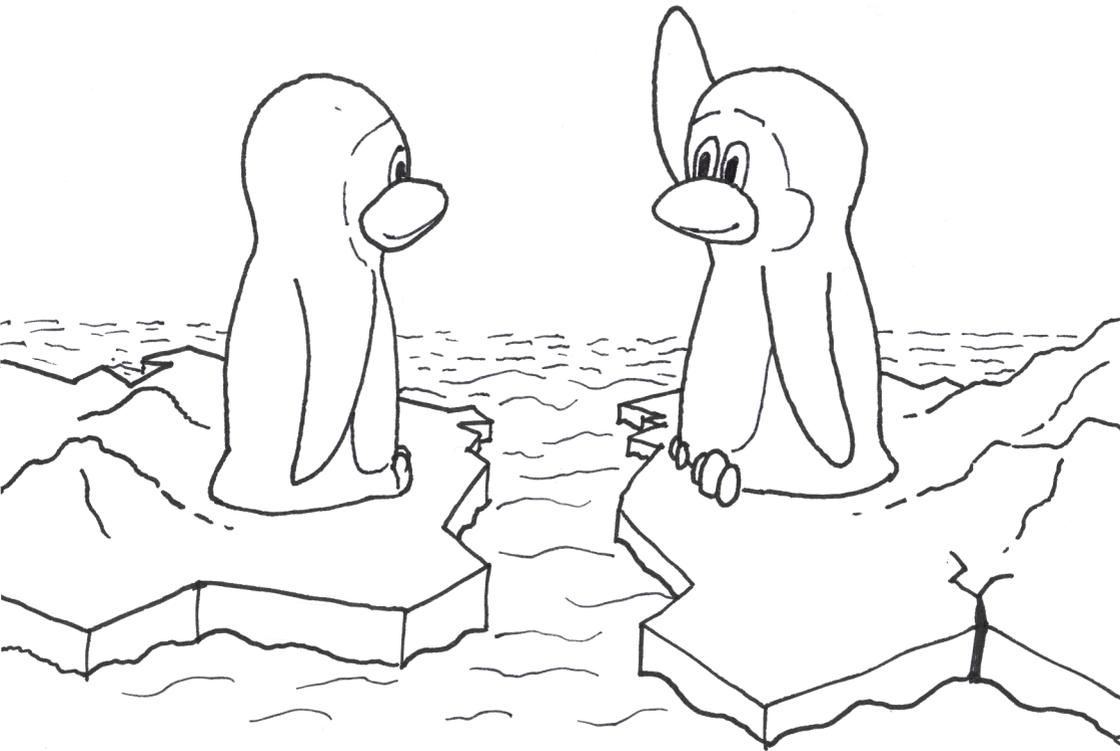
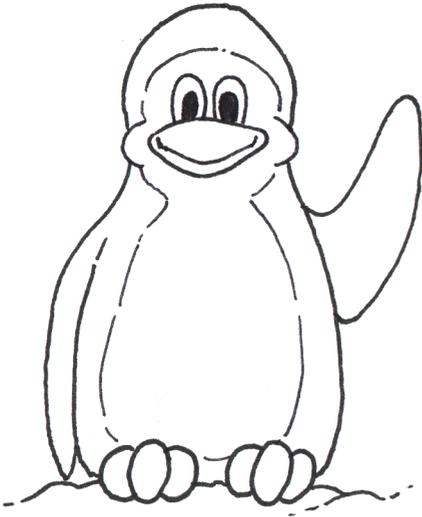


Stateless Address Autoconfiguration SLAAC

explained using penguins

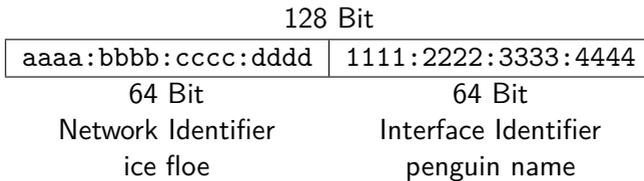




Hi, I am Ping
from ice floe #7
and today I want
to tell you how I
got my name.

IPv6 addresses have a length of 128 bits and consist of two parts.

Like the penguin, they have a part matching the **network** region (or ice floe) and a part unique to the network **interface** (or penguin):



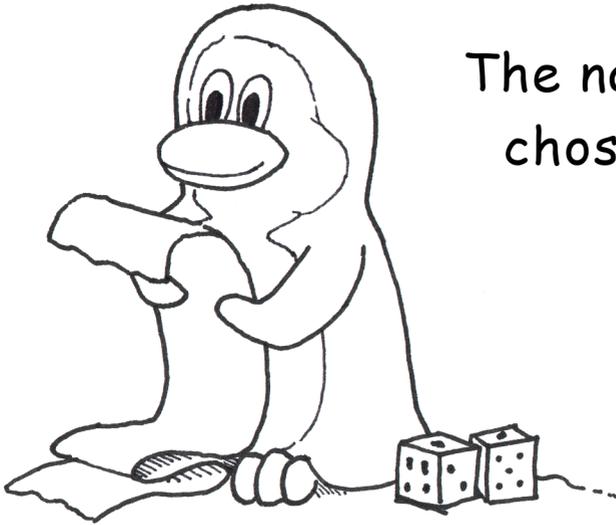
Normally it's grouped into groups of 4 hexadecimal symbols, separated by colons.

When I emerged from my egg, I had no name and I didn't know on which floe I am.



At first a computer starts with no IPv6 address. It has no idea in which network it is or really any information (thus Stateless Autoconfiguration).

To start on its way to get an IPv6 address, it first generates an address only usable for the local floe. Or as its really called: link-local address. The network part for a link-local address is always `fe80:0000:0000:0000`, so that is easy. But from where to take the interface identifier?



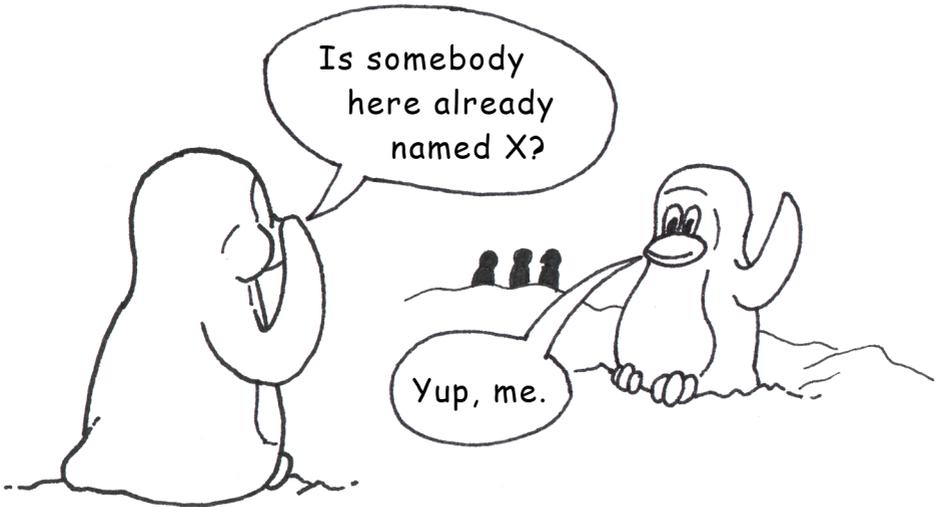
The name I simply
chose by myself.

For SLAAC there is no central authority, which would distribute these interface identifiers, so the computer needs to generate it on its own.

The interface identifier can be generated in different ways:

- from unique attributes, such as MAC address
- from a public key
- completely random (for example by rolling dice, as seen above)
- stable random (always the same in the same network, RFC7217)

Well, it would be bad, if I had chosen the same name as another penguin.

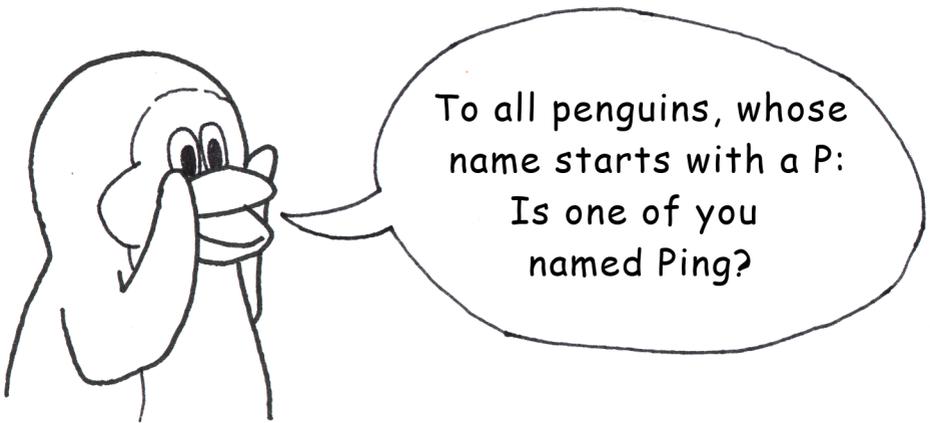


Now another penguin could have rolled the same, so how do we know, that our link-local address is unique and we can start using it?

For this we can use the Neighbor Discovery Protocol. More specifically the Duplicate Address Detection (DAD). Until that is completed, the address is called a tentative address.

Duplicate Address Detection only needs two messages:

- **Neighbor Solicitation (NS):** The computer sends a Neighbor Solicitation addressed to the tentative link-local address, which it wants to validate.
- **Neighbor Advertisement (NA):** If the computer receives a Neighbor Advertisement as answer to the Neighbor Solicitation, the interface-part is not unique and it needs to generate a new interface identifier.



Since nobody reacted,
my name is now **Ping**.

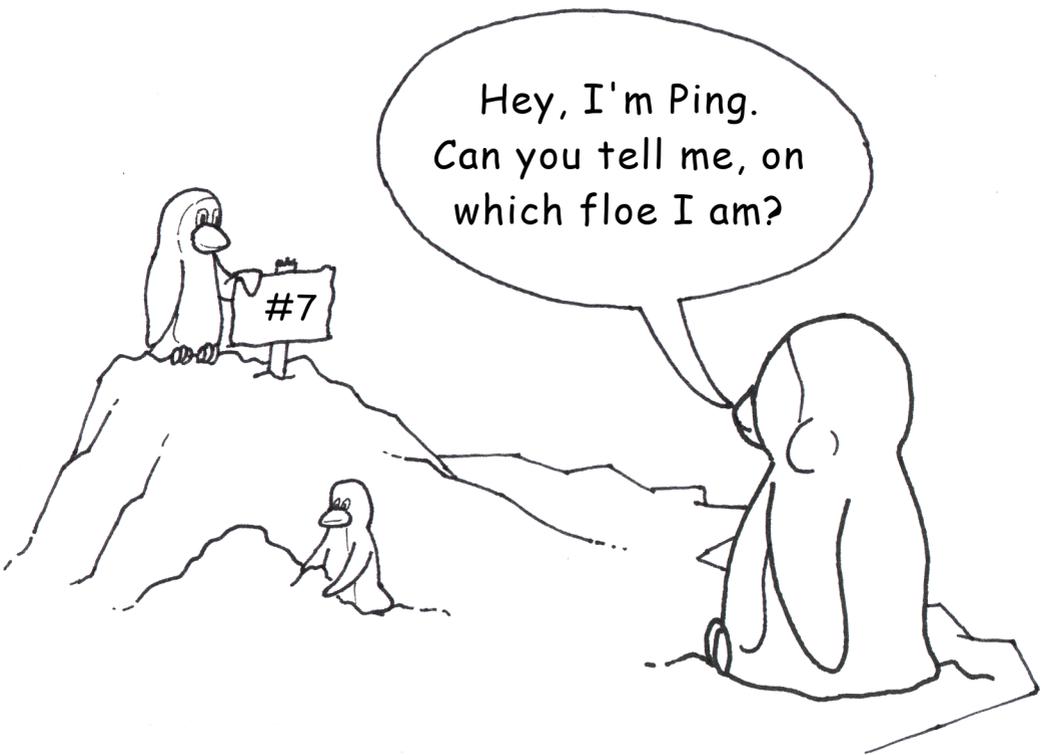
The Neighbor Solicitation is not sent to all computers (or nodes, as they are called in IPv6 context). For this there is the special Solicited Nodes Multicast Address:

ff02:0000:0000:0000	0000:0001:ffXX:XXXX
---------------------	---------------------

last 24 Bit are
taken from
Interface Identifier

Every computer joins the Solicited Nodes Multicast Group for its own address, so it receives the Neighbor Solicitations.

IPv6 has lots of cool features around multicast, but that is stuff for maybe another zine ...



Now we know our own interface identifier and are sure no one else in the local network has the same. With this link-local address we can already talk to local computers.

For a globally routable address we can re-use the interface identifier, but we also need the first part of the address: the network part.

For this we use another part of the Neighbor Discovery Protocol:

- **Router Advertisement (RA):** The router periodically broadcasts various network parameters such as the network prefix (or whether to use SLAAC at all).
- **Router Solicitation (RS):** A computer can also actively ask for a Router Advertisement by sending a Router Solicitation, so it does not have to wait.

And tadaah: We have our IPv6 address!

As you've just seen, a computer (more technically: an interface) can have multiple IPv6 addresses in parallel (e.g. link-local and global address). This is also useful, if your computer generates a new address and in parallel keeps the old address, until that is not needed anymore.

Additional (fun) facts

Canonical representation

Since IPv6 addresses are pretty long, there are ways to write them in a shorter way:

- You can omit the leading zeroes of each block.
- You can replace the longest streak of blocks of zeroes by `::`.

So for example `ff02:0000:0000:0000:0000:0000:0000:0001` becomes `ff02::1`. This is called the canonical representation.

Special addresses

The address used in the example above is a special address. It is called the "link local multicast all nodes address". If you `ping ff02::1` every node on the local segment gets the ping and you can see a list of all devices.

`ff02::2` is similar, but pings all local routers.

`::1` is the new 127.0.0.1, the IP reserved for localhost.

Created by Simon Dreher

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