netherlands Antilles
364	Bahamas (Commonwealth of the)
366	Dominica
368	Cuba
370	Dominican Republic
372	Haiti (Republic of)
374	Trinidad and Tobago
376	Turks and Caicos Islands

Zone 4

DCC	Country or Area
404	India (Republic of)
410	Pakistan (Islamic Republic of)
412	Afghanistan (Democratic Republic of)
413	Sri Lanka (Democratic Socialist Republic of)
414	Burma (Socialist Republic of the Union of)
415	Lebanon
416	Jordan (Hashemite Kingdom of)
417	Syrian Arab Republic
418	Iraq (Republic of)
419	Kuwait (State of)
420	Saudi Arabia (Kingdom of)
421	Yemen (Arab Republic)
422	Oman (Sultanate of)
423	Yemen (People's Democratic Republic of)
424	United Arab Emirates
425	Israel (State of)
426	Bahrain (State of)
427	Qatar (State of)
428	Mongolian People's Republic
429	Nepal
430	United Arab Emirates (Abu Dhabi)
431	United Arab Emirates (Dubai)
432	Iran (Islamic Republic of)
440	Japan
450	Korea (Republic of)
452	Viet Nam (Socialist Republic of)
454	Hong Kong
455	Macao
456	Democratic Kampuchea
457	Lao People's Democratic Republic
460	China (People's Republic of)
470	Bangladesh (People's Republic of)
472	Maldives (Republic of)

Zone 5

DCC	Country or Area
502	Malaysia
505	Australia
510	Indonesia (Republic of)
515	Philippines (Republic of)
520	Thailand
525	Singapore (Republic of)
528	Brunei
530	New Zealand
535	Guam
536	Nauru (Republic of)

Zone 5 (Cont)

DCC	Country or Area
537	Papua New Guinea
539	Tonga (Kingdom of)
540	Solomon Islands
541	New Hebrides
542	Fiji
543	Wallis and Futuna Islands
544	American Samoa
545	Gibert and Ellice Islands
546	New Caledonia and Dependencies
547	French Polynesia
548	Cook Islands
549	Western Samoa

Zone 6

DCC	Country or Area
602	Egypt (Arab Republic of)
603	Algeria (Algerian Democratic and Popular Republic)
604	Morocco (Kingdom of)
605	Tunisia
606	Libya (Socialist People's Libyan Arab Jamahiriya)
607	Gambia (Republic of the)
608	Senegal (Republic of the)
609	Mauritania (Islamic Republic of)
610	Mali (Republic of)
611	Guinea (Revolutionary People's Republic of)
612	Ivory Coast (Republic of the)
613	Upper Volta (Republic of)
614	Niger (Republic of the)
615	Togolese Republic
616	Benin (People's Republic of)
617	Mauritius
618	Liberia (Republic of)
619	Sierra Leone
620	Ghana
621	Nigeria (Federal Republic of)
622	Chad (Republic of the)
623	Central African Republic
624	Cameroon (United Republic of)
625	Cape Verde (Republic of)
626	Sao Tome and Principe (Democratic Republic of)
627	Equatorial Guinea (Republic of)
628	Gabon Republic
629	Congo (People's Republic of the)
630	Zaire (Republic of)
631	Angola (People's Republic of)
632	Guinea-Bissau (Republic of)
633	Seychelles
634	Sudan (Democratic Republic of the)
635	Rwanda (Republic of)
636	Ethiopia
637	Somali Democratic Republic
638	Republic of Djibouti
639	Kenya (Republic of)
640	Tanzania (United Republic of)
641	Uganda (Republic of)
642	Burundi (Republic of)
643	Mozambique (People's Republic of)
645	Zambia (Republic of)

Zone 6 (Cont)

DCC	Country or Area
646	Madagascar (Democratic Republic of)
647	Reunion (French Department of)
648	Zimbabwe
649	Namibia
650	Malawi
651	Lesotho (Kingdom of)
652	Botswana (Republic of)
653	Swaziland (Kingdom of)
654	Comoros (Federal and Islamic Republic of the)
655	South Africa (Republic of)

Zone 7

DCC	Country or Area
702	Belize
704	Guatemala (Republic of)
706	El Salvador (Republic of)
708	Honduras (Republic of)
710	Nicaragua
712	Costa Rica
714	Panama (Republic of)
716	Peru
722	Argentine Republic
724	Brazil (Federl Republic of)
730	Chile
732	Colombia (Republic of)
734	Venezuela (Republic of)
736	Bolivia (Republic of)
738	Guyana
740	Ecuador
742	Guiana (French Department of)
744	Paraguay (Republic of)
746	Suriname (Republic of)
748	Uruguay (Oriental Republic of)