



Automating IPv6 Deployments

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Network Architect

ipSpace.net AG

Who is Ivan Pepelnjak (@ioshints)

Past

- Kernel programmer, network OS and web developer
- Sysadmin, database admin, network engineer, CCIE
- Trainer, course developer, curriculum architect
- Team lead, CTO, business owner



Present

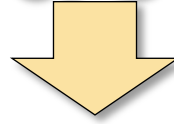
- Network architect, consultant, blogger, webinar and book author

Focus

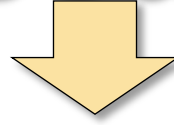
- Network automation and Software Defined Networking
- Large-scale data centers, clouds and network virtualization
- Scalable application design
- Core IP routing/MPLS, IPv6, VPN



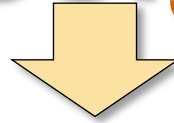
Educate



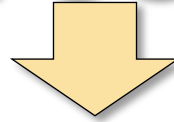
Research



Design



Test



Deploy



HOW MANY...

→ SERVERS

→ SWITCHES

→ ROUTERS

→ FIREWALLS

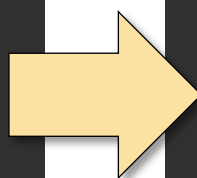
→ LOAD BALANCERS

It's Utterly Boring

IPv6 configuration is very similar to IPv4 configuration

- Slightly different commands and caveats
- Different addresses
- Deploying IPv6 is boring...
- ... and boredom results in mistakes

```
interface Loopback0
 ip address 10.0.1.1 ...
 ip ospf 1 area 0
```



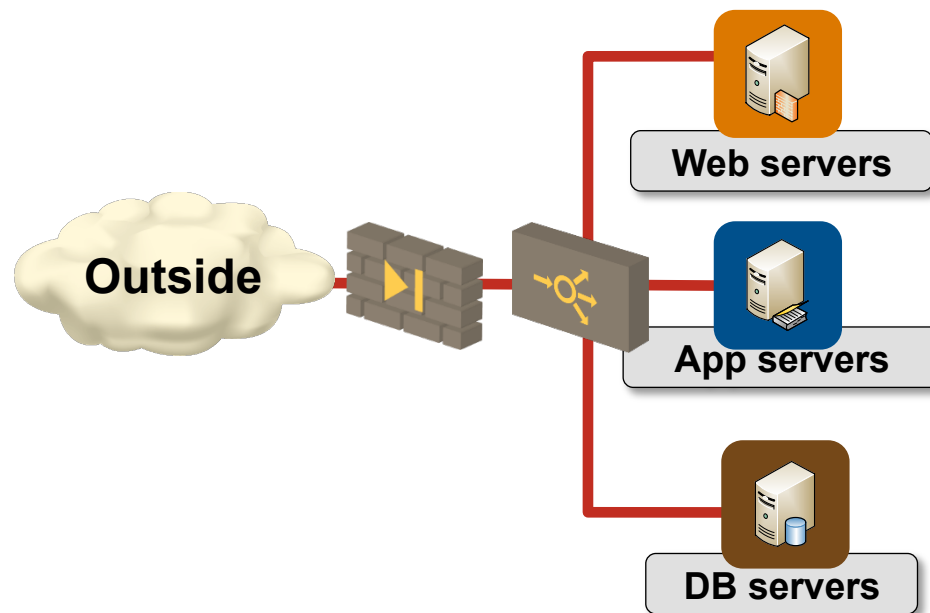
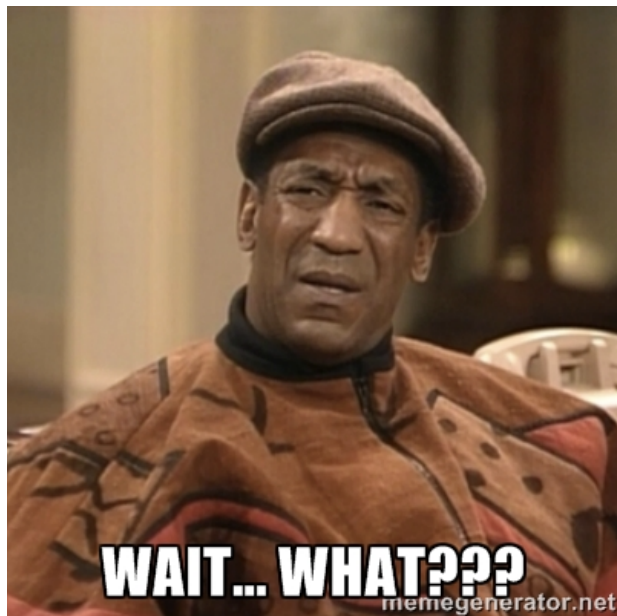
```
interface Loopback0
 ip address 10.0.1.1 ...
 ip ospf 1 area 0
 ipv6 address FD00:DB8:1/128
 ipv6 ospf 1 area 0
```

Failures Are Expensive: Real-Life Example

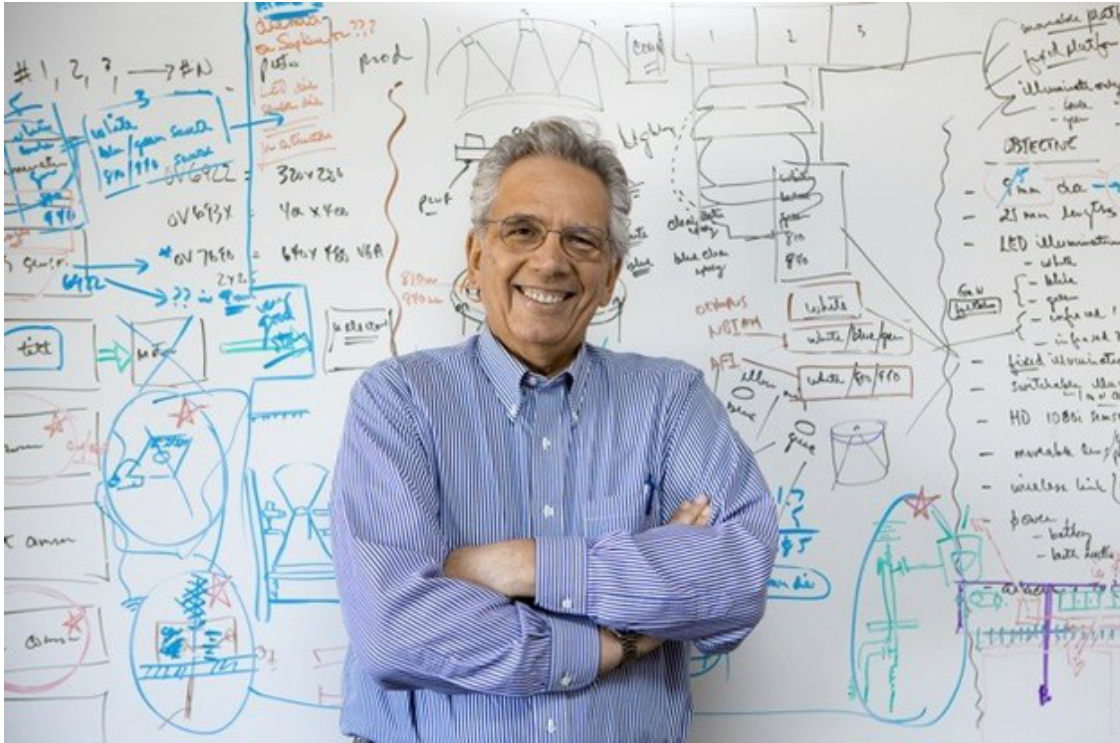
- Enable IPv6 in database segment → OK
- Enable IPv6 in other segments → OK
- Test connectivity → OK

Weeks later...

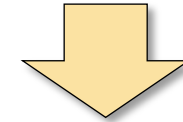
- Add DNS server AAAA record → **CRASH**



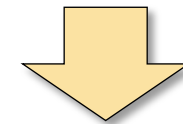
**Every Well-Defined
Repeatable Task
Can Be Automated**



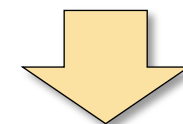
Simplify



Standardize



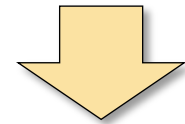
Abstract



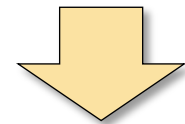
Automate



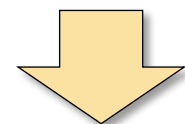
Collect



Audit



Cleanup



Simplify

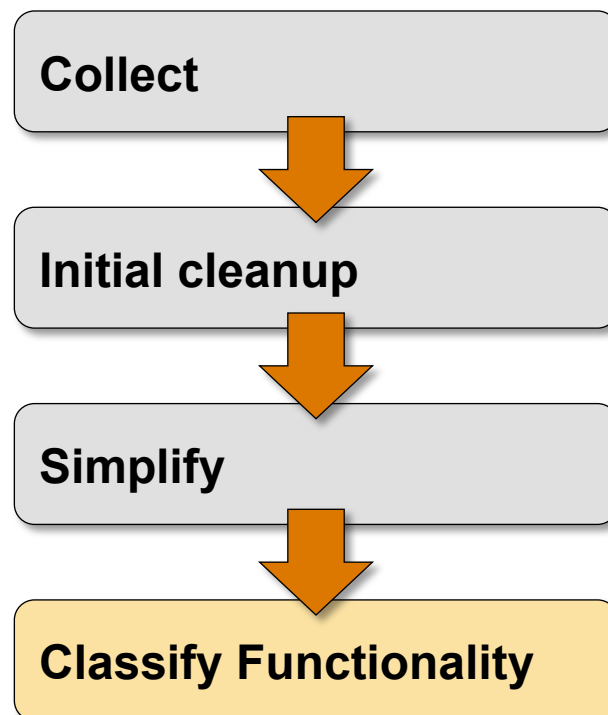
Preparation

Prepare for Migration: Functionality Classification

Identify parts of configuration that have to be migrated to IPv6

Potential classification outcomes:

- Functionality is not IP-dependent
- The functionality will remain on IPv4
- We need dual-stack functionality
- Functionality will move to IPv6



Prepare for Migration: Functionality Classification

Functionality is not IP-dependent

- Hostnames, usernames, passwords,

The functionality will remain on IPv4

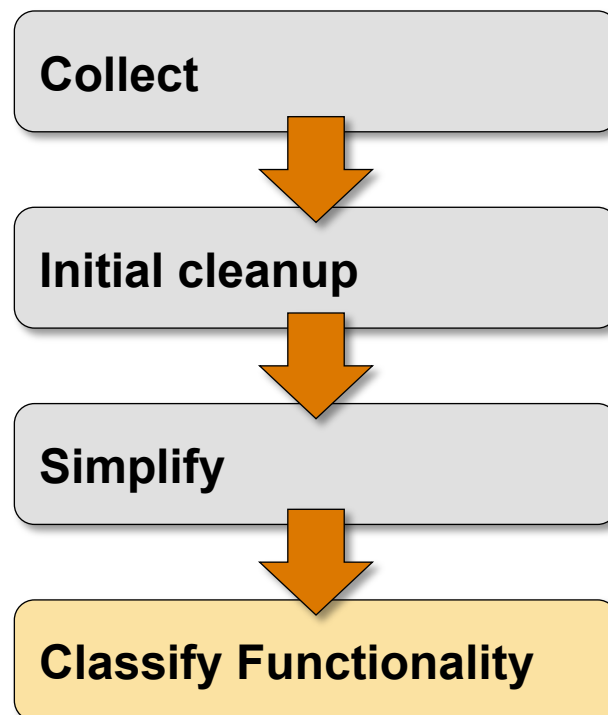
- Network management, MPLS control plane

We need dual-stack functionality

- Interface addresses
- Routing protocols
- Access lists and route maps

Functionality will move to IPv6

- Network management (?)



Classify Functionality: Examples

```
upgrade fpd auto  
version 15.0  
service timestamps debug datetime msec
```

!

```
hostname PE-A
```

!

```
boot-start-marker
```

```
boot-end-marker
```

!

```
logging buffered 4096
```

IP version agnostic

Ignore

Classify Functionality: Examples

```
interface Loopback0
  ip address 10.0.1.1 255.255.255.255
  ip ospf 1 area 0
!
logging host 172.16.1.12
!
snmp-server community cisco RO
snmp-server location Virtual
snmp-server host 172.16.1.12 cisco
!
track 100 interface Dialer3 ip routing
  delay down 10 up 10
```

Migrate to
dual-stack

IPv4 only

Showstopper

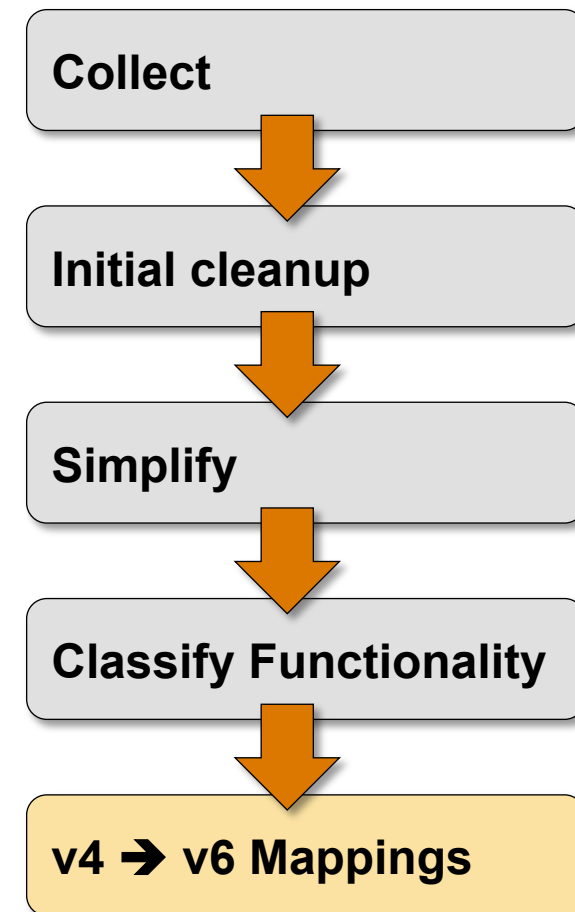
Prepare for Migration: v4 → v6 Mappings

Add IPv6 equivalent of IPv4 configuration for every bit of dual-stack functionality

- Sounds simple
- Need well-defined v4 → v6 mapping
- Where will you get it?

We need single source of (addressing) truth

```
interface Loopback0
  ip address 10.0.1.1 ...
  ip ospf 1 area 0
  ipv6 address FEC0::CCCC:1/128
  ipv6 ospf 1 area 0
```



v4 → v6 Mappings

Ideal use case: IPAM with hosts and subnets

Common: Excel spreadsheet

Worst case: no information



Collect



Initial cleanup



Simplify



Classify Functionality



v4 → v6 Mappings

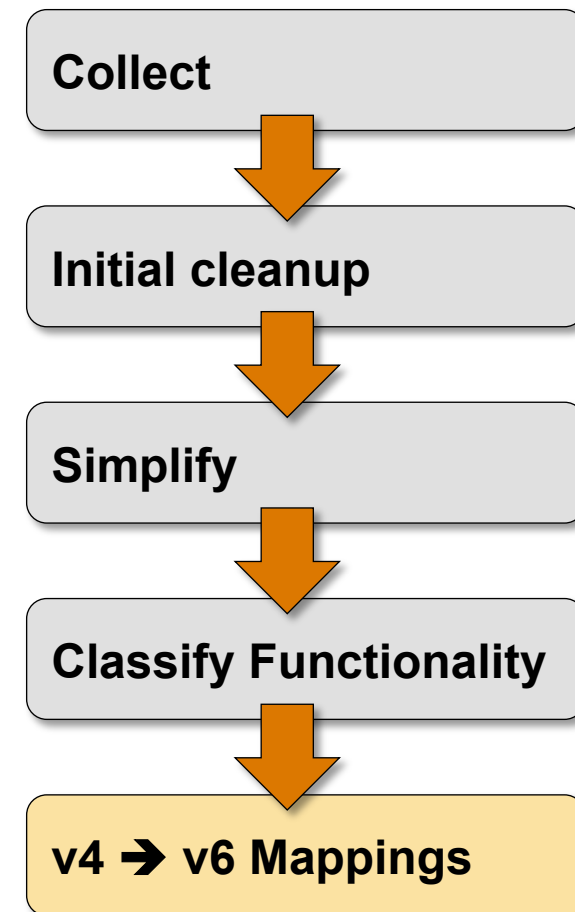
v4 → v6 Mappings: Recovering from Worst Case

Assumptions:

- No IPAM (or reliable Excel)
- Device configurations are the only source of truth

Recovery process

- Analyze router configurations
- Scrape subnet information from interfaces
- Use simple algorithmic v4 → v6 mapping to build IPv6 subnets and host addresses



Unfortunately we can't use DNS lookups

Getting the Job Done

Converting the Configurations: Screen Scraping

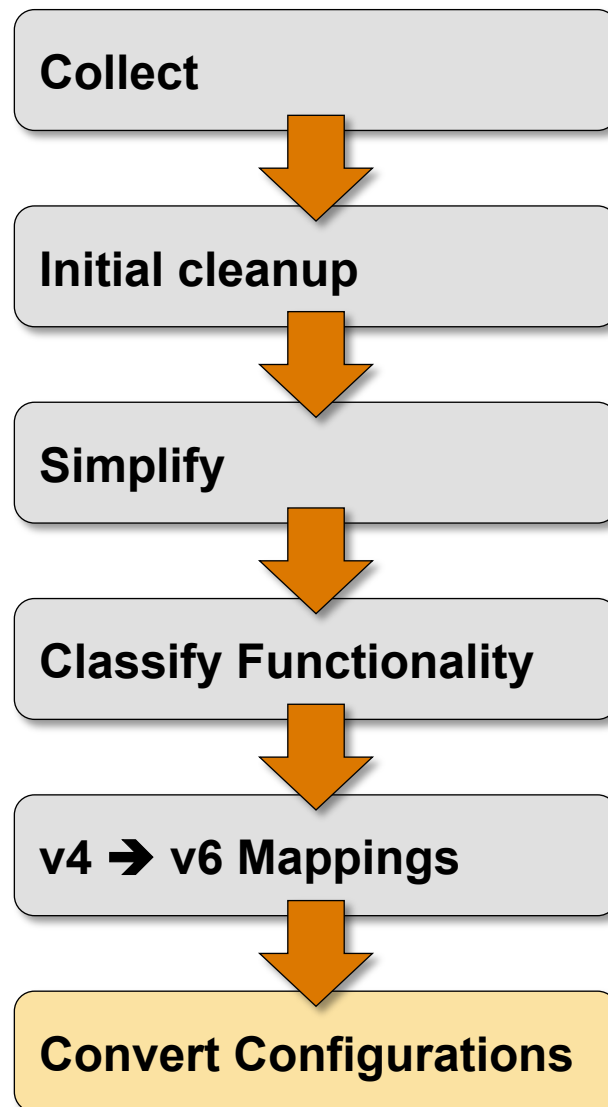
Perl is your friend ;)

Create a script that:

- Parses the configuration text file
- For every IPv4-specific command adds a corresponding (set of) IPv6 command(s)

Challenges: hierarchical objects

- Access lists
- Route maps
- Class maps and policy maps



Beyond Screen Scraping: Use XML or JSON

```
<interface>
  <Param>Loopback0</Param>
  <ConfigIf-Configuration>
    <ip>
      <address>
        <IPAddress>192.168.0.2</IPAddress>
        <IPSubnetMask>255.255.255.255</IPSubnetMask>
      </address>
    </ip>
    <ipv6>
      <address>
        <IPv6Prefix>FD00:DB0::1:1/128</IPv6Prefix>
      </address>
    </ipv6>
  </ConfigIf-Configuration>
</interface>
```

Converting the Configurations: Use JSON or XML

1. Download configuration in XML or JSON format
2. Traverse the XML or JSON object and create new object (or do an XSLT transformation)
3. Merge the new XML object with existing configuration (in script or in device)

Advantage: easier to program

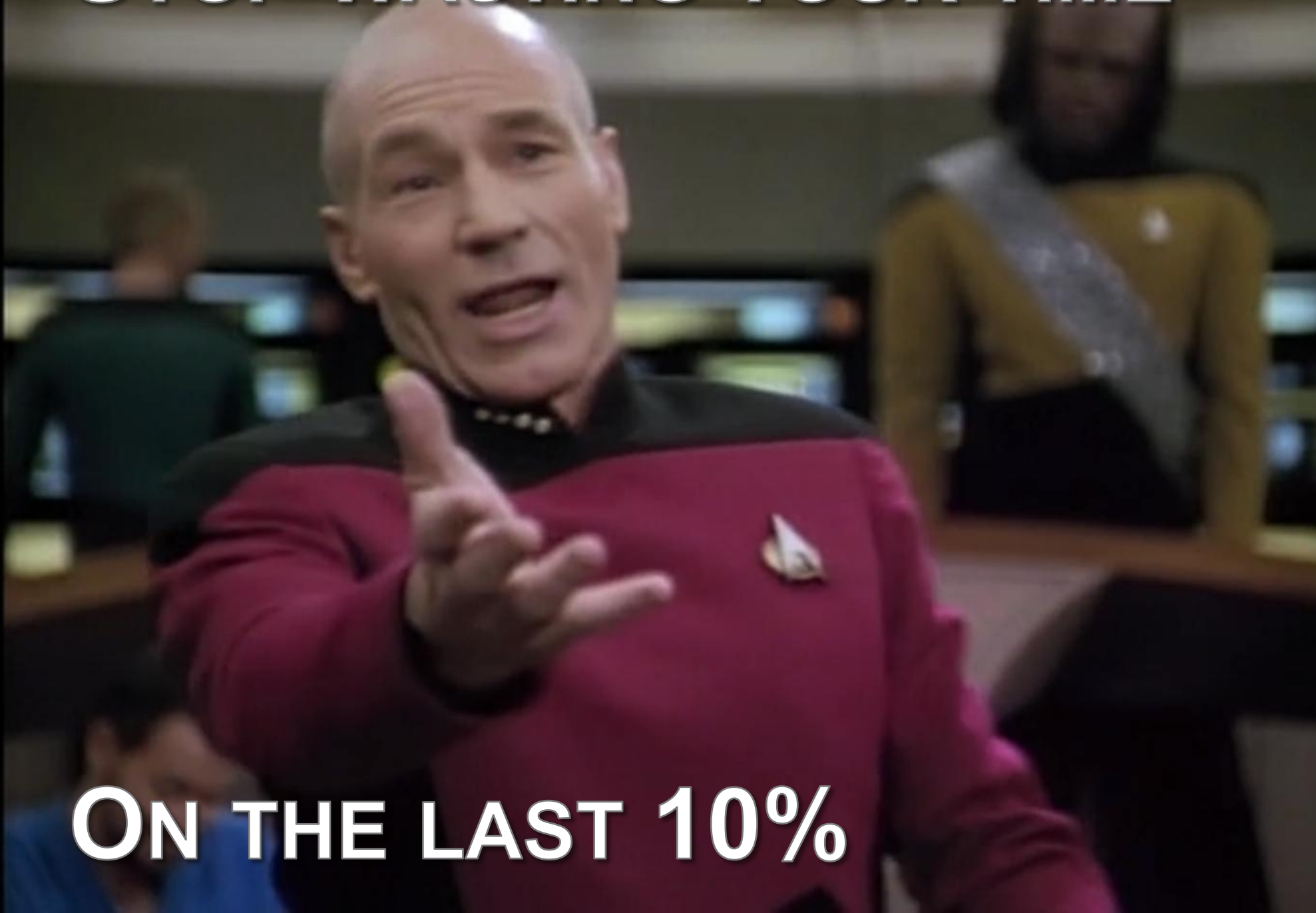
Drawback: hard to check or track with version control tools

```
<interface>
  <Param>Loopback0</Param>
  <ConfigIf-Configuration>
    <ip>
      <address>
        <IPAddress>192.168.0.2</IPAddress>
        <IPSubnetMask>255.255.255.255</IPSubnetMask>
      </address>
    </ip>
    <ipv6>
      <address>
        <IPv6Prefix>FD00:DB0::1:1/128</IPv6Prefix>
      </address>
    </ipv6>
  </ConfigIf-Configuration>
</interface>
```

Real-Life Aspects

STOP WASTING YOUR TIME

ON THE LAST 10%



Real-Life Aspects

- Don't expect to see a supported product – it will be a DIY job
- Pool the expertise – open-source and Github are your friends

Don't try to be perfect:

- Identify the major challenges
(addresses, subnets, ACLs, firewall rules)
- Automate as much as possible
- Lather, Rinse, Repeat...

A close-up portrait of Aragorn from 'The Lord of the Rings'. He has long, wavy brown hair and a light beard. He is looking slightly to the left with a thoughtful expression, his right hand resting against his chin. The lighting is warm and golden, suggesting an indoor setting with a fire or lamp. He is wearing a dark, textured tunic.

ONE DOES NOT SIMPLY

DEPLOY NEW CONFIGURATIONS

Real-Life Aspects

Let's not waste time on change management, however...

- Source code management tools are your friends
- Use them to implement reviews and signoffs
- It's better to have full configurations than snippets of new commands

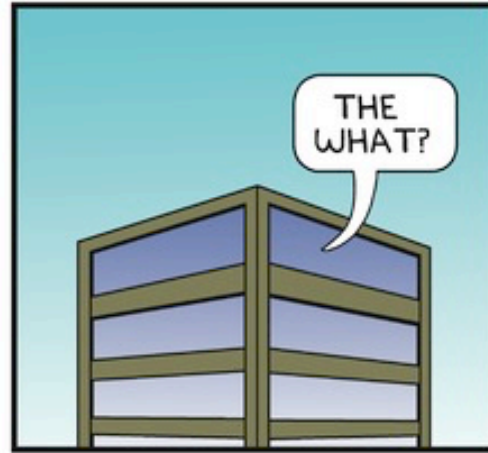
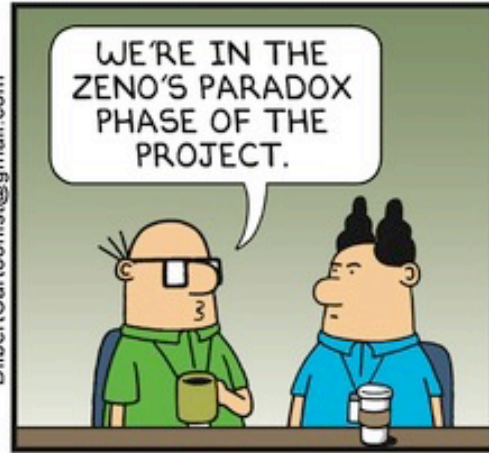
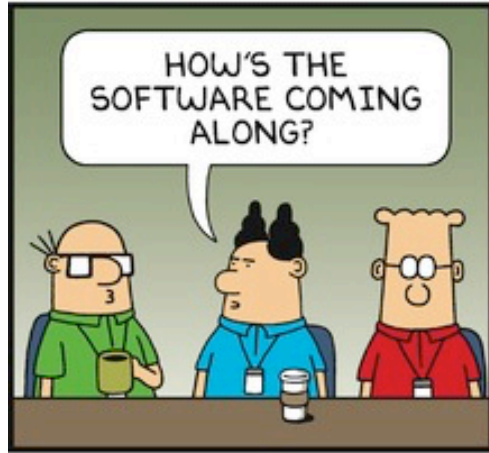
Test, test, test...

- Write as many unit tests as possible for IPv4 world
- Convert these tests into IPv6 (using v4 → v6 mapping)
- Execute IPv4 and IPv6 unit tests after every change

The Zeno's Paradox of Tool Development

DILBERT

BY SCOTT ADAMS



DilbertCartoonist@gmail.com

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1:31-16

A young child stands in the center of a room with a large world map on the floor. The map is drawn in black ink on a light-colored tiled floor. Several black network switches or routers are placed on the floor, connected by a complex network of colorful cables (red, blue, yellow, green). The child is wearing a white t-shirt with red sleeves and dark pants. The scene is set in a room with a tiled floor and a brown wall in the background.

Questions?

Send them to ip@ipSpace.net or [@ioshints](https://twitter.com/ioshints)