Computer networks in enterprise environment

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Topics

- Who am I?
- Vaisala
- Networks
- Network Services
- IPv6
- Vaisala Opportunities

Who am I?

- Name: Vesa Jääskeläinen
- Company: Vaisala Oyj
- Title: Principal Software Architect, R&D

- Work includes working on Vaisala's Embedded Linux Platform, helping other teams, security, manufacturing, and R&D <-> IT co-operation

- Master of Science from Lappeenranta University of Technology in 2006 from IT/Software Engineering
- Also worked in the university for master's thesis work
- Worked together with Jouni Ikonen on with network related things

Vaisala Company Presentation Slides in here

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Networks

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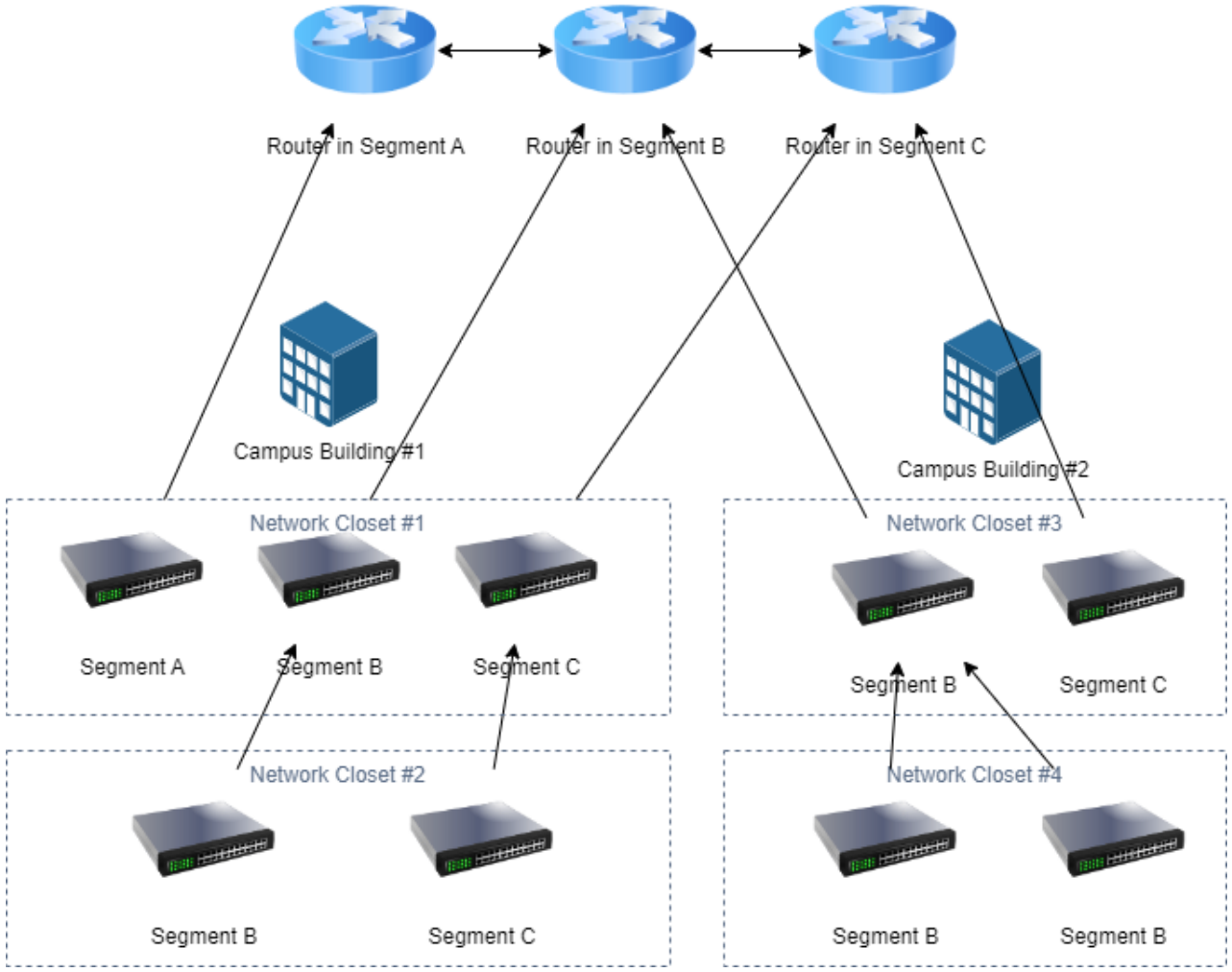
Modelling networks

- Common steps:
  - Analyze the needs now and a bit further in the future
    - Common problem: whups – we ran out of IP addresses in this network
  - Think about network security and physical security
    - Have protections in multiple layers – often goes with term security onion model
  - Think about network functionality in special situations
    - Campus power failure
  - Think about network resiliancy – i.e. how to recover from problems
    - What if construction worker breaks your optical fiber cable?
  - Think about network traceability – i.e. how to debug problems
    - There is network node somewhere that is causing problems
    - Routing does not work from this node but works over there

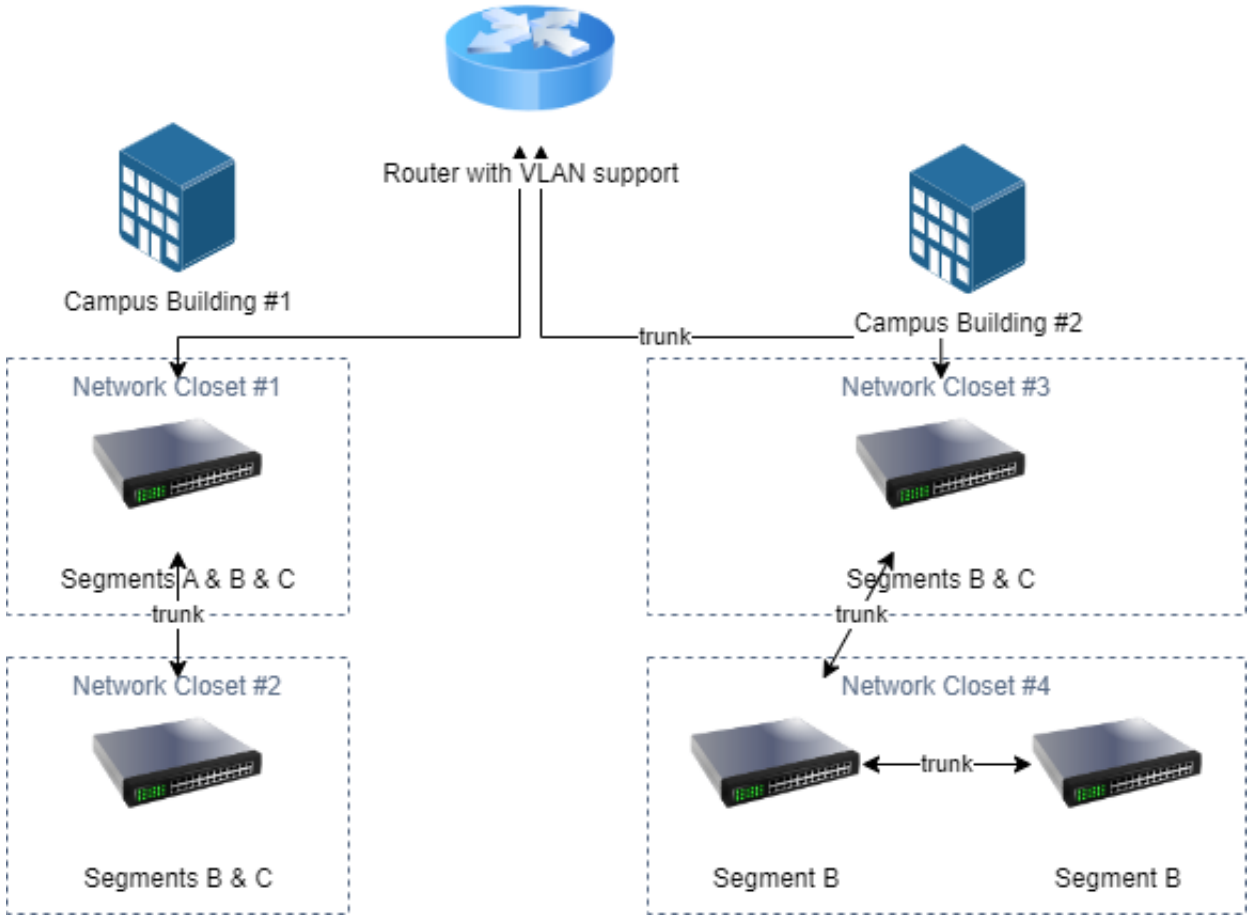
Network segmentation (1/2)

- Network segmentation is all about how to slice your networks in smaller pieces
- Simplest way to do network segmentation would be to have physically different networks and having network routers in between to enable connectivity between them
- Problem with this approach is that there would be lots of "extra" cables and network switches for different networks around the campus



Network segmentation (2/2)

- Virtual LAN's has been developed to solve this problem and enables one to construct virtual physical networks
  - VLANs work in data link layer (Ethernet) and is not part of network layer's (IP) routing
  - Requires that there is coordinated list of VLANs in campus
  - VLAN trunks creates shared "physical networks" medium in one cable
  - Network switch configuration needs added security controls so that it does not become attack vector



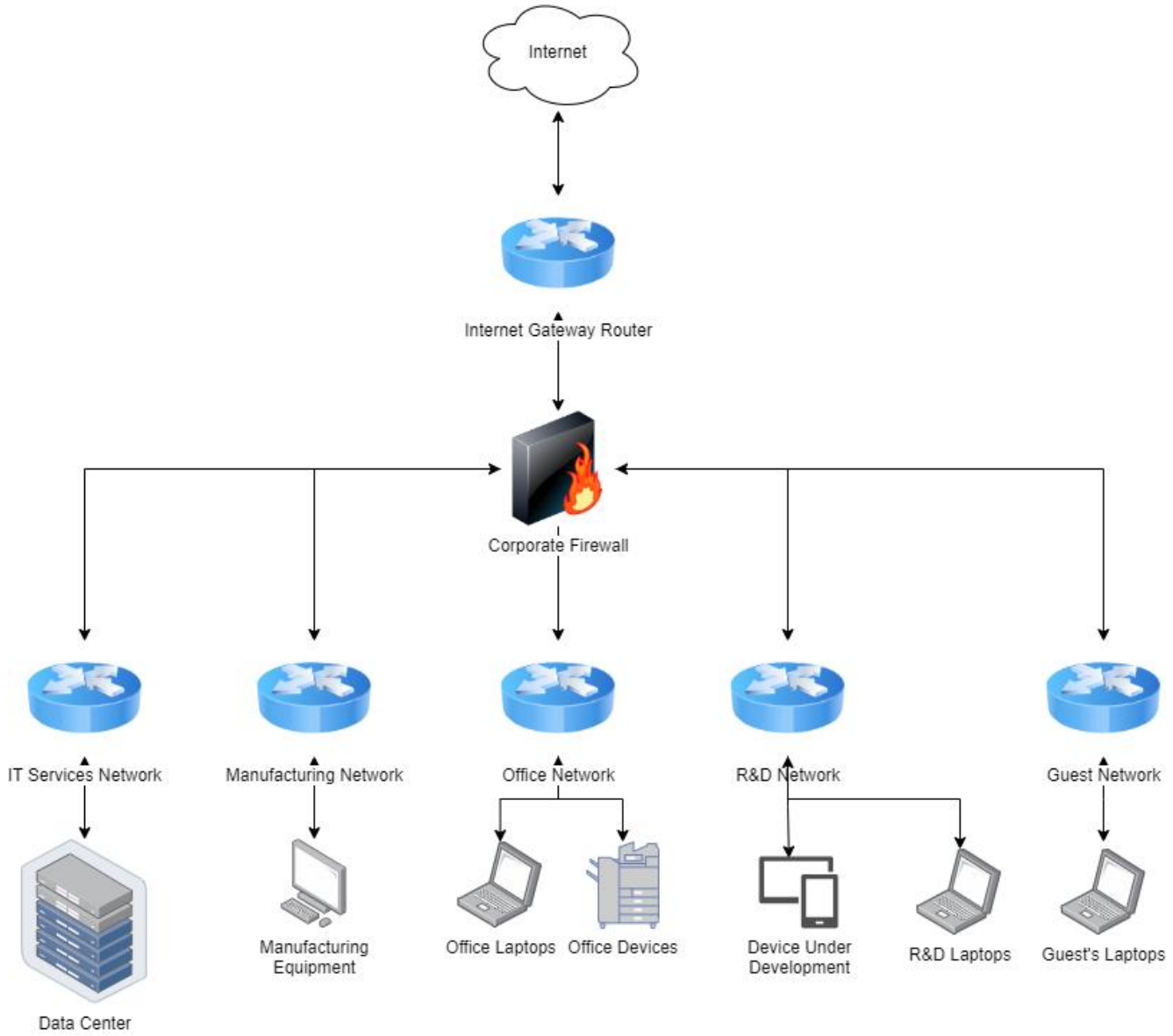
Corporate environment example

- Example functions within company:
  - Communications & PR
  - Guests
  - HR
  - IT services
  - Legal
  - Manufacturing
  - Other business support
  - R&D
  - Sales

Let's think about how to segment this network…

- What are the most important functions?
- What are the likely sources for problems?
- Are there some other factors that come into a play?
- What kind of equipment would be needed?

Corporate Network Segmentation Example



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Internet Protocol

- Today the majority of the traffic goes with:
  - Internet Protocol v4
  - Internet Protocol v6
- And in corporate networks Ethernet and WIFI are the transfer mediums
- Virtual LAN (VLAN) is the main Ethernet level protocol for handling network segmentation around the corporate campus
- Majority of the traffic is with TCP protocol and on top of that with HTTPS protocol

Network services

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What are the most important services?

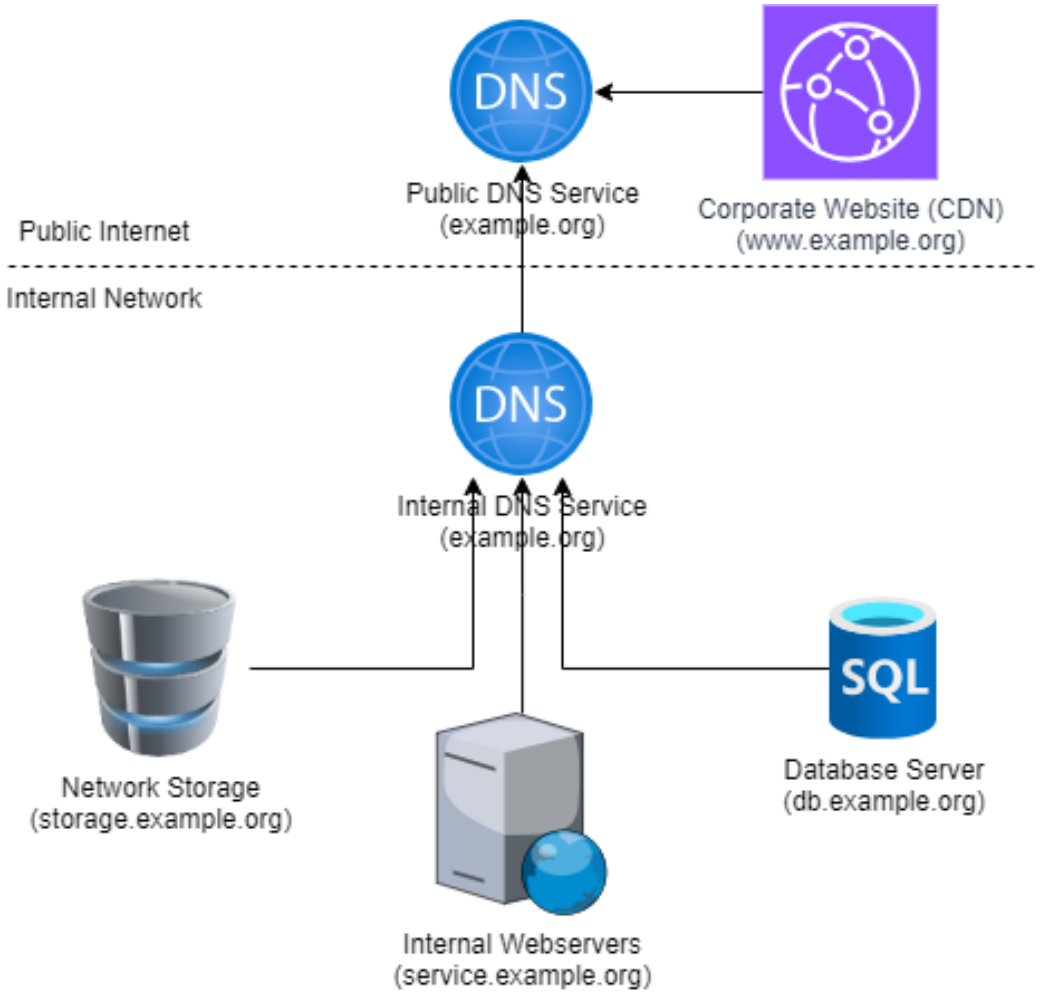
- Network address resolution (DNS, ARP, …)
- Network support services (DHCP, ICMP, NAT, Routing, VPN, …)
- Network security services (Device Authentication, Intrusion Detection Systems, Network Firewalls, …)
- User authentication (Active Directory, Digital Certificates, IdP, MFA, Radius, …)
- Time (NTP, SNTP, …)
- HTTPS (websites)
- SMTP (e-mail)

Time

- Time starts to be very important service for computers
- NTP/SNTP protocols are the primary sources of time
  - It is a good to understand how secure the time is
  - It has been tried several times to standardize more secure protocols – still waiting
- Digital certificates need to be verified to so that HTTPS/TLS connections can be made
- One needs a reputable source for time
- GNSS is one option to get good accurate time locally in campus
- Backup time service(s) are a very good idea just in case other services are being maintained or there is partial network outage
- National time sources is one option to consider
- Other sources: ntppool.org, time.aws.com, time.cloudflare.com, time.google.com, …

Split DNS

- Different views of DNS from public network and from internal network
- Can be used to direct traffic to different places
- Mainly used to hide internal networks from public
- Allows one to have easy domain names for internal services
  - To support HTTPS/TLS needs corporate PKI systems



Virtualization Environments

- Broadcom's (VMWare) vSphere is still the market leader even thou they have fought back with new pricing models
- All cloud vendors do provide virtual machines – but be cautious with their pricing
- Kubernetes is kinda well known
  - Kubernetes is hard to maintain – so warm advice is to think on using some commercial offering with support agreements
  - Managed Kubernetes in the cloud is pretty good solution if that fits the bill
- Most enterprises are in mixed cloud – on-prem environments
  - Modern mantra: Implement features where they are best implemented
  - Utilize cloud features where they provide most benefit
  - Some systems are just more practical (price, functionality, special situations) to implement in on-prem

Support and maintenance

- It MUST NOT be underestimated how much work it is to develop custom system versus buying a commercial solution
- With any kind of solution it is wery well adviced to understand well what you are doing
  - Otherwise solution could be completely wrong
  - Or some vendors already know that they have a good opportunity to sell more development services to actually make something working
- If something does not work -- especially on criticial systems – you start to count on seconds on how much it costs
  - Good recent public example – Nordea is having problems with their banking services
  - CrowdStrike's security software update caused that almost whole world stopped because systems failed to boot and that caused havoc around the globe i.e. part of the air traffic was stopped
- Recovery plans can be well spent activity even if they never need to be used

IPv6

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IPv6 – governments and regulations

- China:
  - In July 2021, China's office of the Central Committee for Cybersecurity and Information announced a plan to increase the nation's IPv6 traffic share to 50 percent by the end of 2023 and to as much as 70 percent traffic share and reach 800 million IPv6 addresses by the end of 2025, and finally phasing out IPv4 and replacing it completely with IPv6 technology by around 2030.
  - China Next Generation Internet – Wikipedia
- Finland:
  - Recommendation to adapt IPv6 in consumer networks
  - Suositus-IPv6n-kayttoonotosta-kuluttajalaajakaistaliittymissa.pdf (traficom.fi)
- Norway: IPv6 supported, dual-stack possibility
- Sweden: recommendation for IPv6, no requirement

IPv6 – governments and regulations

- India:
  - a) All Government organizations should complete IPv6 transition and migration of their websites on IPv6 latest by 30th June,2022.
  - b) All new retail wireline customer connections provided by Service Providers after 3 pt December, 2022 shall be capable of carrying IPv6 traffic either on dual stack or on native IPV 6.
  - c) The Service Providers shall endeavour to progressively replace/upgrade the CPEs which are not IPv6 ready and are owned by Service Providers latest by 31st December,2022.
  - IPv6 Transition | Department of Telecommunications | Ministry of Communication | Government of India (dot.gov.in)
- Malaysia: Effective July 2025, IPv6 test Reports will be mandatory for the Approval and Renewal of non-Wi-Fi-enabled Devices in Malaysia

IPv6 – governments and regulations

- USA
  - Whitehouse executive order: M-21-07 (whitehouse.gov)
  - Internet Protocol Version 6 (IPv6) Policy | U.S. Department of Commerce
    - An IPv6 implementation plan will be developed by the end of FY 2021 to update all networked Federal information systems (and the IP-enabled assets associated with these systems) to fully enable native IPv6 operation. The DOC Information Resources Management (IRM) Strategic Plan will be updated as required. The IPv6 implementation plan shall describe the agency transition process and include the following milestones and actions:
      - At least 20% of IP-enabled assets on Federal networks are operating in IPv6- only environments by the end of FY 2023.
      - At least 50% of IP-enabled assets on Federal networks are operating in IPv6- only environments by the end of FY 2024.
      - At least 80% of IP-enabled assets on Federal networks are operating in IPv6- only environments by the end of FY 2025.
    - All Federal information systems that cannot be converted to use IPv6 will be identified, the finding justified, and a schedule provided for replacing or retiring these systems.
  - Estimating IPv6 & DNSSEC Deployment Status (nist.gov)
  - USGv6 Program | NIST

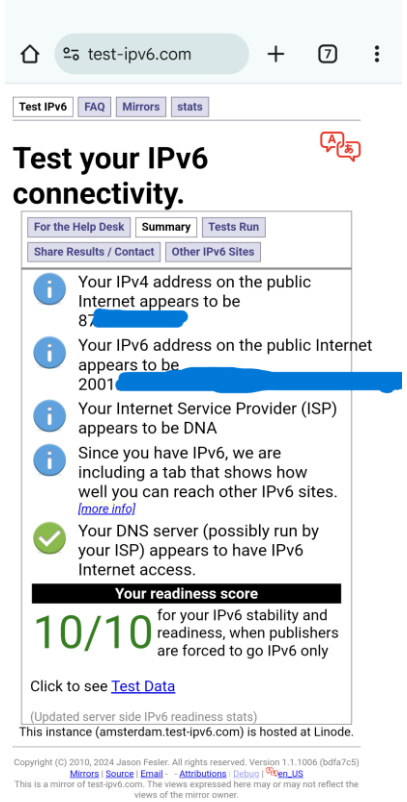
IPv6 – governments and regulations

- Guidance in procurement process:
- Requirements For IPv6 in ICT Equipment — RIPE Network Coordination Centre
  - 7 Skill requirements of the systems integrator
  - **Vendors and resellers that offer system integration services must have at least three employees who have valid certificates of competency** from the equipment manufacturers for the equipment that is sold as part of the tender. Additionally these employees must have general knowledge of the IPv6 protocol, IPv6 network planning and IPv6 security (eg. as indicated by certification for these skills also). **If it becomes obvious during the equipment installation and integration that the integrator's knowledge, competence and experience is not sufficient to successfully install and configure the equipment to establish normal IPv4 and IPv6 communication with the network, the agreement shall be canceled and become null and void.**
- Some seem to refer to this as a requirement

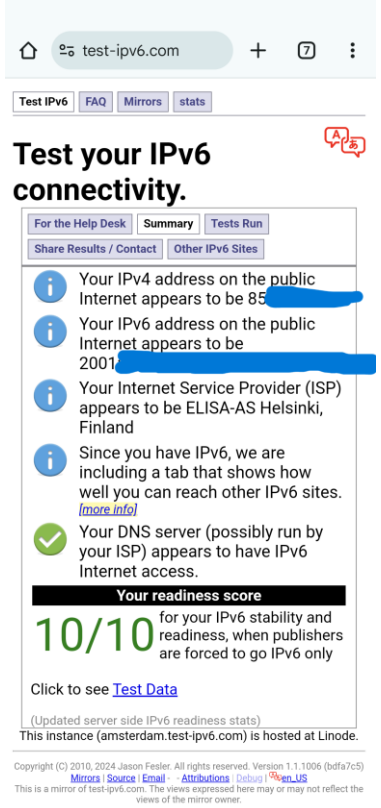
IPv6 – connectivity test

Try it yourself: https://test-ipv6.com/

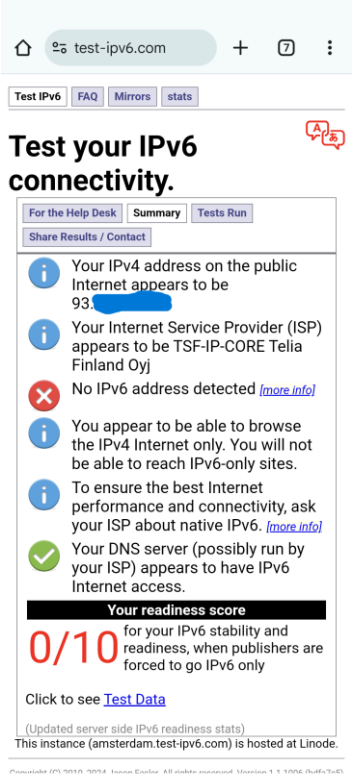
- DNA



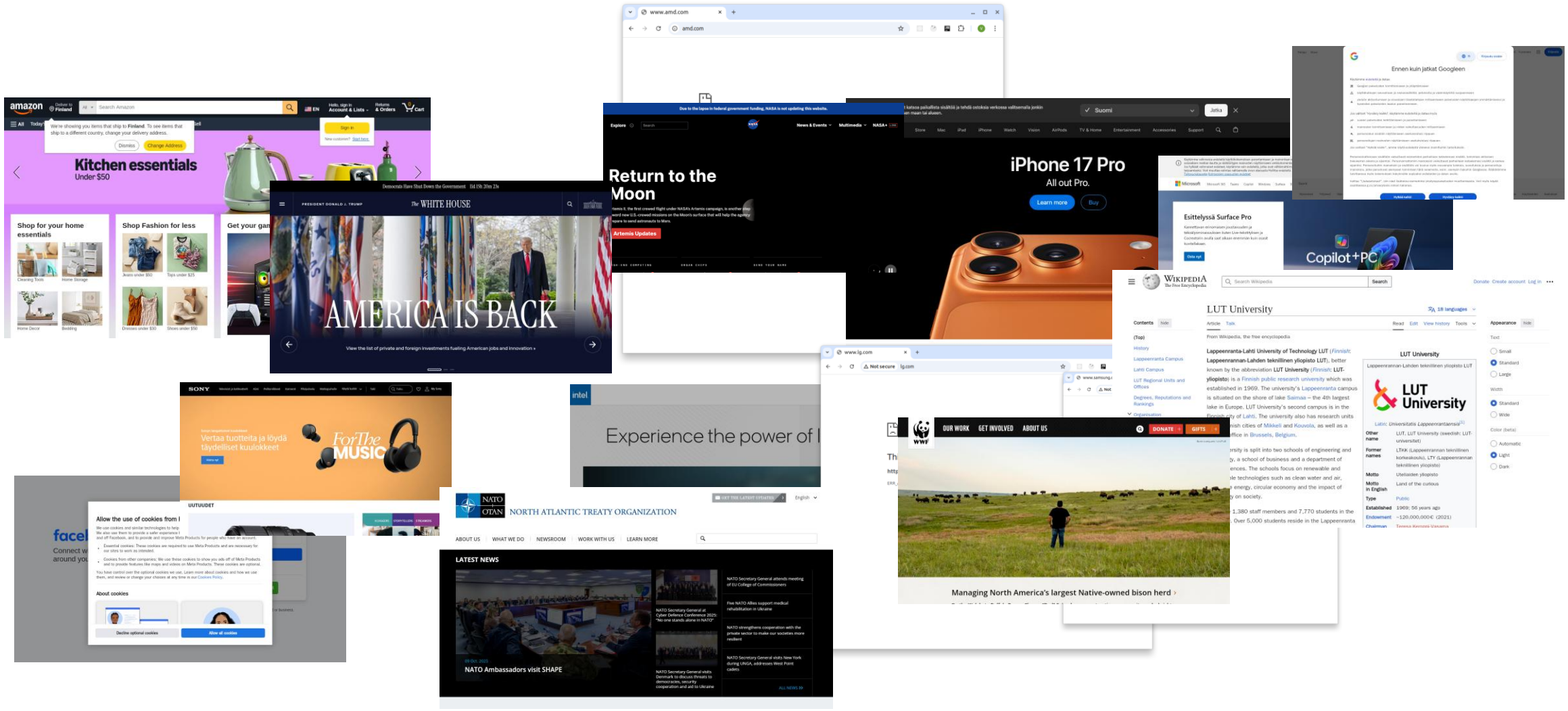
- Elisa



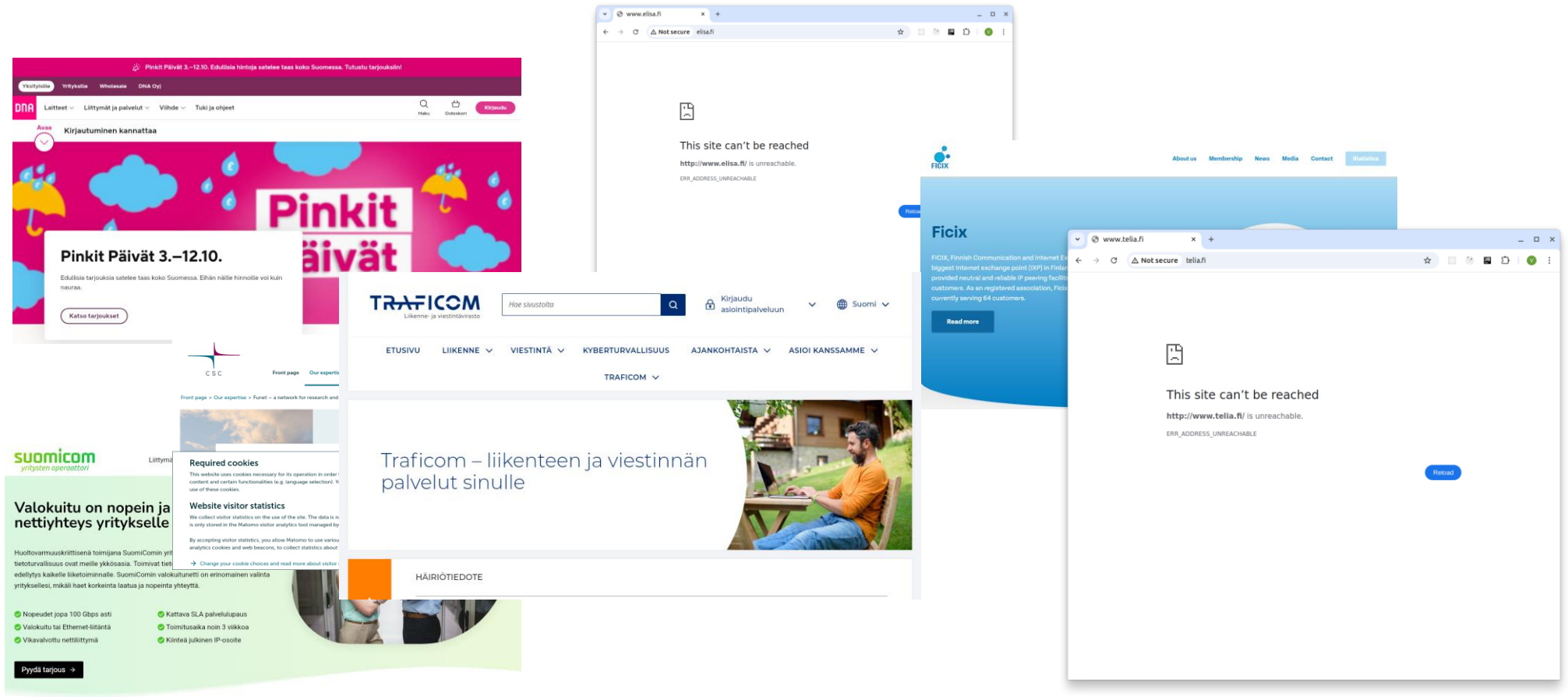
- Telia



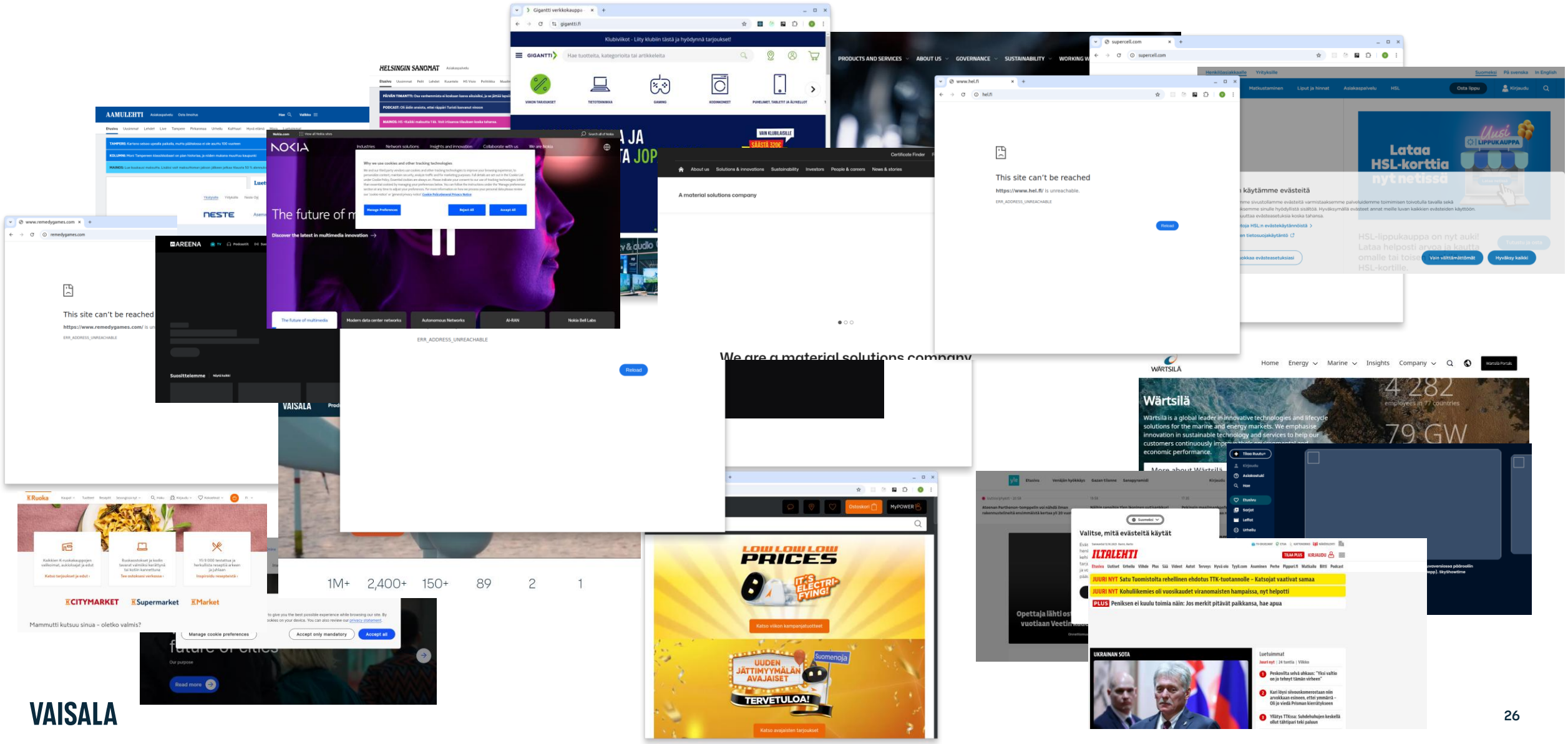
IPv6 test – Global organisations



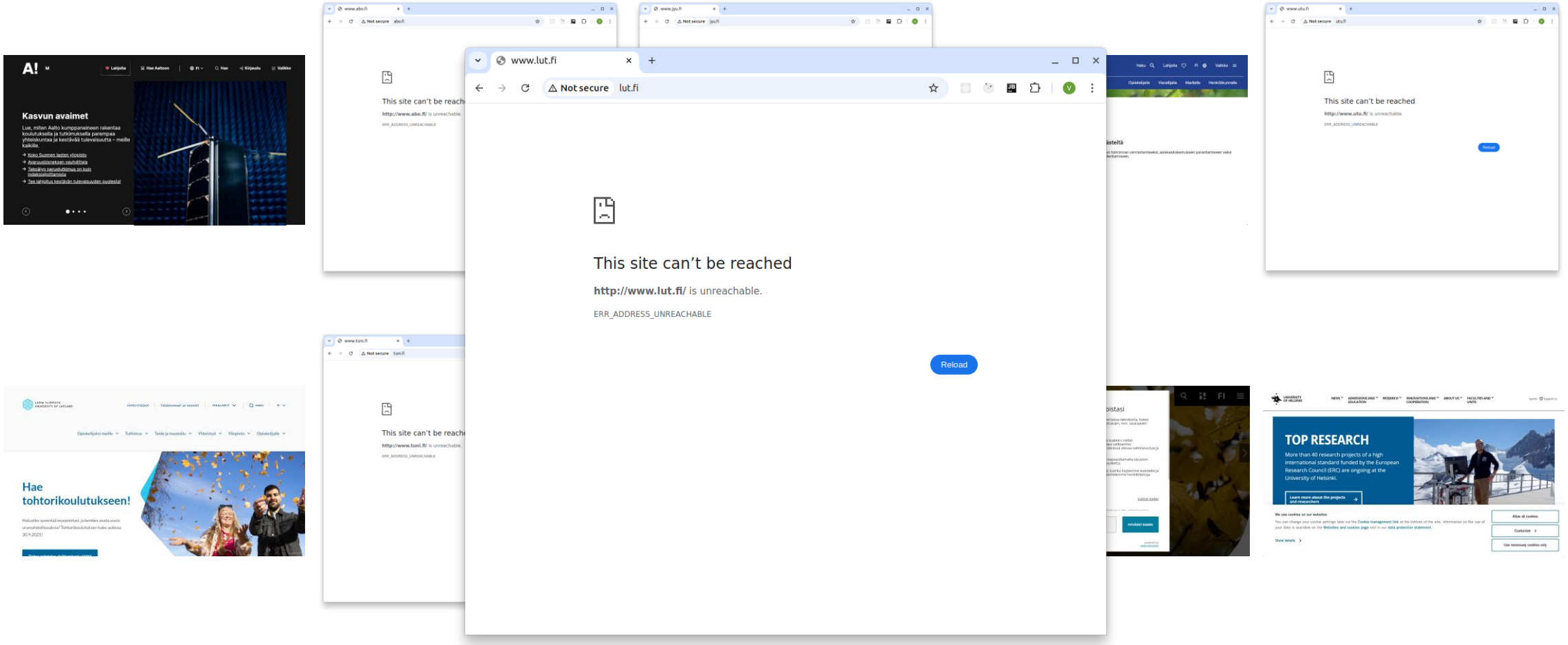
IPv6 test – Finnish networks



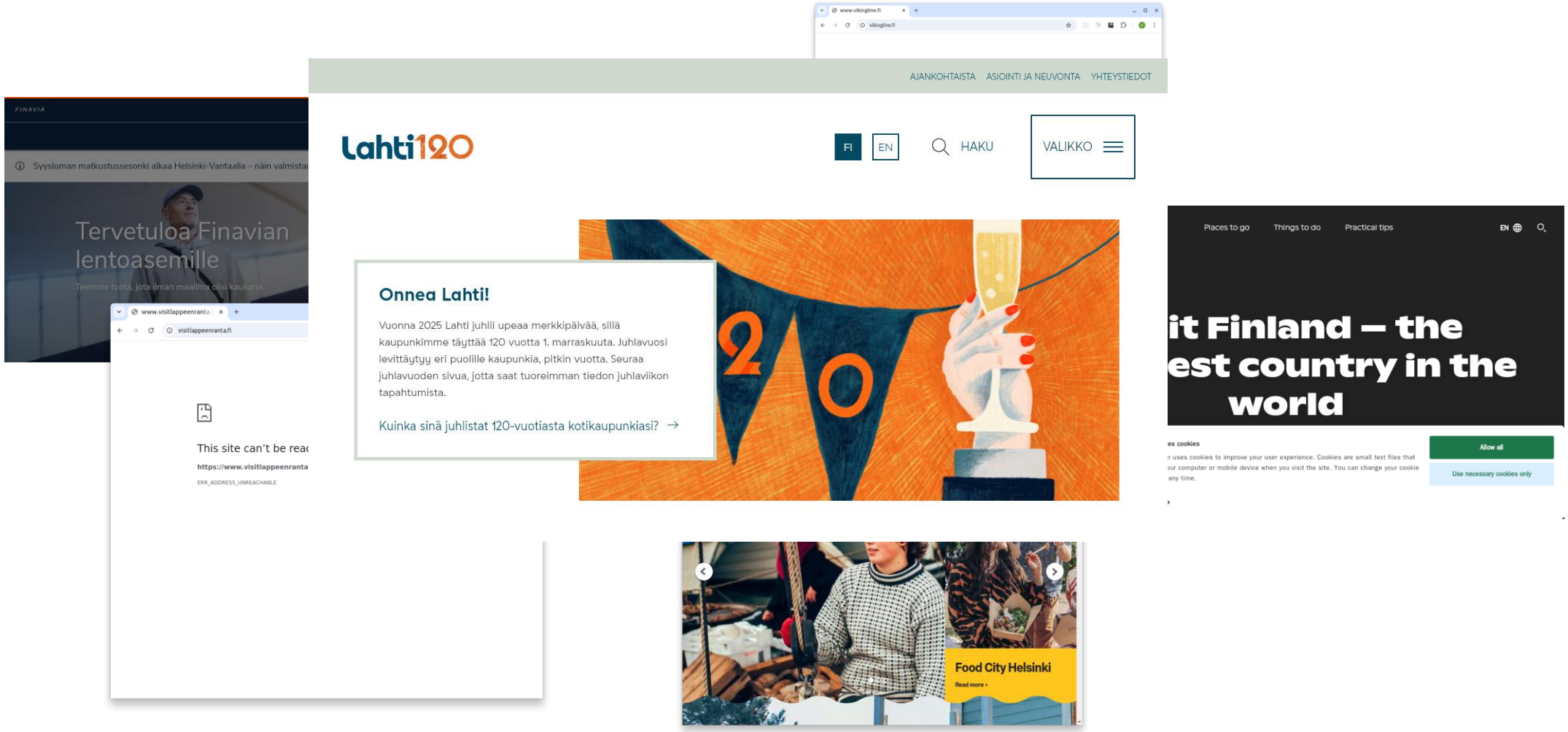
IPv6 test – Finnish companies



IPv6 test – Finnish universities



IPv6 test – Finnish travel related



IPv6 - Easy steps to do

- There is no need to have everything in corporate networks in IPv6
  - This is a big undertaking to do
  - If you start fresh – consider IPv6 right away
- Do the easy parts – use the cloud services
  - Use Content Delivery Networks (CDN) to serve your public corporate websites, content and API's
    - These come with dual-stack options out-of-the-box
    - Just configure CNAME or with direct IPv4 and IPv6 mappings
  - Most applications and network devices/services also support dual-stack
    - Back-end services can even live in IPv4 networks
  - Most AWS services are IPv6 ready

IPv6 - Example with www.vaisala.com

```
$ dig www.vaisala.com aaaa

; <<>> DiG 9.18.28-0ubuntu0.22.04.1-Ubuntu <<>> www.vaisala.com aaaa
;; global options: +cmd
;; Got answer:
;; ->>HEADER<<- opcode: QUERY, status: NOERROR, id: 16717
;; flags: qr rd ra; QUERY: 1, ANSWER: 3, AUTHORITY: 0, ADDITIONAL: 3

;; OPT PSEUDOSECTION:
; EDNS: version: 0, flags:; udp: 65494
;; QUESTION SECTION:
;www.vaisala.com.               IN      AAAA

;; ANSWER SECTION:
www.vaisala.com.        56      IN      CNAME   www.vaisala.com.cdn.cloudflare.net.
www.vaisala.com.cdn.cloudflare.net. 238 IN AAAA 2606:4700::6812:1856
www.vaisala.com.cdn.cloudflare.net. 238 IN AAAA 2606:4700::6812:1956

;; ADDITIONAL SECTION:
www.vaisala.com.cdn.cloudflare.net. 56 IN A     104.18.24.86
www.vaisala.com.cdn.cloudflare.net. 56 IN A     104.18.25.86

;; Query time: 3 msec
;; SERVER: 127.0.0.53#53(127.0.0.53) (UDP)
;; WHEN: Sat Oct 12 11:15:45 EEST 2024
;; MSG SIZE  rcvd: 180
```

IPv6 testing in Vaisala campus

- Now that world is starting to require IPv6 we started to plan how to bring IPv6 for product testing purposes into Vaisala campus networks in Vantaa
- We had initial IPv6 trainings couple years ago for network persons
- We got funding approved for 2025
- During summer of 2025 we got first IPv6 connectivity tests done
  - We utilized network configuration expert as we needed to do changes to live networks
  - It went much better than we anticipated
- As of today we have provided initial test points for R&D with basic services
- Unexpected benefit – web browsing got faster on those locations
  - Likely the RFC 6555 - Happy Eyeballs has something to do in here

IPv6 transition methods

- There are lots of different IPv6 transition mechanisms – they are more or less obsolete
- First try to use native IPv6 (e.g dual-stack)
- If there is a need to have IPv6 -> IPv4 access one can utilize NAT64
  - Well know prefix for NAT64 is **`64:ff9b::/96`** but one can also allocate own prefix for the purpose
  - There is shorthand translation available to ease it out **`<nat64-prefix>:<ipv4-address>`**
    - **`64:ff9b::192.168.1.1`** resolves to **`64:ff9b::c0a8:101`**
- NAT64 can be paired with DNS records or with DNS64 for automated translation generation
- Don't hide things – just fix them to be native IPv6/dual-stack – disable IPv4 in laptop and try it out
- Transition Mechanisms — RIPE Network Coordination Centre
  - *Dual stacking your entire network is the preferable solution if possible*

Vaisala Opportunities


Ready to take every measure for the planet?
Vaisala as an employer
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Key figures

Customers in over
150
countries

565 MEUR
in net sales

2,400+
experts

1,400+
shipments weekly

59
nationalities

28%
of our people work
in R&D

We look after our people

- Vaisala scores 4/5 in the engagement of its employees and has zero gender-pay gap.
- This is a company that takes pride in your career growth. From learning and mentorship programs to international job rotations, we've created a workplace where employee wellbeing is a priority. Our global team is one of the cornerstones of our success, and commitment to equality is a given.
- Open positions and career stories: Careers | Vaisala

Where instruments meet intelligence

- 28% of us work in R&D - creating science-based innovations and industry firsts.
- Our state-of-the-art innovation hub, advanced laboratories and in-house cleanrooms spark scientific progress and innovation. Vaisala instruments and intelligence are used where they matter most – from the world's leading medical laboratories to the melting ice of the Arctic and the rugged surface of Mars.

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Ready to lead your own project?

- We launch about 25 new projects for students every year
- Application time will start in January 2026, internship period May/June – August/September

- Read more: Giant Leap Internship Program | Vaisala

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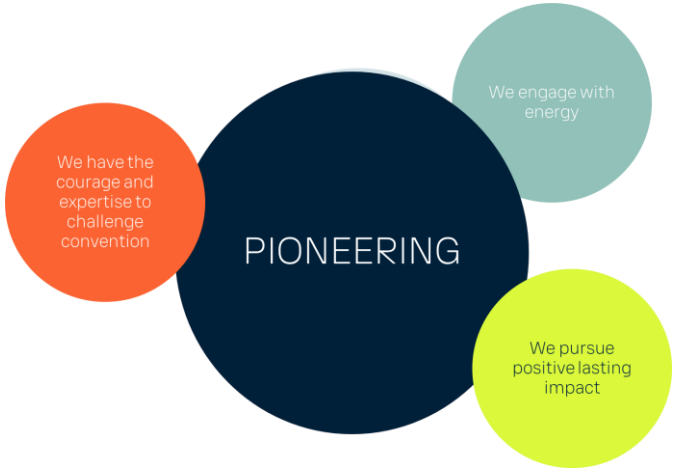
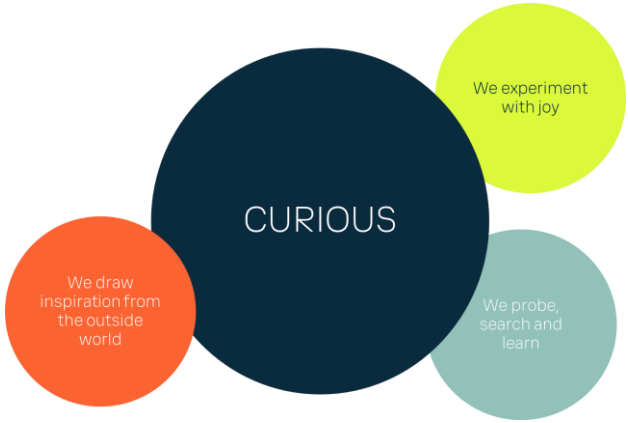
Pioneering, curious and committed?
Welcome onboard!





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