Svensk Tele Utveckling & Produkt Innovation
STUPI AB

- History
- Lab Survival Availability & Redundancy
- Frequency Standards
- Time & Frequency Measurement Capabilities
- IP Network Capabilities
- NTP Services
- Future Plans

Stupi AB, Box 9129, S-102 72 Stockholm Sweden

History:

- Incorporated 1983
- Independent research/development
- Time & Freq resources established 1993
- Three locations; Karlstad, Stockholm, and Los Altos CA
- Focus on IP based equipment and infrastructures

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History

As most projects this started with non helpful people..

- Per Hedeland had discovered Dave Mills work and the protocol NTP, but there was no server-clock to chime with.
- So he sends me an email, “Peter can you get a NTP server we can talk to?”
- At that time I did spend my days at KTH trying to create a working public Internet in Sweden and Europe.
- A first look at the problem reveals that what is needed is a computer with a IP stack, a time source and a way to synchronize the computers time to the time source.
- Have computers, have soldering iron and a kitchen table to build projects on, but no time source that works 24H and have a stable frequency. (GPS was not fully operational.)
- Need 1PPS pulses and a stable frequency, or stable frequency
- Official Swedish Time is kept by “Telia/Televerket” and they only way they would help was if we paid about $100K/year for their “service”.
- No $100K budget, resources paid for by tax payers not available
- Some months of searching for a frequency source stable enough.....
- One day a gray haired man stands in my office, “I’m visiting my wife, I work at a factory that makes cesium frequency standards in St Petersburg....”


SAPFIR
SIGNAL
POWER

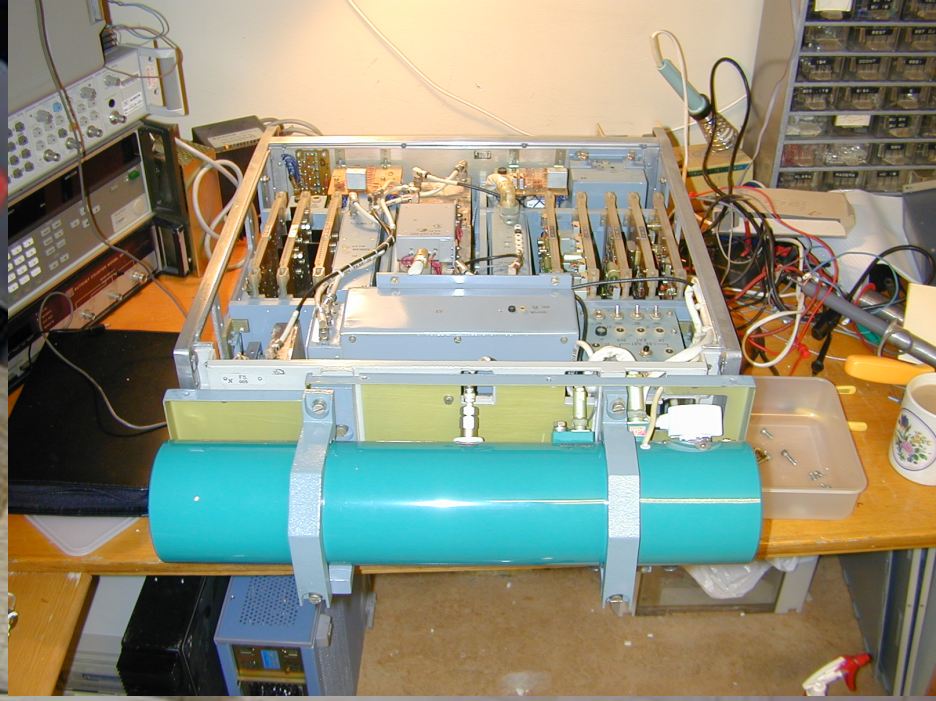

SAPFIR
STUP I
STOCKHOLM
2/4
BEC 62 KT


SAPFIR
STUP I
STOCKHOLM


ЗИП 17Н749
№ 74724422
ЯЩИК 1

The price was $5000 in Rubles!

This required armed escort to the bank..



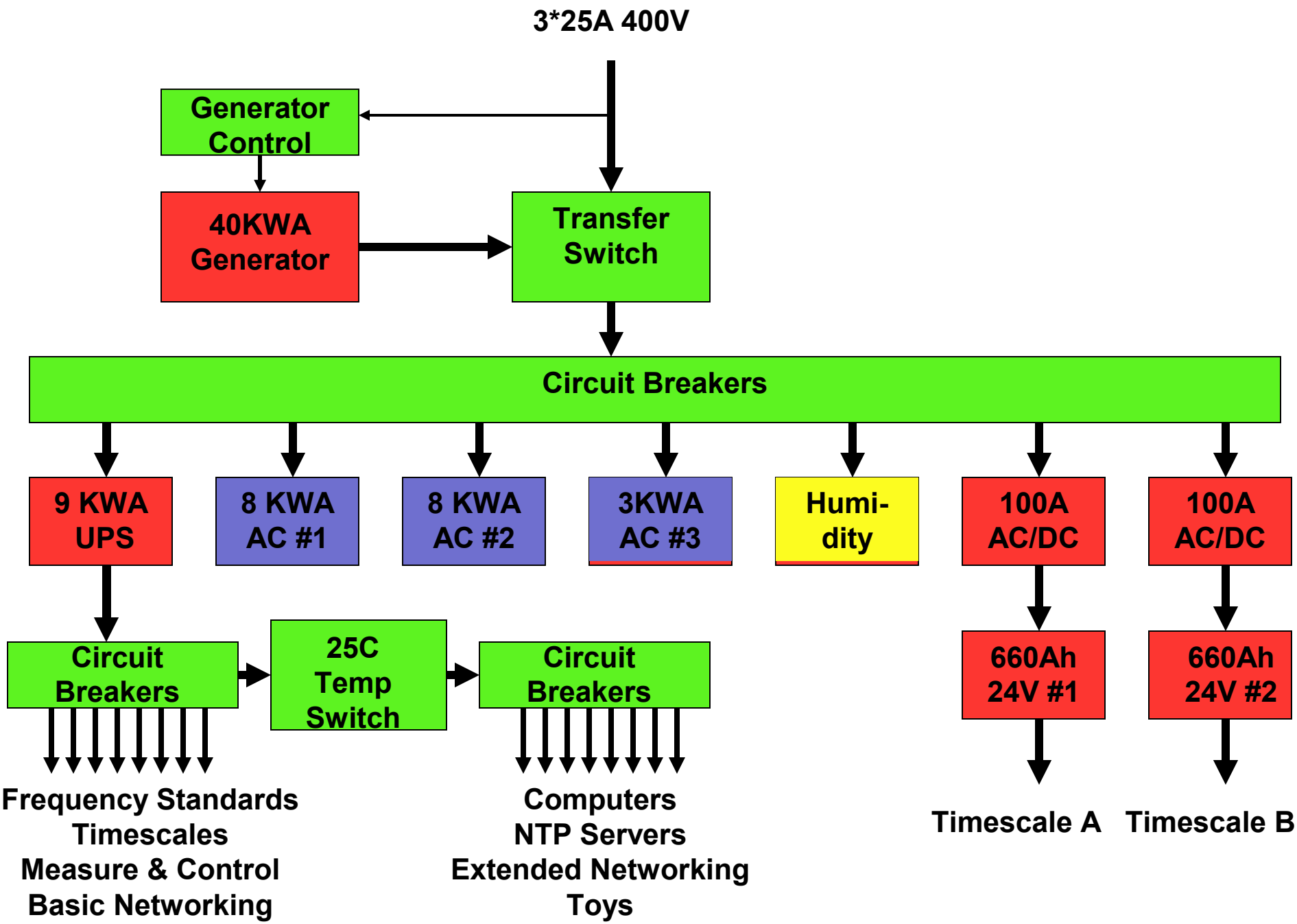
Renovated in 2004
Still working, but space/performance is not up to par with modern cesium's

History

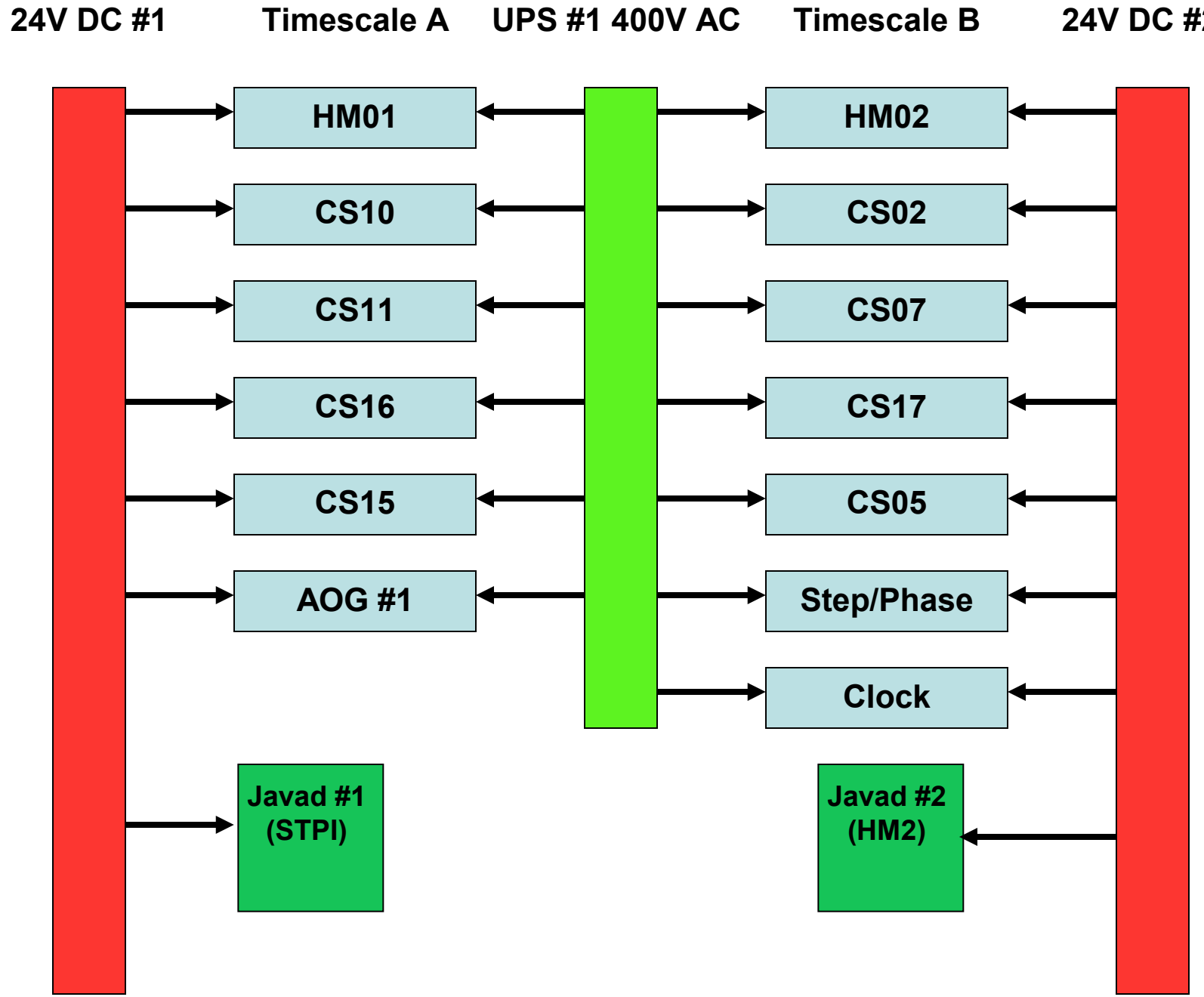
Turns out that a in house frequency standard is useful

- Once the NTP service was operational NTP queries' showed up from Telia. They where asked to stop, but claimed as they where Televerket they had exclusive rights to use everything..

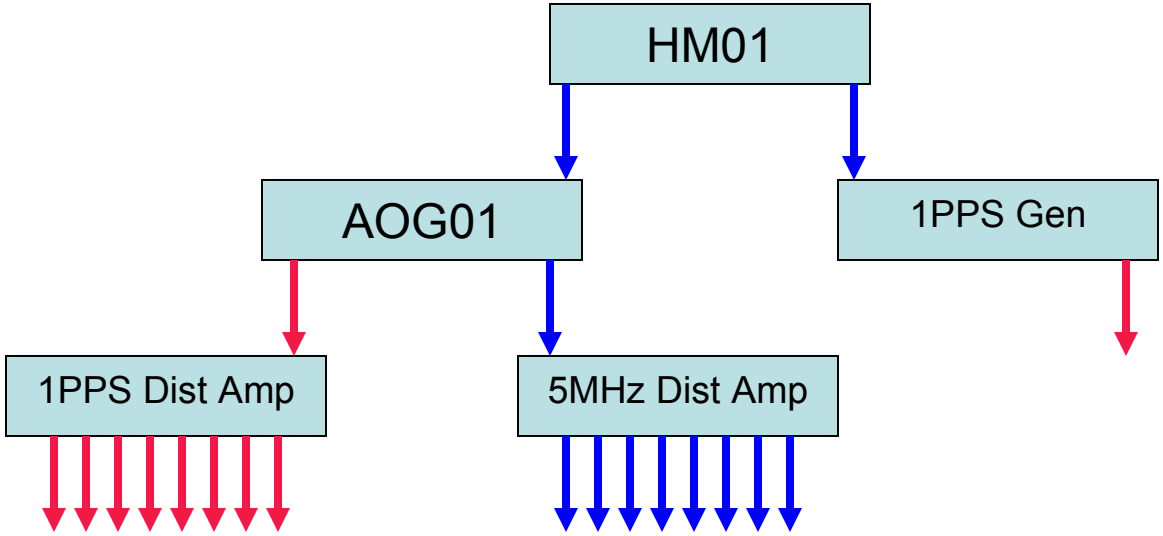
  They where asked to pay the $100K/year they wanted from me, but referred to the above.. So practical BGP filtering was implemented to drop them.
- In the late 1990's the responsibility for national time and frequency was moved to SP in Borås.
- It is amazing what improvement in attitude some 400KM from Farsta does.
- SP and Stupi has collaborted on reserach and operations if timescales for 10 years now.
- Most of the Swedish infrastructure for time distribution is a result of this collaboration.



AC Power Distribution

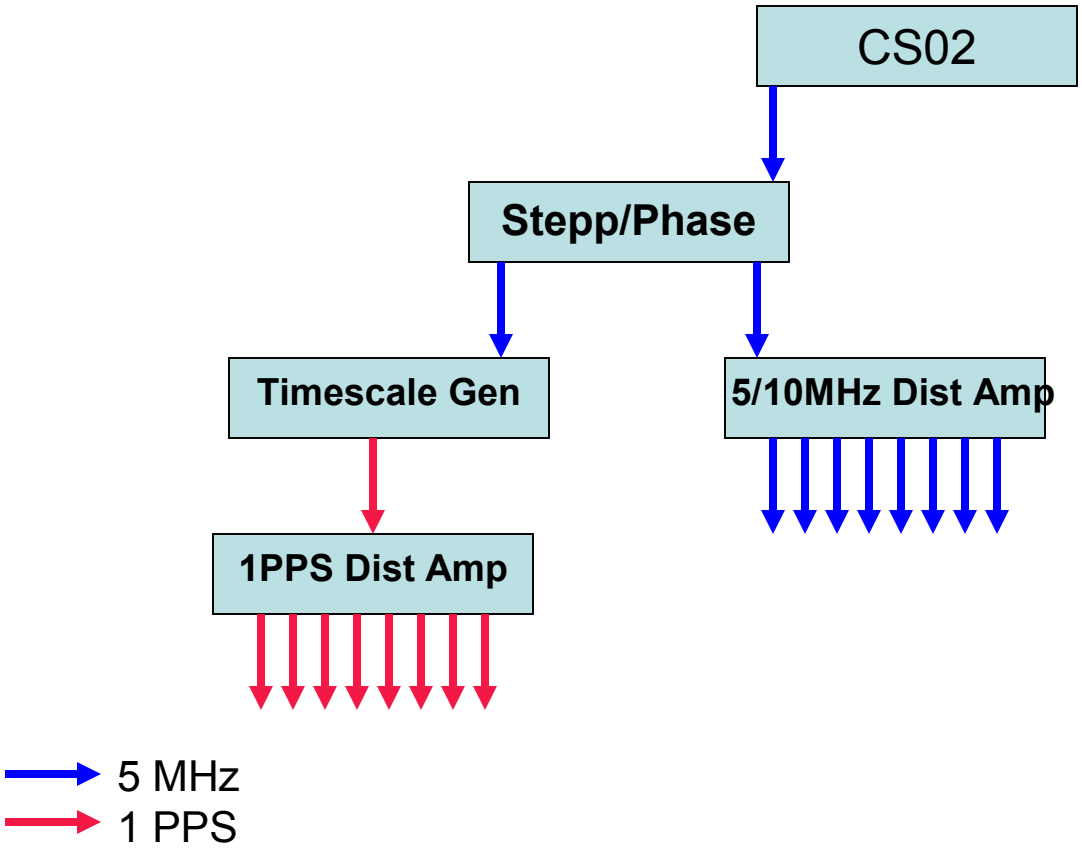


Timescale Power



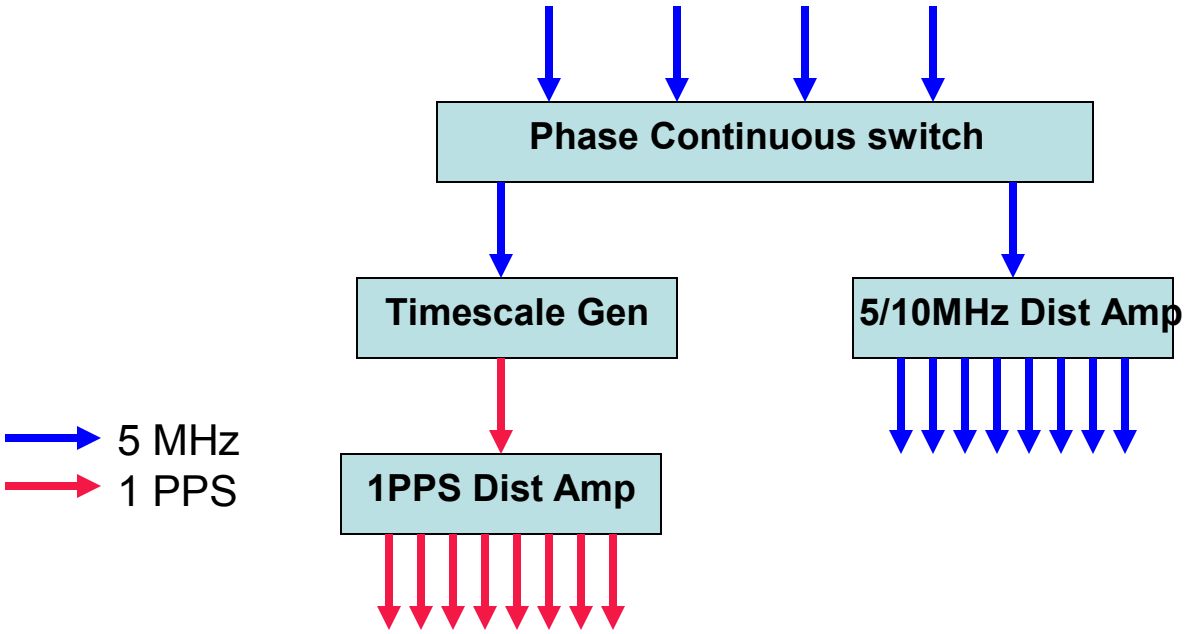
5 MHz
1 PPS

Master Clock A

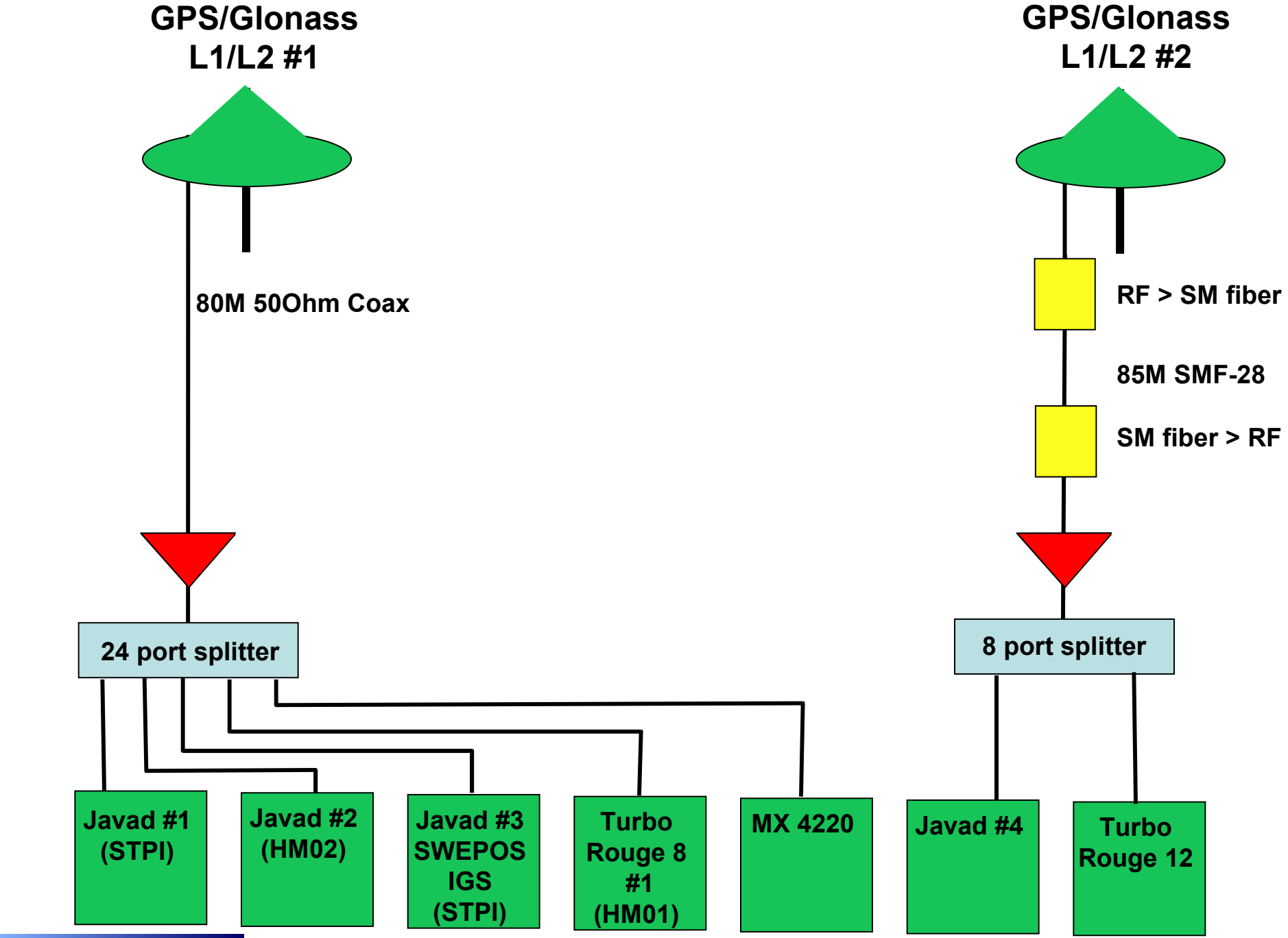


Master Clock B

STPI-A STPI-B HM02 CS07



NTP-A Timescale


GPS/Glonass
L1/L2 #1
GPS/Glonass
L1/L2 #2
80M 50Ohm Coax
RF > SM fiber
85M SMF-28
SM fiber > RF
24 port splitter
8 port splitter
Javad #1
(STPI)
Javad #2
(HM02)
Javad #3
SWEPOS
IGS
(STPI)
Turbo
Rouge 8
#1
(HM01)
MX 4220
Javad #4
Turbo
Rouge 12

- Hydrogen Maser (3)
  - Climate controlled to +-0.1C and +-1.5% humidity

1s 2x10-13
10s 3x10-14
100s 7x10-15
1000s 2x10-15
1 day 1x10-15

- Cesium Beam 5071A (6)

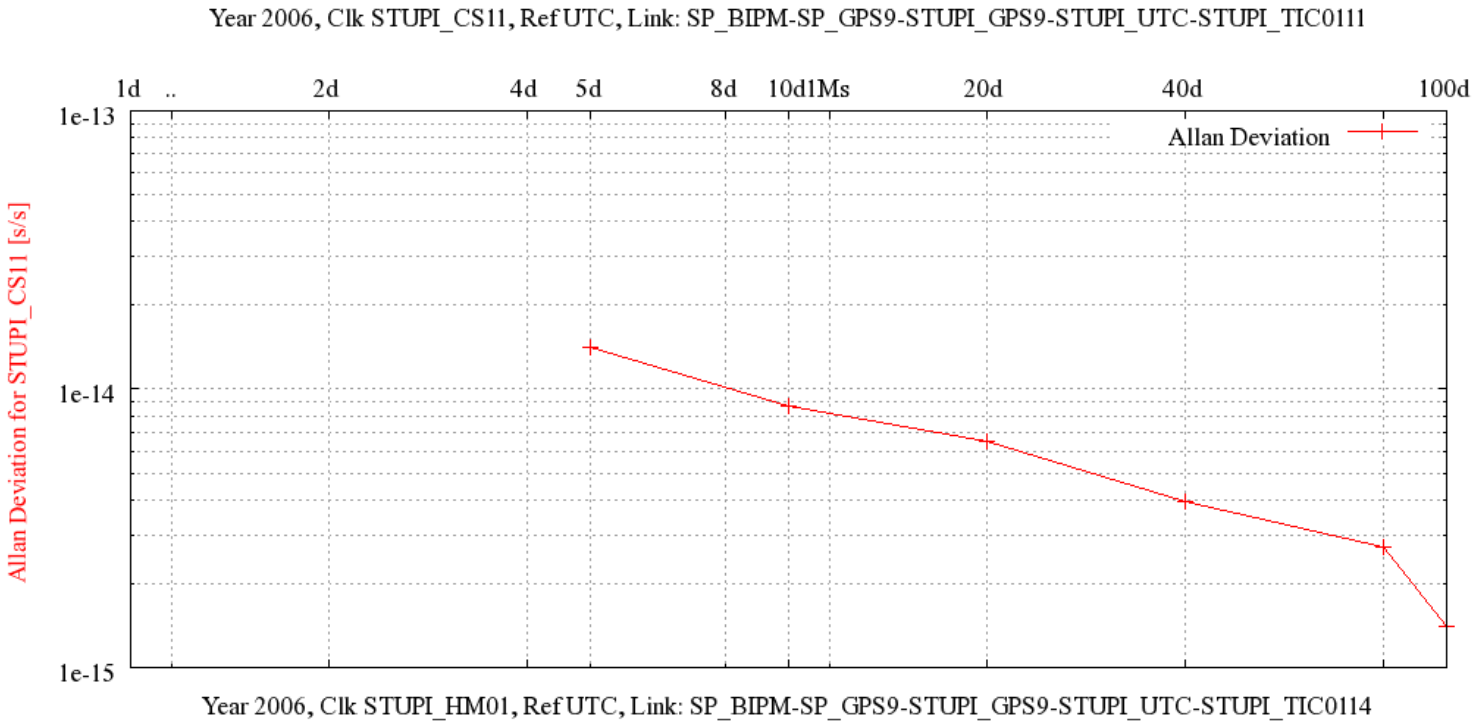
1s 5.0x10-12
10s 3.5x10-12
100s 8.5x10-13
1000s 2.7x10-13
1 day 4.7x10-14

- Low performance Cesium Beam (12)

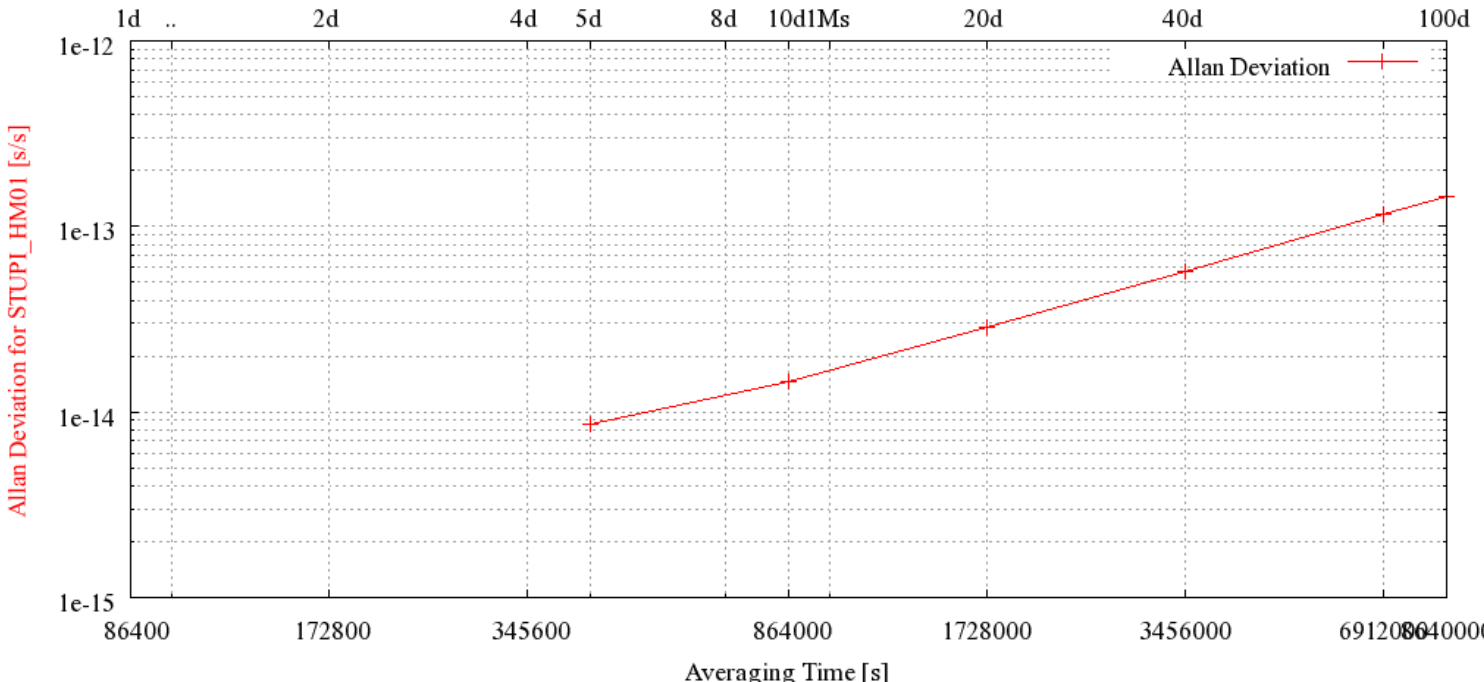
1s 1.5x10-11
10s 7.0x10-12
100s 1.5x10-12
1000s 6.0x10-13
1 day 2.0x10-13

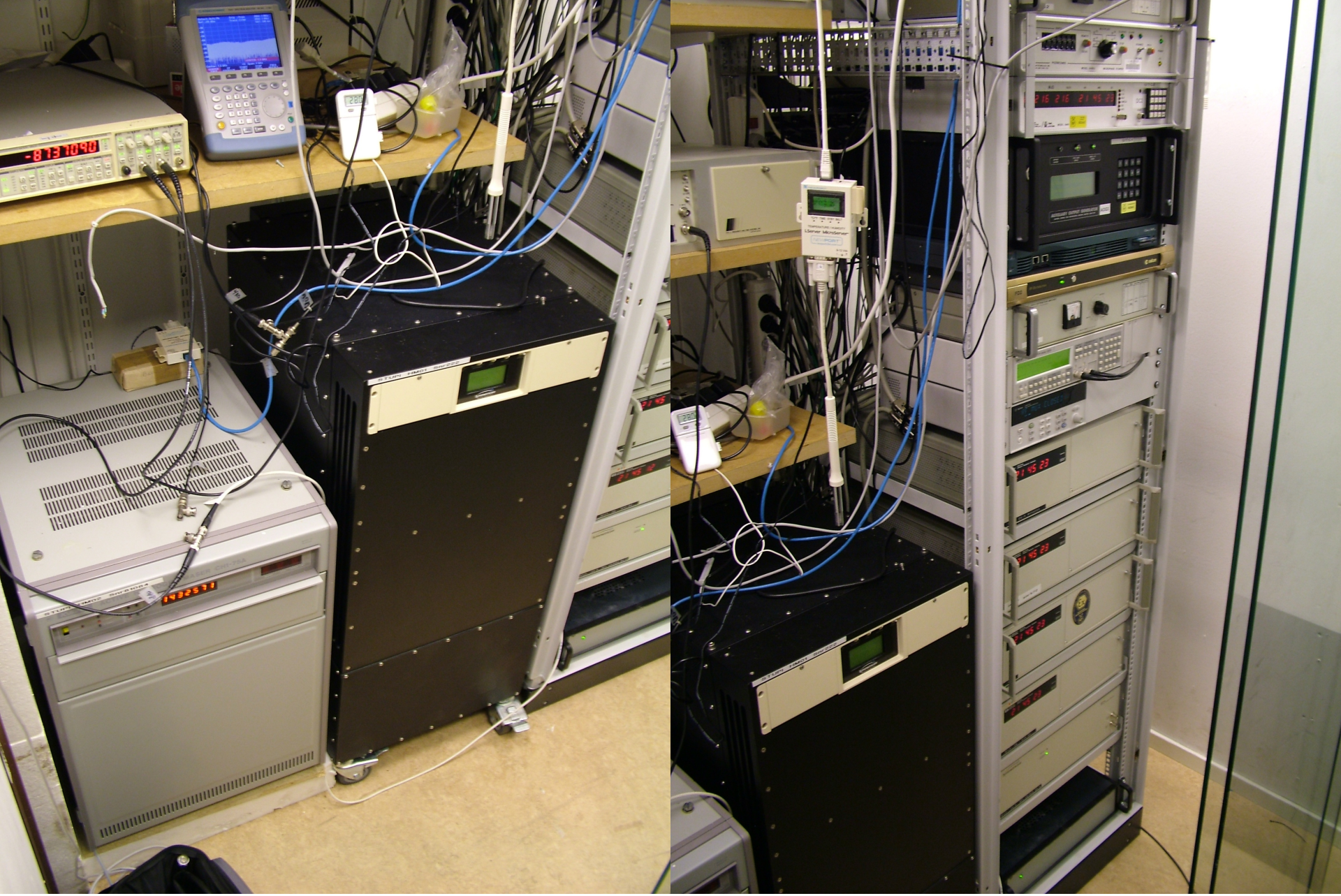
- Assorted Rubidium and Quartz Standards
  - **Ask if we can help you..**

CS11


Year 2006, Clk STUPI_CS11, Ref UTC, Link: SP_BIPM-SP_GPS9-STUPI_GPS9-STUPI_UTC-STUPI_TIC0111
1d
..
2d
4d
5d
8d
10d1Ms
20d
40d
100d
1e-13
1e-14
1e-15
Allan Deviation
Allan Deviation for STUPI_CS11 [s/s]

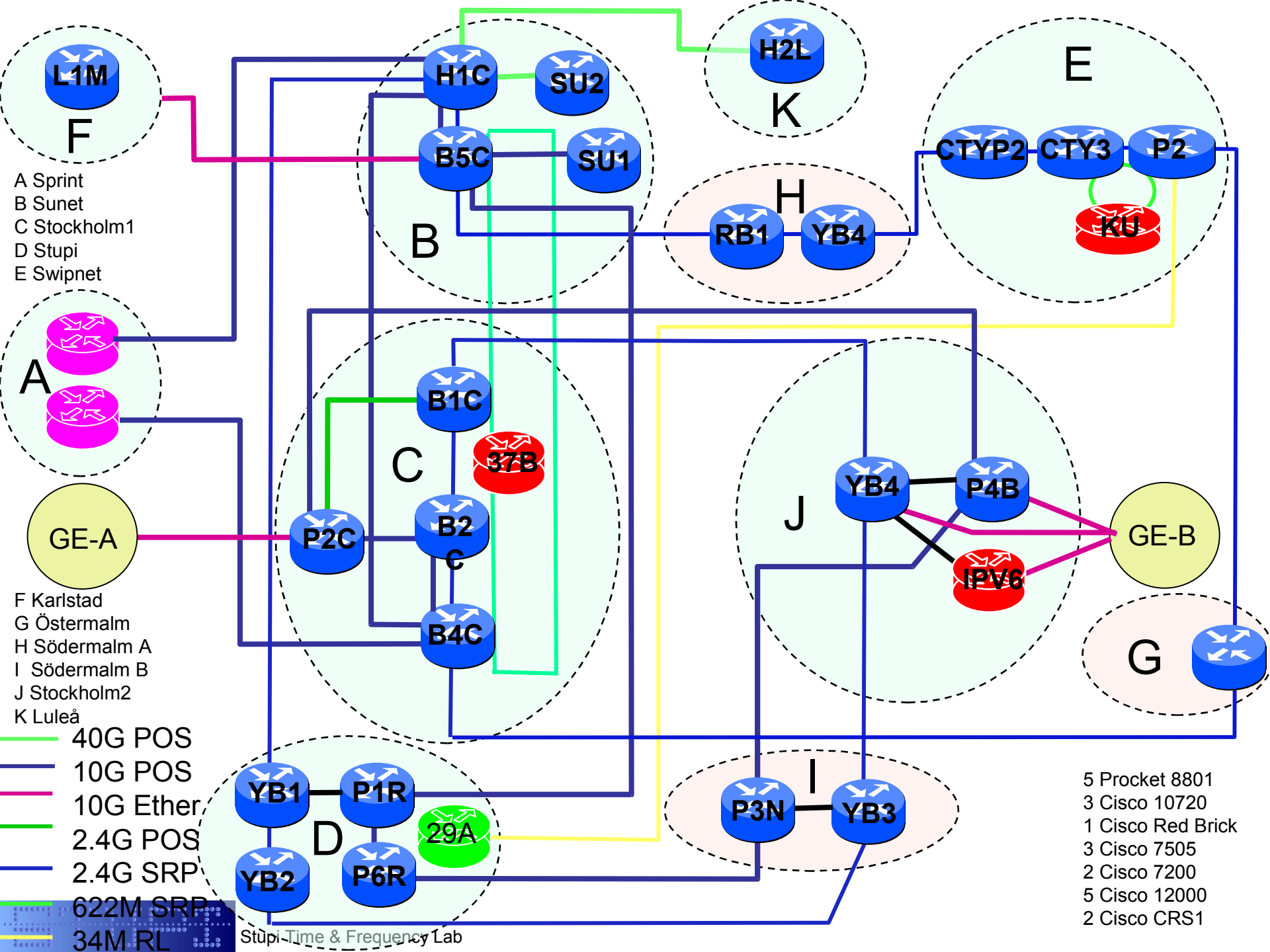
HM01

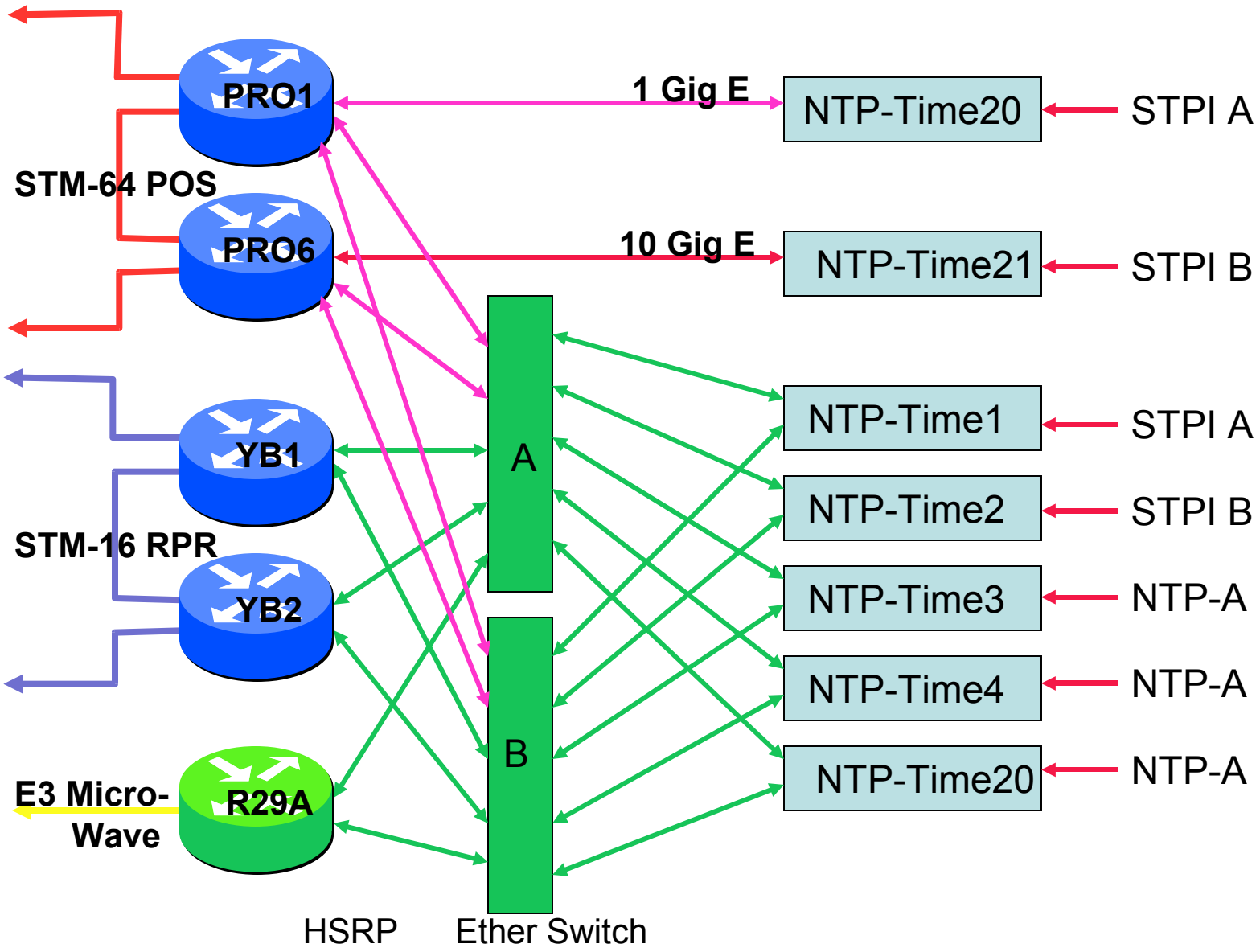

Year 2006, Clk STUPI_HM01, Ref UTC, Link: SP_BIPM-SP_GPS9-STUPI_GPS9-STUPI_UTC-STUPI_TIC0114
1d
..
2d
4d
5d
8d
10d1Ms
20d
40d
100d
1e-12
1e-13
1e-14
1e-15
Allan Deviation
Allan Deviation for STUPI_HM01 [s/s]
86400
172800
345600
864000
1728000
3456000
6912000
8640000
Averaging Time [s]



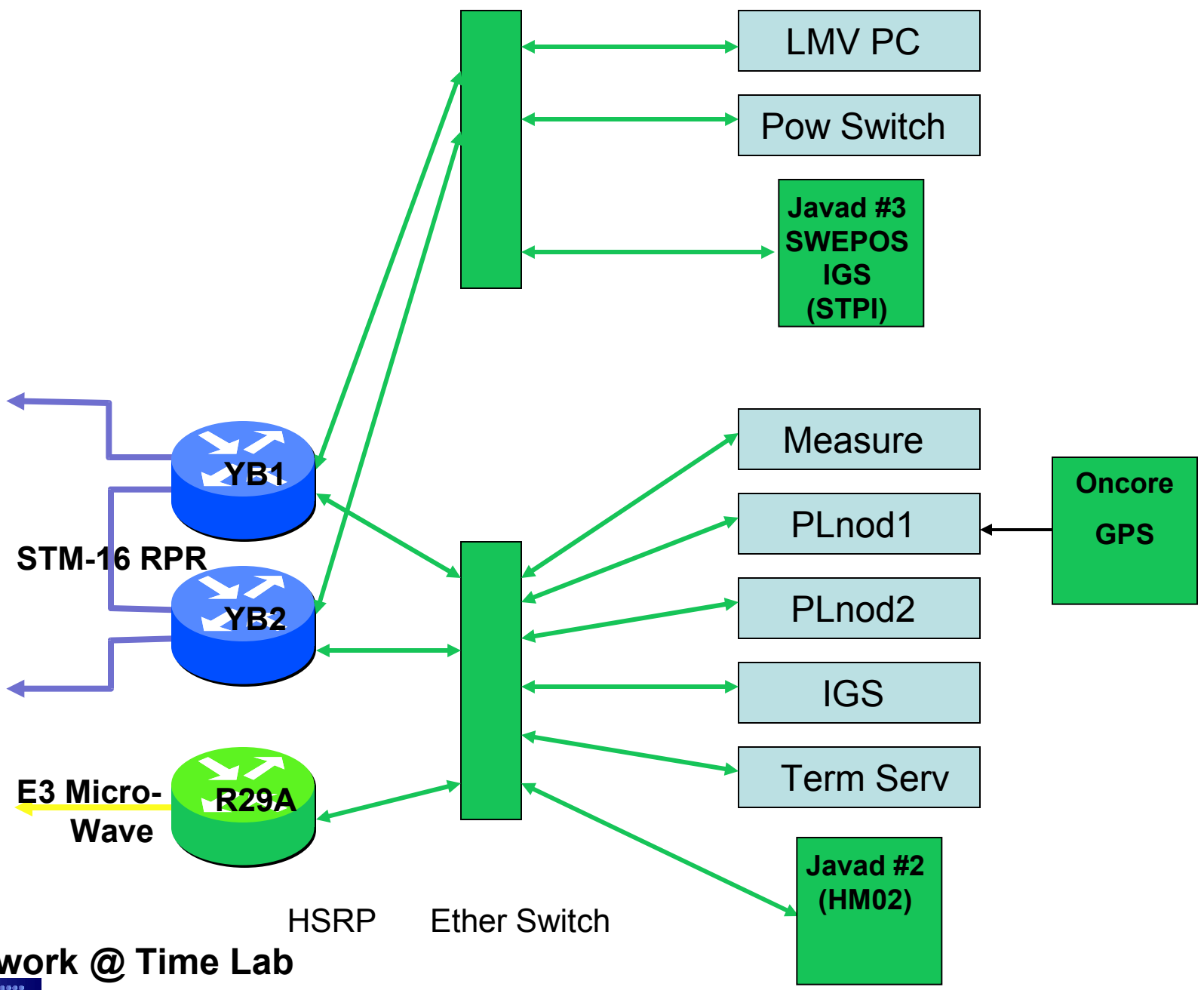
- Time interval Measurements
  - 25 ps typ (40 ps max)
- Phase
  - -147 dBc Noice
  - 1x10-14 @1s Allan Deviation
- Frequency measurements
  - 0.1MHz – 100 MHz +-2x10-13
  - 100MHz – 10 GHz +-6x10-13
- Frequency generation
  - 0.1Hz – 20MHz @4x10-13
  - 10MHz- 2400MHz @ 6x10-13

Mesurement Capabilities


L1M
F
H1C
SU2
B5C
SU1
B
H2L
K
E
CTYP2
CTY3
P2
KU
H
RB1
YB4
A Sprint
B Sunet
C Stockholm1
D Stupi
E Swipnet
A
B1C
C
37B
P2C
B2
C
B4C
GE-A
J
YB4
P4B
IPV6
GE-B
G
F Karlstad
G Östermalm
H Södermalm A
I Södermalm B
J Stockholm2
K Luleå
40G POS
10G POS
10G Ether
2.4G POS
2.4G SRP
622M SRP
34M RL
YB1
P1R
D
29A
YB2
P6R
I
P3N
YB3
5 Procket 8801
3 Cisco 10720
1 Cisco Red Brick
3 Cisco 7505
2 Cisco 7200
5 Cisco 12000
2 Cisco CRS1
Stupi Time & Frequency Lab

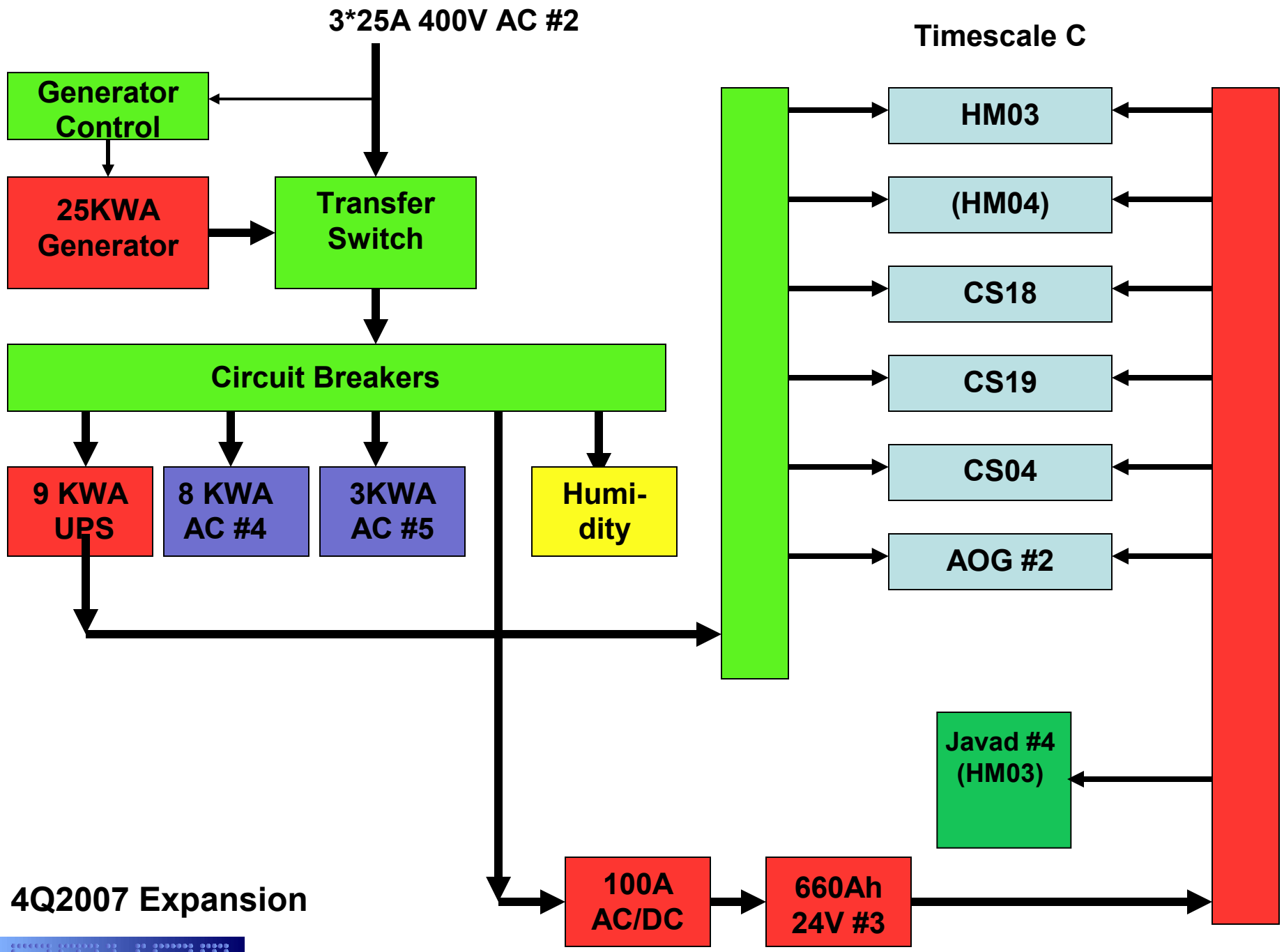


IPv4/IPv6 Network @ Time Lab



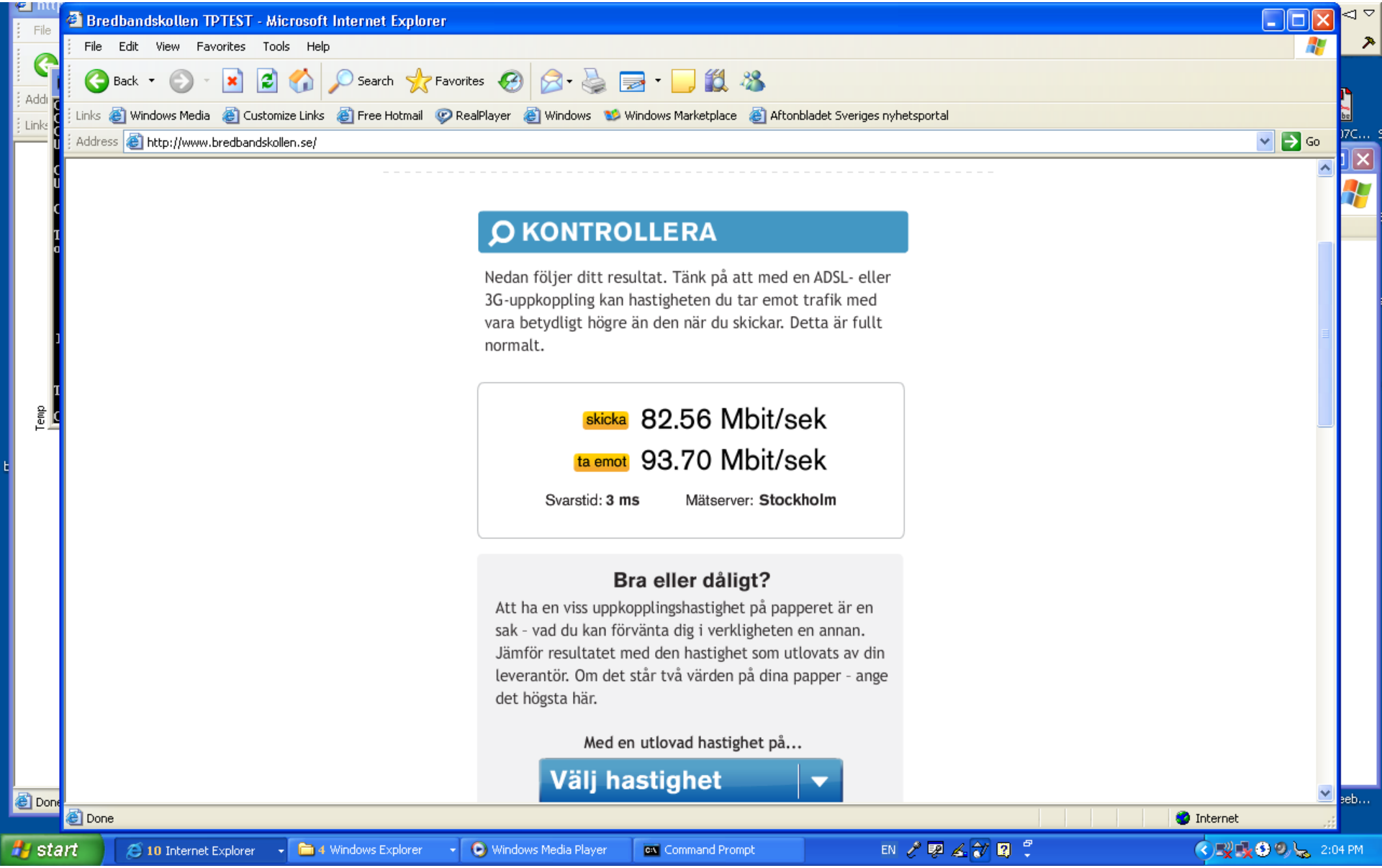
Control Network @ Time Lab

- Build a additional master clock room
  - Clock systems in individual climate chambers
  - Physically separated
- Build a slave clock at NetNod
  - CS+RB clocks
  - Two way time transfer on single fiber
- New NTP Servers with 10Ge networking
- New measurement/control system
  - Based on phase measurements in addition to today's 1PPS based system.
  - Make use of the short term stability of masers
  - Allow steering in real-time of frequency synthesizers
  - ……


3*25A 400V AC #2
Timescale C
Generator Control
25KWA Generator
Transfer Switch
Circuit Breakers
9 KWA UPS
8 KWA AC #4
3KWA AC #5
Humi-dity
HM03
(HM04)
CS18
CS19
CS04
AOG #2
Javad #4 (HM03)
100A AC/DC
660Ah 24V #3
4Q2007 Expansion


We Also Have a GPS Antenna
...And the background is prettier than in Borås..

So is it 82.56Mbit/s or 93.70Mbit/s on a 100M Ethernet????



Noll_Kollen

Stupi Time & Frequency Lab