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Halloween

On Addressing and Related Issues.  
(or: Fuel for a Discussion)

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This note is about addressing of hosts on local nets.

#### THE AXIOM-A1

According to our current model a local net (LN) is an InterNetworkly (like "internationally") known network, having an 8-bit Net-ID (NID) assigned by the czar, registered in the official registry, etc., etc.

Furthermore, we have Axiom-A1 which states that:

(A1): All Gateways know how to get to ALL Networks.

Here, both "Gateway" and "Network" are spelled with capital letters to indicate that they are part of the global InterNetwork Environment as opposed to some trivial network or gateway, like the hidden ones, for example.

An interesting question is: "Is every local network a Network?".

Now the answer seems to be "yes". I beg to differ.

I cannot escape the feeling that if we hold to this practice we will soon find that slow nets, like the ARPANET, cannot keep up with all the inter-Gateways traffic needed for all Gateways to know all about all Networks, or at least about their existence and how to get there. In addition the storage capacity to keep this information and the cycles to process it may also exceed any reasonable estimate. In addition, the 8-bit field may turn out to be too small for the NID.

This fear is based on the experience with the ARPANET routing update which was frequent when the net was lightly loaded, hence least needed, and less frequent when it was needed the most, when the net was heavily loaded.

Also, so far we have 31 NID's assigned (according to page 2 of IEN-117, August 79) and this does not even include the 10 telephone lines each of which has to be treated as a Network, according to Dave Clark; the 3 (at least) LN's at ISI, at Lincoln, SRI, LLL, LBL, CMU and more. In the very near future every installation will have an LN (DECNETS and the like) and probably so will any medium and big computer system.

If every PDP-10 (and bigger) computer has a local net to communicate with its devices, file systems and the like, and if local nets have NIDs then we may need LOTS of bits in LOTS of tables, and lots of cycles to process them, if we ever manage to get enough bandwidth to communicate them.

I propose the following:

- \* Let NID='377 be an escape-code, and NID=0 mean "this-Net".
- \* Let networks which have only one connection to the IN-environment (e.g., one Gateway only) be defined as Ln's. Note, net, not Net.
- \* Let Ln-addresses be 24 bit wide. The value 24 is used here for convenience only. Obviously it may assume any other value, as is needed for any particular network.
- \* Let Ln's not have NID's!!! and their gateways considered as gateways (not Gateways); and
- \* Use source-routing to get to the hosts on these Ln's.

Hence, if there is a local net at site-X, which is connected to the IN-environment via IMP-Y on the ARPANET, then the addresses of processes on this net should be:

```
<NID=ARPANET> <IMP=Y> <HOST/LINK=Local-gateway>
<NID='377> <the 24-bit address of that process>
```

Note that this is a 64-bit address !!

In comparison, now we have only 32-bit addresses, such as:

```
<NID=X> <the 24-bit address of that process>
```

However, for sites on Networks with only 16-bit addressing (e.g., the ARPANet and WBnet) it is most advantageous to have local nets with 8-bit addressing only, since this allows packing of the entire address in a single IP-address without the need for source-routing.

For example, the IP-address of host-123 on the local-net which is connected to the INE via the gateway which is on interface-3 of IMP-22 could be:

```
<NID=ARPANet> <IMP=22> <HOST=3> <Ln=123>
```

The main idea is that if all the communication to X has to pass through "g" then there is absolutely no point in propagating to the outside world any information about the structure of the environment inside (i.e., "inwards" or "beyond") of "g".

If CMU, for example, has 5 local nets, all of which are connected to the world via the same IMP, then there is absolutely no point in treating them as Networks with NID's, and polluting the world with information about them, how to get to them etc., since the only way to get there is to get first to the ARPANET and then to the CMU-IMP.

Proliferation of information which is not needed may be very costly, in storage, in cycles, and in bandwidth.

I don't believe that the fact that someone adds a local network in Timbaktoo has to be propagated to all the Gateways.

In summary: Let's adopt the policy of non-proliferation of NID's and let's use source routing.

#### THE THEOREMS T1, T2 and T3

The following three theorems have been proven experimentally and require no more discussion:

(T1): Any fixed size field will be found to be too small.

(T2): Any fixed number of fields will be found to be too small.

(T3): You can fool T1, or T2, but not both.

It is important to understand that T1 is not the only reason to avoid Networks proliferation. By having a very-very long NID field (say 100 bits) T1 may be fooled for some time.

#### THE POSTULATE-P1

Addressing hosts and processes which have several physical connections with the INE (the InterNetwork Environment, or "Catenet") is a messy and nasty problem.

This problem may be stated as: "What is the address of X if it is connected with the INE both as HOST-m on NET-i and as HOST-n on NET-j?".

If X is a network, say NET-k, then there are Gateways in between, and according to Axiom-A1 there is no problem in addressing it as NET-k, since all the Gateways anywhere know how to get to it.

But if X is a host, or any other non-network type of process, then there is a problem with its dual-homing (or better: multiple-homing).

If the choice between the multiple addresses is left to any process which tries to communicate with X then we have to admit that our communication system is not capable of solving ALL the addressing issues, and push this problem "up" into hosts. It goes without saying that this does not mean that people (like senders of text messages) have to remember these multiple addresses, and that programs and tables could be used for it.



Here is where Postulate-P1 is defined.

(P1): Every process should have only one IN-address.

This is possible to achieve by simply defining any process, or collection of processes, as a Network. For example, if hosts (which are not Gateways) and local networks which have more than one connection to the INE, are defined as Networks, with their own NID's, then Axiom-A1 guarantees that Postulate-P1 is always true.

Note how nicely this alleviates the problem of handling multiple addressing, source routing, the mess required to handle variable length addresses, and more.

#### THE INNER STRUCTURE OF GATEWAYS

After establishing both Axiom-A1 and Postulate-P1 the addressing issue is totally under control. There may be a slight difficulty with handling the number of Networks which are required, but T1 can always be fooled by assigning a very long field for the NID and by assuming that the bandwidth, the storage and the cycles are available at all the Gateways to handle all the information about ALL these Networks.

Next, consider a process P which is inside the Gateway G(i,j) which connects NET-i with NET-j. Such a process may deal with access control, checks and balance, routing, or any of many other possible issues.

What is the address of this process?

G(i,j) is both HOST-m on NET-i and HOST-n on NET-j, just like X above.

Since our Postulate-P1 does not allow multiple homing, we cannot let the address of this process be

either  $\langle \text{NET}=\text{i} \rangle \langle \text{HOST}=\text{m} \rangle \langle \text{P} \rangle$  or  $\langle \text{NET}=\text{j} \rangle \langle \text{HOST}=\text{n} \rangle \langle \text{P} \rangle$

Hence, we must define the inside the Gateway to be another Network.

The new Network is obviously connected both to NET-i and to NET-j. But how? Simply, as shown in  $\langle ** \rangle$  below:

$\langle ** \rangle$  Via two Gateways, each of which is itself a Network with an InterNetworkly known NID.

How is each of these Networks connected to its own neighboring Networks? Simply, as shown in  $\langle ** \rangle$  above.

Well, this does not seem to jibe perfectly with the notion of finite length NID-fields... By the way, I suspect that you did not trace the above explanation to its logical termination. Did you?

There are several tacks one may take here to mend this situation. I dare say that un-adopting Postulate-P1 is one of the better ones.

Let's do it, hence we accept that the multiple-homing issue is not necessarily always solved completely by the Gateways.

There is a lot to be said about multiple-addressing but this is left for yet another note.

Once this heresy is introduced -- even Local Networks with more than one connection to INE may be treated as Ln's without NID's !!

#### CONCLUSION

Local networks, regardless of the number of connections which they have to the INE, should NOT be treated as Networks with NID's.

#### AFTERTHOUGHTS

The network forefathers demonstrated remarkable foresight by allocating an 8-bit field for HOSTs on the ARPANet. The notions of that many hosts, that many IMPs and several computers connected to a single IMP at one location were ahead of their time.

Since then the scenario developed in several directions. First, it is not THE network any more. Many networks, of different technologies are in existence. Second, on many occasions there is more than one computer at the same location.

The concept of HOST is gradually and implicitly replaced by the new concept of SITE. Here "site" is some combination of an organization and a certain location, like "ISI", "MIT" or "BBN", but not like "DoD" or "Cambridge".

The association of processes, people, files, devices is not per-host, as it used to be, but more and more per-site. This is especially apparent when text messages ("mail") are discussed. It is typically expressed by statements like: "I know that he is at MIT, but have no idea on which machine there, and don't even care to know!".

I suspect (but am not quite sure) that the similarities between local-networking and Networking (a la ARPANet, WBCNet and PRNet) are deeper than just a lucky coincidence, but less than a deep fundamental phenomena.

Treating local networks with all the "glory" which is associated with "real" (or "global") networks -- may be misleading and may cause more artifacts than what we bargain for.

Let's think about it.....

A COMMENT ABOUT MULTIPLE-ADDRESSING.

Without suggesting anything to the INE, following are some examples of the handling of multiple-addressing in Telephonia.

My addresses, at ISI, are 1-213-822-1511 thru 1-213-822-1519 (plus some non-contiguous numbers). However, no one outside of ISI has to know these numbers, since all the communication which is addressed to the one of them is automatically re-routed to the rest, if so needed.

I have one address at ISI, and another at home. The re-routing between them takes place outside the "pure" communication system, unless its definition is augmented to include the human operators, secretaries, and the like.

If I am not around someone probably can provide the sought information. This multi-address (of the information!) is the choice of whom-to-ask. It is very difficult to stretch the definition of communication systems to include that.

These examples show that in Telephonia the multiple-addressing issue is handled at several levels. Maybe the same is true for internetting, too.