

# Development of Swedish IXPs

## MENOG<sub>5</sub>, Beirut Lebanon

# Early history

- pre-deregulation of the telcoms market
  - The idea of a commercial IP provider had emerged
  - The Swedish NREN had started trials with IP networks
  - These two projects (as well as various early ideas for a pan-European commercial IP network) needed interconnections
  - Started at the Royal Institute for Technology (KTH) around 1989
- Post-deregulation
  - Interconnects at D-GIX run by KTH from around 1992

# History

- Netnod was formed from then D-GIX at KTH-NOC in 1996 / 1997
- Reason for creating Netnod was to create a independent and resilient exchange infrastructure
- Early on focus was on redundant systems
- Also from a national infrastructure point-of-view

# History

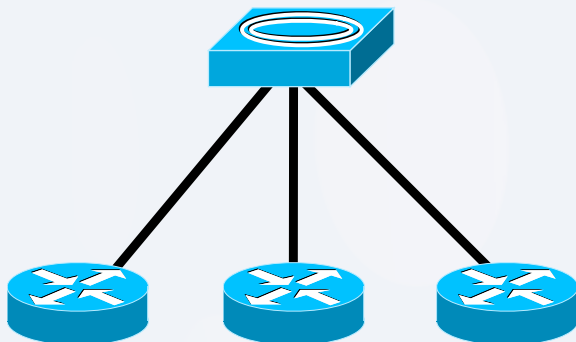
- At the time of creation
  - Government report that cited the Internet as critical national infrastructure
    - That some of that infrastructure was more important than other
- Design of Netnod was influenced by the view on national security

# Layer 2 design 0.1

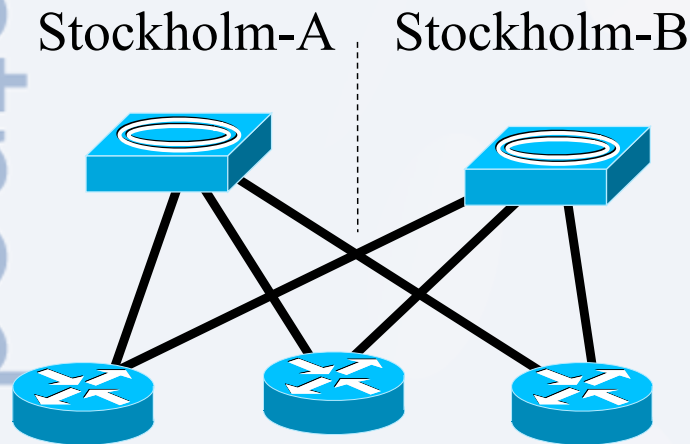
- The early versions of the IX was various forms of HUBs

# Layer 2 design v 1.0

- Original KTH-NOC location was a single FDDI structure
- Everyone had dual attachment FDDI up to KTH-NOC
- Some only had single attachment

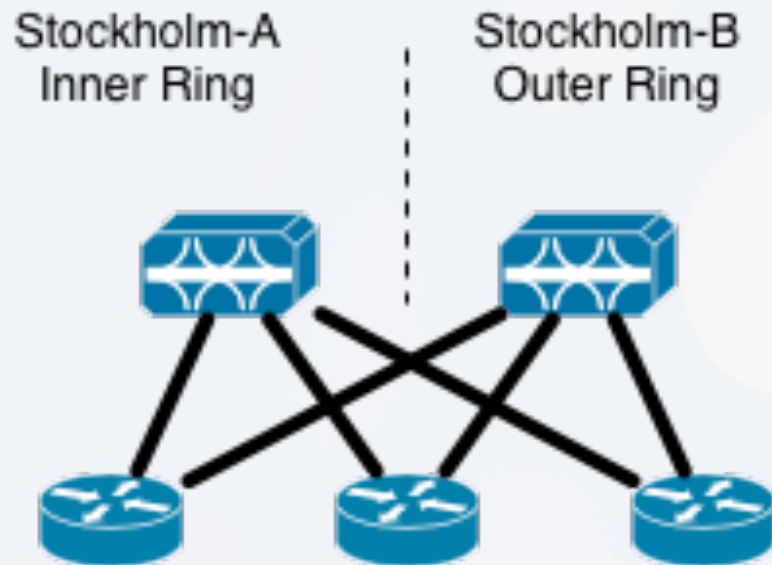


# Layer 2 design v 2.0



- The infrastructure was migrated to a dual FDDI ring infrastructure as the switches were migrated away from KTH-NOC
- In Stockholm they were located at two different physical locations
- In the other cities there were only one location
- Requirement for dual-attachment

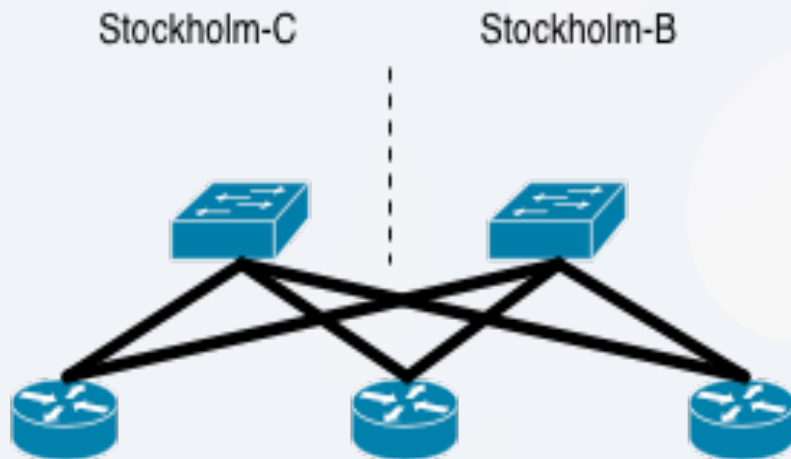
# Layer 2 design v 3.0



- FDDI was full at around end of 1998
- Migration to DPT/SRP due to then shortcomings of GigE
- Originally DPT 622Mbps
- Same structure used for DPT 2.5G



# Layer 2 design 4.0



- All exchanges now GigE based
- Only 1GE & 10GE connections
- In Stockholm dual switches that are not interconnected
- One in each bunker
- No SPT and no trunking issues

# Physical separation / redundancy

- Early on it was decided that the exchange of traffic had to work even in times of national crisis
- Stockholm would not be a focus point
- Any backup site had to survive on it's own
- Search for suitable locations started
  - And turned out to be a fairly complex process

# Locating sites...

- Criteria that had to be met
- Population / Traffic volume
- “Carrier capacity”
  - It had to be fairly easy to get to
  - Preferably most operators where already present
  - Was probably the hardest criteria to meet....
- Somewhat spread across the country
- Existing bunker...

[www.netnod.se](http://www.netnod.se)



# Other effects of the diversity

- Early on local exchange of traffic was seen as a possible “Good thing™”
- However turned out to be somewhat harder than first thought
- Until around 1999 traffic was still sent through Stockholm even for ISPs connected to Gothenburg
- This slowly changed
- Today a lot of local traffic (most) is exchanged locally
- Gives overall better performance

# The bunkers...

- For the establishment of Netnod, it was decided it would be better to migrate away from KTHNOC to “neutral” ground
- At this point in time there were no neutral co-location facility in Sweden
- Reason for this was the establishment of a city-owned fiber monopoly in 1993, that sold dark-fiber at cost in Stockholm - so everyone just built their own datacenter

# The bunkers...

- Earlier the regulator had constructed a number of telecommunication bunkers around the country to house critical PSTN infrastructure
- Netnod, building on the earlier government report, asked to get the same status and housing agreements
- Was approved

# The bunkers...

- The following is a very general description....
- The bunkers are built to withstand a “close miss”
  - For some definition of close
  - For some definition of miss
- Each bunker have an access road down to a larger “cave”
- Each cave houses a number of “buildings”



# The bunkers...

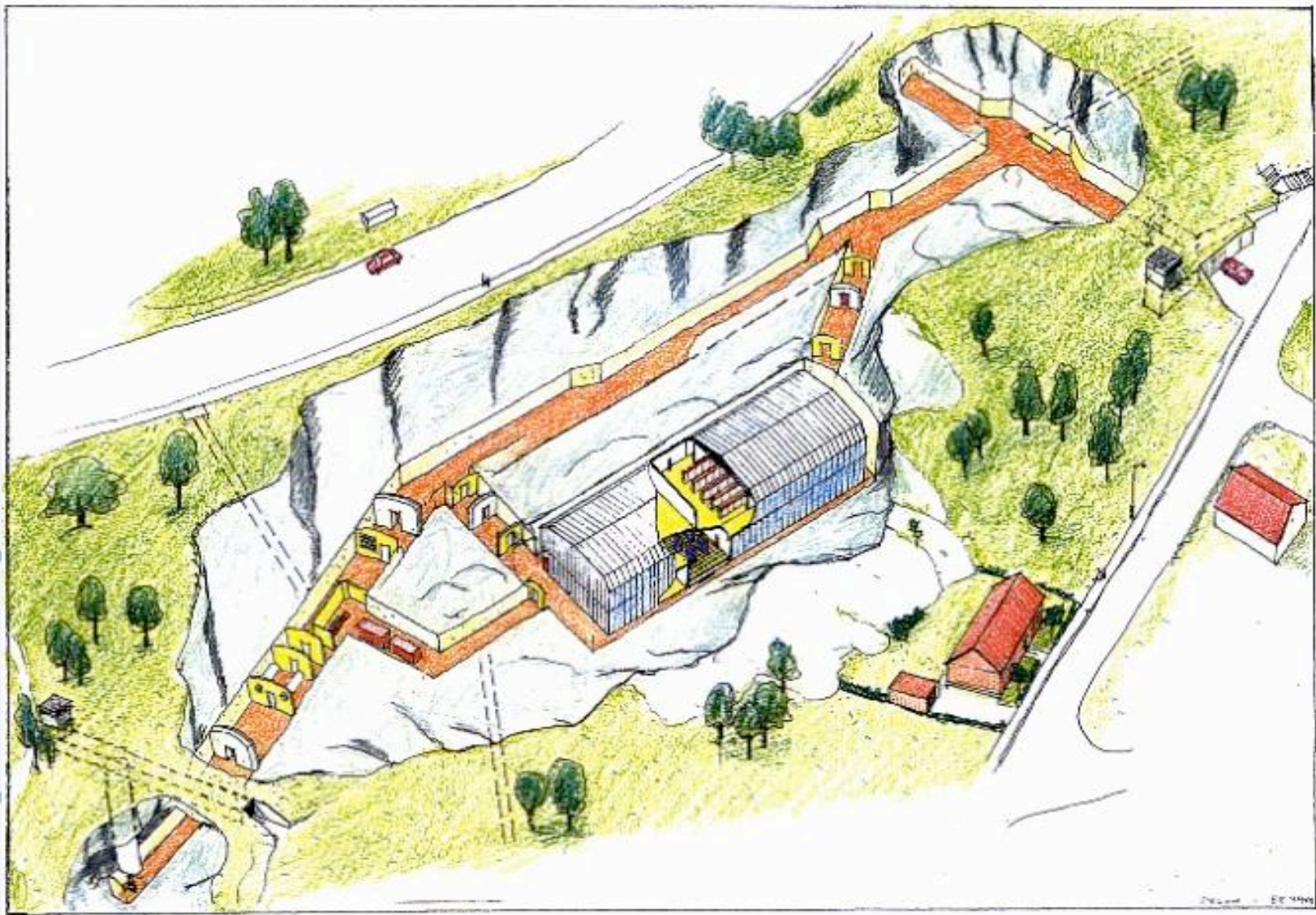
- Each building is protected against EMP
- Each cave have at least two fibre access paths
- Dual power and cooling built in the bunkers
- We in addition have dual 48V and AC UPS and battery infrastructure

# The bunkers...

- Netnod rents a room with access control inside each of the buildings
- Only Netnod staff have access to the rooms
  - Entries into the rooms are reviewed every month
- The bunkers are operated by various entities
  - Some by the military, some by others
  - Netnod hands-on used to be done by the military as well

# The bunkers...

- In Stockholm the charges for connecting to Netnod includes the cost for two separately routed fiber pairs.
  - One to each bunker
- In the other cities, the ISP have to find a fiber provider themselves
- Co-ordination needed to patch through to us



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# Critical infrastructure

- It was decided that it was of importance to locate some of the critical common Internet infrastructure at the Exchange points as well
- Netnod have tried to develop the amount of services available at the exchanges



# Common Services

- Official Swedish time through NTP
  - In Malmö, Sundsvall, Gothenburg and one bunker in Stockholm
- i.root-servers.net
- .SE TLD-service
  - Stockholm, Gothenburg, Sundsvall
- A number of TLDs in Stockholm
  - Among others Verisigns .com and .net
- Copy or RIPE routing registry in Stockholm

# Service Resilience

- Most services distributed
- For i.root-servers.net we are deploying anycast
- Today in Stockholm, Helsinki, Oslo, London, Amsterdam, Brussels Frankfurt, Paris, Geneva, Vienna, Milano, Bucharest, Ankara, Qatar, Washington D.C, Chicago, Miami, San Jose, HongKong , Bangkok, Singapore, Wellington, Perth, Beijing, Taipei, Manila, Jakarta, Katmandu



# Lessons learnt

- During Netnod's creation, technology choices and other steps in its development - we worked closely with the operator community
- Netnod grew from the needs of the operator community
- The government offered help, and the founding capital was a grant from the government
- But we have never been regulated or run by the government

# Lessons learnt

- We were “lucky” and had early support from the incumbent
- But they were a “late” adopter of IP
- The operators formed the Swedish Operator Forum
- Cooperation was very high

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# Contact

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