AVC_R_ISA: a MAC layer for NOS/net

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ABSTRACT

In this paper we describe an implementation of the protocol AVC-R-ISA (Access Virtual Channel Radionet-Independent Stations Algorithm) performed in the NOS/net program. AVC-R-ISA may be a solution to the problem of traffic control in a packet switched network, like for example the amateur packet network. This multiple access strategy may be viewed as an alternative for the MAC layer to the popular CSMA and is aimed at improving the channel throughput with an optimized distribution of the channel itself among the users.

INTRODUCTION

Channel distribution among several users requires the application of access methodologies, of which various different kinds have been developed and successfully implemented. Amateur packet in one-level networks is well suited for a fully distributed access method like CSMA. When we consider a multilevel structure based on the presence of backbone stations and local area routers, the presence of a base station (a station involved in the data exchange at every turn-over) offers the possibility of enhancing the network throughput. This may be the case of a backbone station serving area routers being hidden to one another.

The access method called AVC-R-ISA (Access Virtual Channel Radionet-Independent Stations Algorithm) is based on an adaptive strategy, that tunes itself according to the network status. We briefly recall the adopted methodology: the backbone station, called master, well positioned to be received from all the other area routers, selects a group of them according to the R_ISA algorithm [1] and requests their transmission, being able to make an estimate of the traffic generated by every station known to be currently active on the network. **As** is consistent with intuition, enabling a set of stations with a "large" presence probability increases the possibility of a collision, whereas a set of stations with a "low" presence probability may more easily result in an empty transmission period. In both cases bandwidth would be wasted. There is **a tradeoff** where the number of enabled stations maximizes the network throughput, and the adaptive strategy tends to optimize it.

In the next section of this paper we briefly review the AVC-R-ISA principles and describe how the ideas presented in [2] have been improved.

In the last section we propose an implementation of AVC-R-ISA in the KA9Q Internet package. Our choiche is due to the large diffusion of this package that, together with the availability of the well structured source code, allows a practical test of new ideas. The commands added to NOS/net are also described.

THEORETICAL ASPECTS

The theory of R_ISA shows that for an efficient traffic forecast, some parameters are necessary, including the identity of every station active on the network. In other words, the set of stations must be known before the network is activated.

AVC-R-ISA by-passes this restriction by including in its enabling list a set of "accessing stations ". For this group of stations, like for every other, a logical channel is defined, that simply consists in a single identifier assigned to every station at its entry into the network activity.

It is intuitive that only one common identifier (say, 0) may be assigned to all stations still out of the round, because they are "unknown" to the master. For an analysis of ISA and its evolution we refer the reader to [1,2]. The AVC (Access Virtual Channel) was added to R-ISA to allow stations enter the network. However, when several stations are ready to go on the air on the next access slot with the same identification, one must try to minimize the collision probability.

The easiest solution is to have these stations use a slotted-ALOHA access rule, whenever enabled to transmit by the ISA procedure. However, a fixed retransmission parameter for the ALOHA strategy, as previously adopted, turns out to be very inefficient. Therefore we have decided to use Rivest's pseudo-Bayesian broadcast [3] which is one of the most efficient strategies to optimize and stabilize slotted-ALOHA. It requires the estimation of the number of "backlogged" stations on channel 0, which is done by means of channel feedback, and must interwork with the estimation of presence probabilities performed by ISA. [4].

AVC-R-ISA frames cannot be received from a normal TNC running AX25 software, because bytes are added in front of the AX25 frame. AVC-R-ISA is located at a lower layer (MAC) than AX25, and is connection oriented. For this reason, single hop addressing is resolved at the AVC-R-ISA level and any AX25, IP or NETROM frame is simply encapsulated in it.

NOS/net NEWS

The modified NOS/net program is able to manage Master and Slave stations. The two types of stations have anyway available different frames. They have been slightly modified with respect to those proposed in [2], because during the experiments some more control frames showed to be necessary.

The Master can use the following frames:
1) Slave connection request; 2) Slave disconnection request; 3) Forced disconnection of all the Slaves; 4) Slave Synchronization; 5) Slave connection accepted; 6) Slave connection refused; 7) Slave disconnection accepted. The first 4 frames are activated by the master while the following 3 are sent in reply to Slaves' incoming frames.

The Slave can use:
1) Master connection request; 2) Master disconnection request. Information frames are then added to the above either for Master or Slave stations.

NOS/net transportability (PC, Macintosh, Amiga and Unix) has been maintained and also the set of services (AX25, IP, ICMP, TCP, UDP, ARP and, as applications, FTP, TELNET and SMTP). In the present version, the new MAC level has been implemented for the "asy" interface

(Standard PC Asynchronous Interface using the 8250 or **16550A),** but we plan a version running other devices, like Software Packet Driver of the FTP Software Inc.

The software has been written preserving modularity. Data **structures** are included in a single **data block,** and they have been **connected to** the **physical interface with the** "attach" command. In the **"iface"** structure, two new fields **are** now available:

"isa_raw" and **"isa_recv"** (similar to the existing "raw" **and "recv"),** that activate the ISA channel control function.

After receiving frames from the upper **levels, "isa_raw"** generates a timed FIFO queue. In the case of channel congestion, to prevent the queue growing too large, **a** demon adjusts the time to live **(ttl)** of **the** frame, deleting it when the **ttl** reaches **a threshold.** This procedure **is** transparent to the frame **structure, so** that compatibility **is maintained** also with **new** upper levels and protocols.

The solution helps avoiding packet repetition **on** the channel. At **heavy load** conditions, the timeout of upper level managers may **request** a retransmission, even if the packet has not yet been transmitted for the first time or the transmission was successful but not yet acknowledged. In this case, removing **"too** old" ties **from** the queue prevents channel overload.

"isa_recv" is activated by the "network" demon after receiving an error-free **ISA-frame.** In this case, if the transmission queue is not empty, one **frame** is taken **from** the FIFO queue and placed in the **tx_buffer,** and then on the air after attaching the header containing MAC protocol information. The **tx_buffer** is then cleared only after the Master feedback on the successful reception of the **frame** is received.

If the program is running on the Master station, **"isa_recv"** calls the routine calculating the permissions table. This table will **be** transmitted to the slaves in a bit-map format. Obviously, Master and Slave procedures **are** sometimes different, but they may run together on the same node. A PC may act **as** gateway, being master of a network and at the same time **slave** of another network. Moreover, the master must provide sending on the air the sync for the network. This must be done also in absence of active Slave stations to enable the Access Channel: in this case, we prefer avoiding a continuous polling on the air, muting the Master **and** waiting for the presence of an ISA carrier. The Slave requesting entrance in the round on its part watches the channel, and after detecting no activity for a certain time, assumes the access channel is enabled and **transmits.The** Master must also pay attention to a station leaving the network without disconnecting from it. A procedure takes into account the elapsed time **from** the last transmission of every Slave and **disconnects** it when this time reaches a threshold. A "shutdown" frame is also available for the Master, that is able to signal a forced standby avoiding Slaves "hanging" on the channel.

A very important factor affecting the performance of the ISA algorithm is the geographical position of the master station. As already mentioned, two **different** versions of **ISA/NOS** were developed. The first one is devoted to end-users, i.e., it can only act as a slave station or as a slave gateway between ISA-net and other networks supported from the original **KA9Q package.The** second one is primarily &voted to area management, but it also supports the function of both master and slave roles, allowing the development of networks with hierarchical structure.

The hardware requirements for this latter version are:

- a 386 Personal Computer with a mathematical co-processor,
- a **connection** of its serial port to the CD signal detected **from** the **TNC.**

Of course, the ISA networking is possible only between stations running this modified version of the **KA9Q** package, as the frame structure cannot be decoded by the **AX25-based** available **TNCs.** In or&r to define the parameters affecting the ISA environment, we added some new commands. The syntax is:

isa <subcommand> [<optional **parameters>].**

Their **semantic** is the same as used by P. **Karn** in the **"Net User Reference Manual".** Moreover, we **modified the** "attach **asy"** command, that now provides, in **addition** to the **three** previous **operating** modes (slip, ax25 and **nrs), also** the ISA **mode, thus allowing to define an interface acting as** master **or** slave station. Therefore the command **syntax is the following:**

attach asy **<ioaddr> <vector> slip ax25 nrs isa <label> <bufsize> <mtu> <speed> [<**flags>].

For instance, if one wants to **attach** an ISA interface on **COM1,** the command is:

attach asy 0x3f8 isa ax0 2048 256 9600.

Additional commands are the following:

ISA checkcount **<iface>** [<value>]

Sets or displays the time interval after which the Master disconnects an inactive slave station. This command is reserved to master stations and it activates only after no connection is present. The range (in seconds) of this parameter is from 10 **to** 64000.

ISA **mastercall** [<call>]

Sets or displays the ISA master station callsign. The used **sintax** is **that** of **a standard** AX.25 address. This command must be executed before any "attach" directive using ISA **mode.**

ISA **<iface> [<n.station>]**

Sets or displays the maximum number of slave stations that can be accepted by the master. This command is reserved to the master stations and it is accepted if no connections are present. The range of n.station is between 7 and 254.

ISA **slotch0** [<value>]

Sets **or** displays the maximum number of transmissions after which the local **identifier 0** (the access virtual channel) is certainly enabled. This parameter may be **a** critical factor for a good performance of the network. Therefore great attention must be paid in choosing this value, in order to avoid both **a** too long queue of slave stations waiting for connection and a too **frequent** enabling of the virtual channel access. This command is reserved to the master station and it is accepted only if no **connection** is present.

ISA status **[<iface>]**

Without argument, it displays the status of all inferfaces operating in **isa** mode. If **<iface>** is specified, only the related informations will be displayed.

ISA switch <iface> [on|off]

Sets or display the specified interface status. The transition from an inactive to an active status of a slave station is not immediate, but it needs the acknowledgement of the master station. If this command is executed by a master station, this sends a shutdown frame and stops the ISA activity.

ISA type <master|slave>

This command is available only for the version running on master stations. It allows a station to be master of one ISA network and slave of another in order to build a hierarchical structure.

CONCLUSIONS

We have considered an implementation of the AVC_R_ISA adaptive access strategy in NOS/net for operating in an amateur environment. The updated version of the program is now under test, and a network composed of a master station and six slaves will be soon on the air on the UHF band. The whole network is organized in a "master to area routers " configuration, the master ranging a radius of about 100 miles. Area routers will then collect the traffic of OM local stations spread over the North-West part of Italy offering a real test-bed for the system. We hope the utility of such strategy will be demonstrated, thus justifying the increased complexity.

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