How to build and finance a robust national time distribution system

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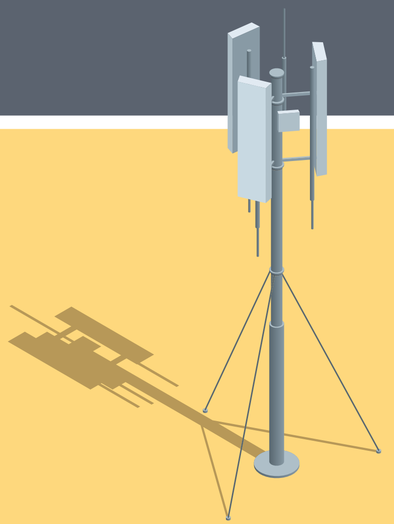
nts.ntp.se

Robust funding



Telecom operator

Money – 1ppm of the turnover

PTS
Swedish Post and Telecom Authority

Swedish government

Fund for robust infrastructure

We need

You need

Robust Network

- Redundancy
- 2nd Power
- Sync/time

Supporting critical infrastructure

at the core of the Internet

Netnod provides critical infrastructure support ranging from Internet exchanges in the nordics to time services, DNS services and root server operations.

With a worldwide reputation for its services and the expertise of its staff, Netnod ensures a stable and secure Internet for the Nordics and beyond.

Netnod's range of time activities include:

- **Netnod Time Direct**
  Time is distributed over a separate port or dedicated VLAN in one of Netnod's IX switches.
- **Netnod Dime Remote**
  Time is distributed over a secure access to remote locations where a CPE (customer premises equipment) ensures stability and robust time.
- **Precision Time Protocol (PTP) service**
  Delivered over a dedicated fibre an accuracy at the level of nanoseconds can be achieved.
- **Network Time Protocol (NTP) and Network Time Security (NTS)**
  Using NTP is a simple and effective way to set your local time. Connect for free to NTP servers around the world. For more security, you can also use NTS.

Why a national time distribution system?

1. Citizens and critical community services are dependent on the availability of electronic communications
2. Electronic communications have a dependency on correct time and frequency
3. Time and frequency distributed by GNSS can be easily spoofed or interrupted

Given these factors we identified a public need which is not delivered by the market:

- A system without GNSS dependency which, from a national perspective, can guarantee robust and secure time
- The system must be robust and available throughout the country
- The government must have visibility and direct input regarding the infrastructure, which means it must be located in Sweden
- The services delivered from the system must be affordable for networks so that the price is not a barrier for implementation

How did we make it happen?

- The **SGEI regulation** (Service of General Economic Interest) is an EU decision which can be an alternative to procurement
- Utilizing SGEI gives us the opportunity to work in a more long term context
- ISPs in Sweden need redundant and robust time infrastructure as a complement to GNSS as a part of their role to support critical telecommunications. This is why PTS stepped in and initiated this initiative.
- State sponsored through what is termed “Robust funding”, which PTS can use to secure critical infrastructure such as time and other telecom infrastructure.
- For example, “expensive” redundant paths for fibre
- Backups for power supplies

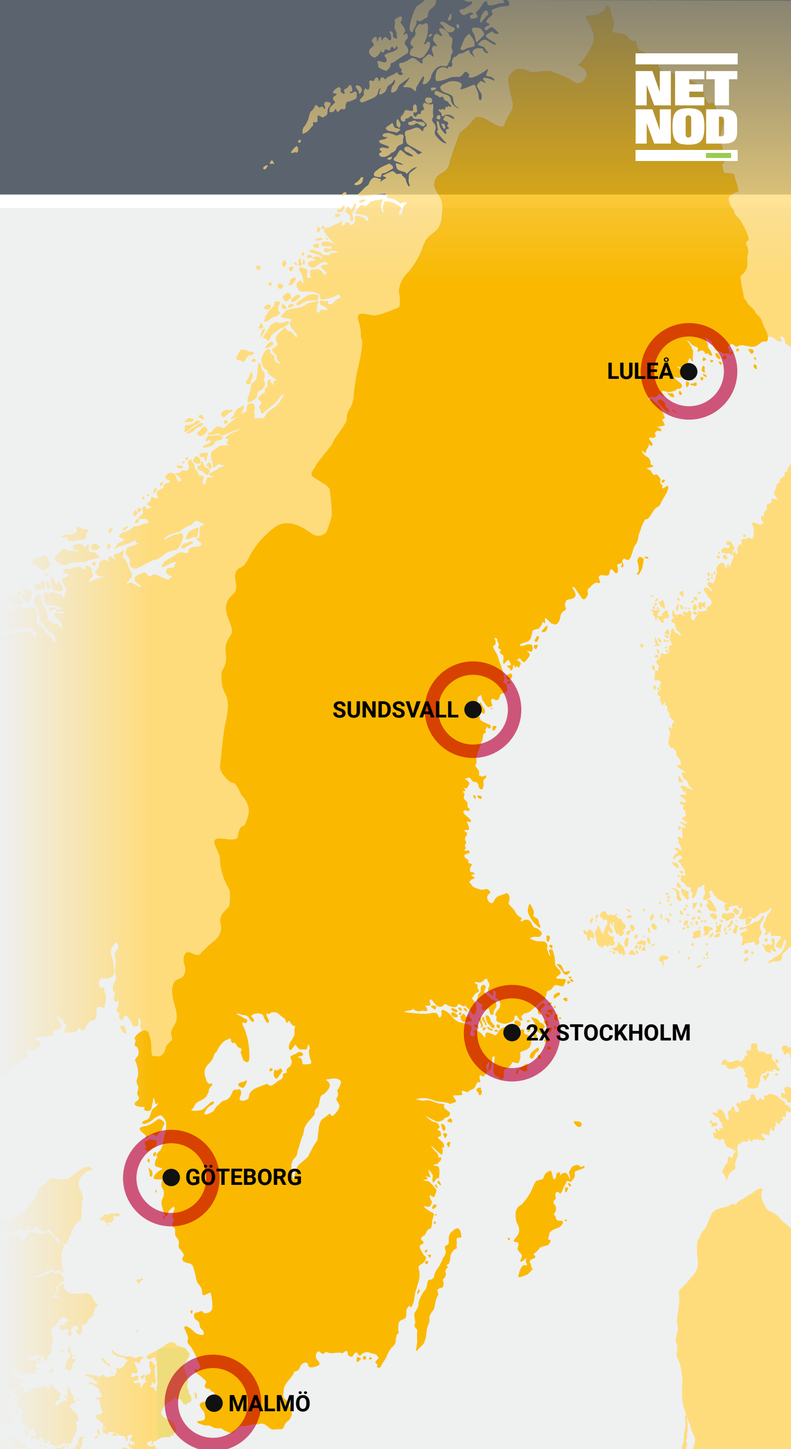
Success factors:

- Transparent cooperation between Netnod and PTS
- Dynamic requirements: in order to succeed a very close cooperation is needed between the parties
- A long term approach to ensure stability in maintenance and development of the service
- Dedicated resources working with the services ensures stability and predictability
- The services delivered from the system must be affordable for networks so
  that the price is not a barrier for implementation

Technical implementation

Robustness measures

- Geographically distributed
- Each node can work independently, essentially forever
- Nodes have redundancy with failover, two of all critical things
- Located in secured facilities
- UPS and diesel generator backup for power
- 3 days of extra battery backup for the time keeping components (24 V DC)

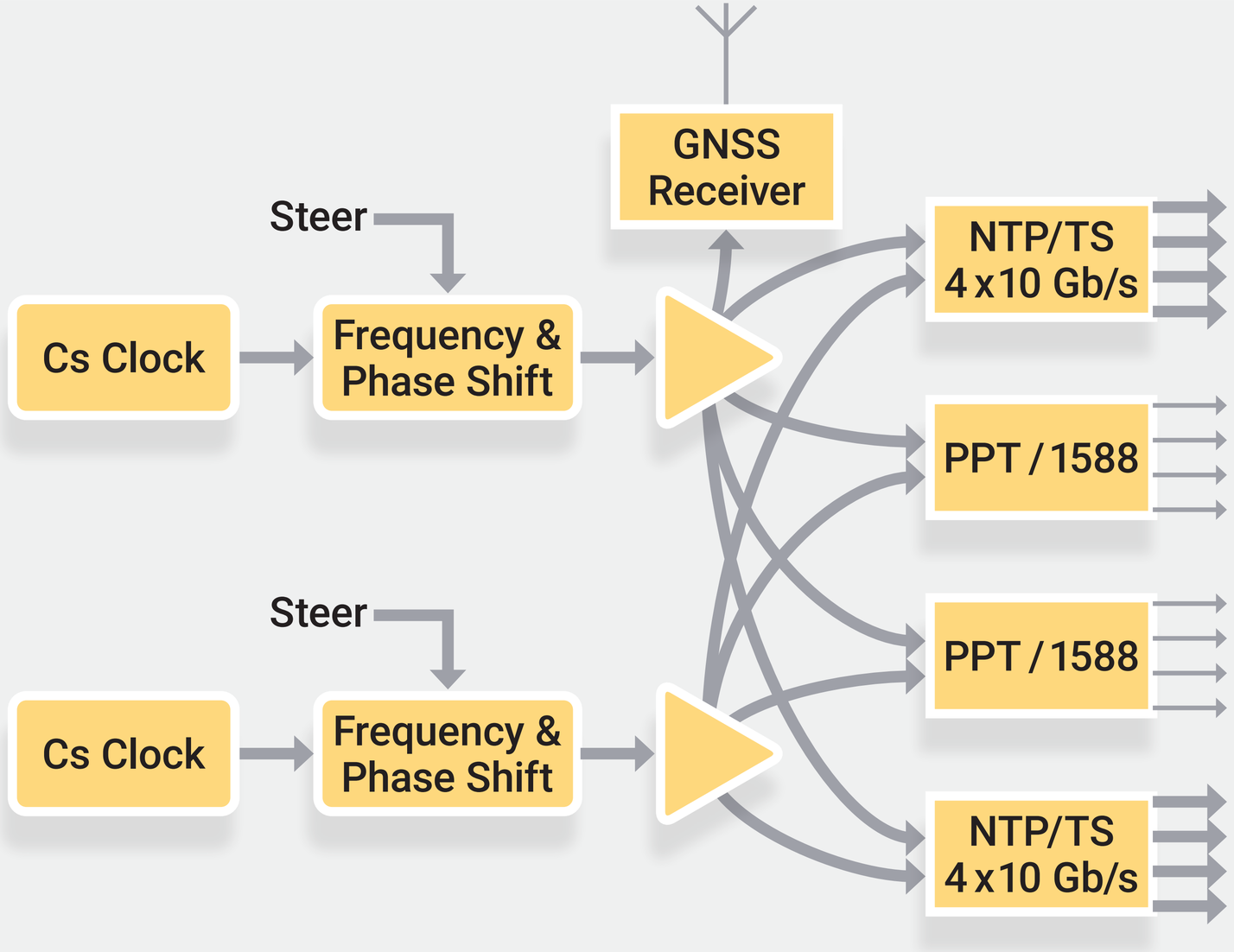


A time node

- Two redundant nodes – all critical equipment duplicated for redundancy
- Almost all equipment is off-the-shelf products
- Modular design
- Replace/renew components
- Easy to add new distribution components

Node overview

- All equipment in the node is constantly monitored for correct time
- Two independent measurement systems



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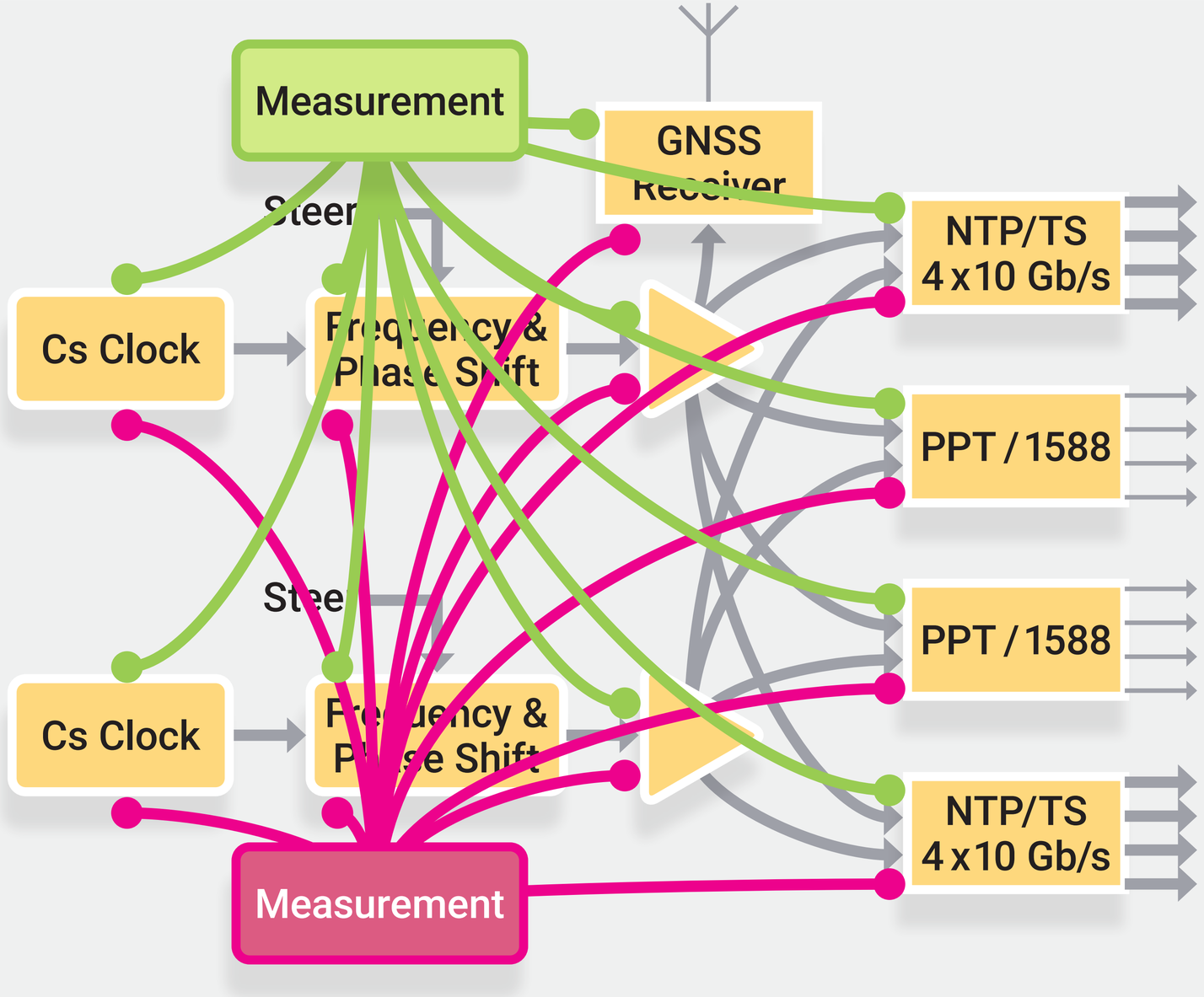


PTP distribution

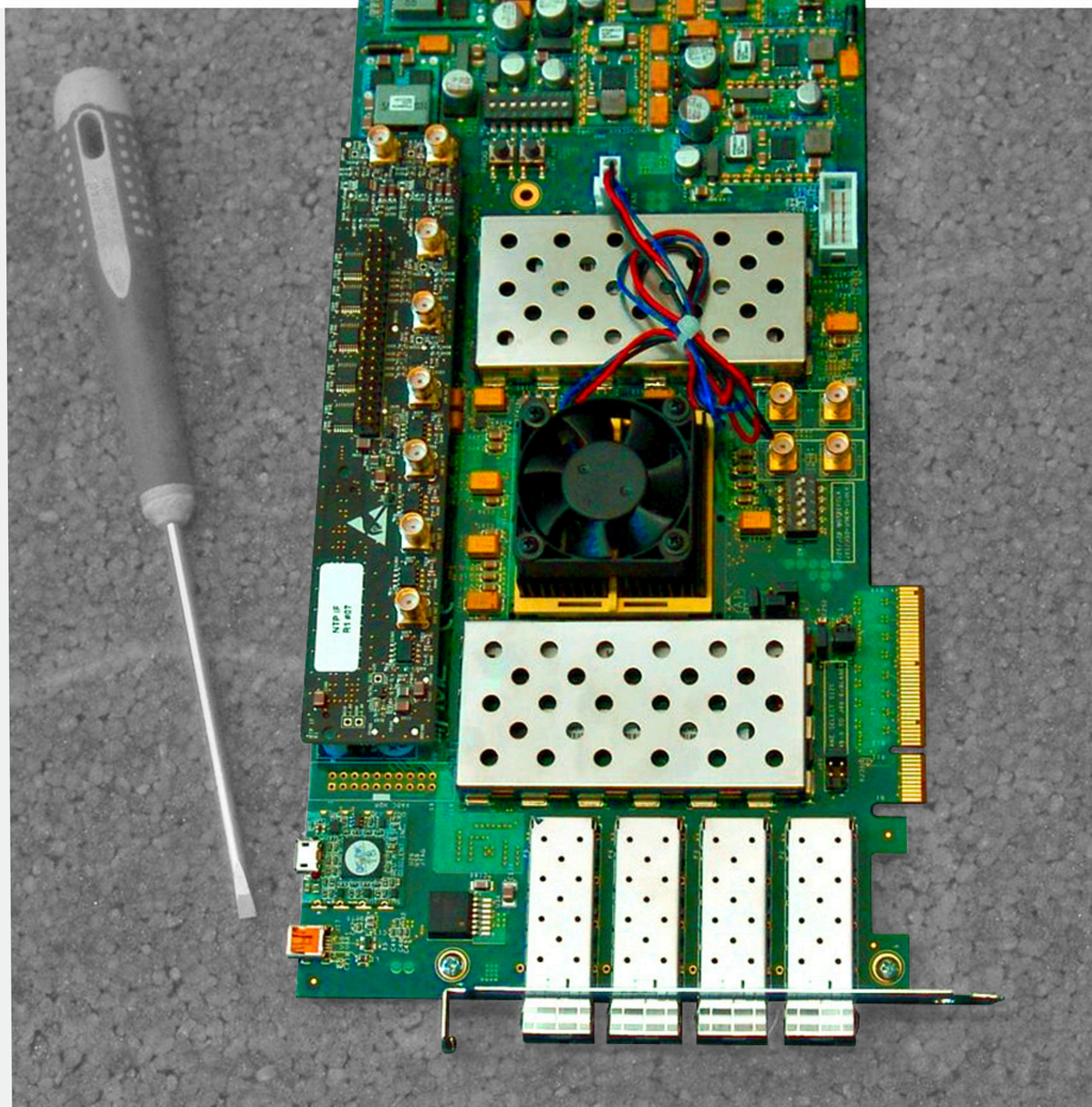
- Uses commercially available PTP distribution equipment
- Over dedicated fibre, with separate Grand Master for each customer – best accuracy
- Or, over Netnod’s access infrastructure

Used by

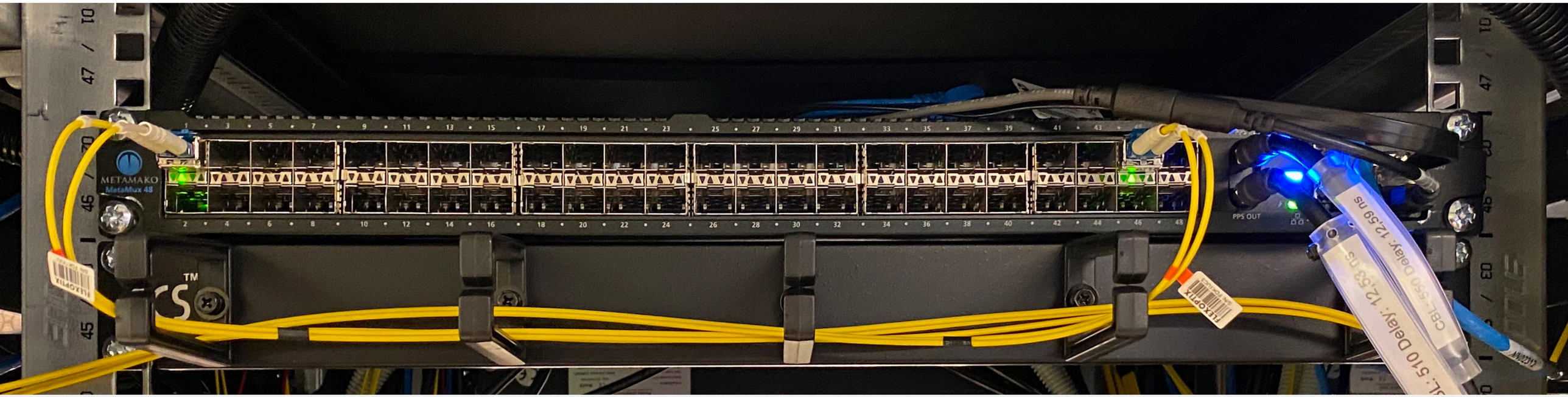
- Telecom
- Power grid
- Finance
- Infrastructure
- Broadcast media
- Government
- …

Hardware NTP server in FPGA

- Public Internet service
- 4 x 10 Gb/s full wire speed
- IPv4 and IPv6
- Secure - NTP traffic stays in the FPGA
- Standard FPGA board, with custom interface for time input and output(1 PPS & 10 MHz)
- Open source FPGA code



Hardware NTP with NTS server in FPGA



- NTP with Network Time Security
- RFC 8915
- Public Internet service

- Our implementation runs in a commercial vendor’s box (white box), many other variants possible
- Open source FPGA code

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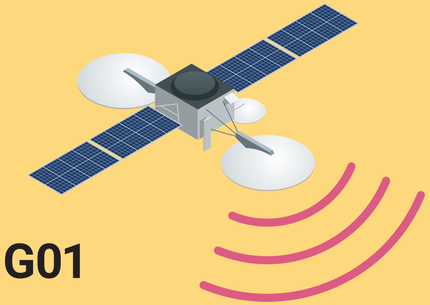
Rear view

(Where it actually happens)

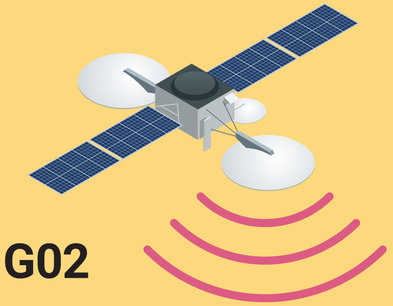
GNSS Common View

4711 – Beep!



G01

22193521 – Beep!



G02

80087 – Beep!

G03

Data transfer:
A 14:43:39:002 – G01: 4711
A 14:43:39:819 – G02: 22193521
A 14:43:40:315 – G03: 80087