



*Bild 8. TCI vertikalt polariserat log-periodiskt antensystem vid Enköping Radio*

# The Stockholm Radio Aeronautical HF System An overview

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# Agenda

- **Introduction to aero HF**
- **Evolution 1967 to today**
- **Systems architecture and design philosophy**
- **Control site; "Systems Kernel"**
- **Transmitter site**
- **Receiver site**
- **Competition and prospects for the future**
- **Summary**



# Introduction to aero HF

- **The original over-the-horizon communications medium**
- **Roots in the 1920s**
- **Regulated by ITU and ICAO rules and procedures**
- **Spectrum allocations in the 3, 4, 5, 8, 10,11,13,15,17,21 and 23 MHz bands**
- **Essentially unchanged since the late-1960s when SSB started to replace AM**
- **Datalinks were proposed already in the 60s, but were difficult to implement**

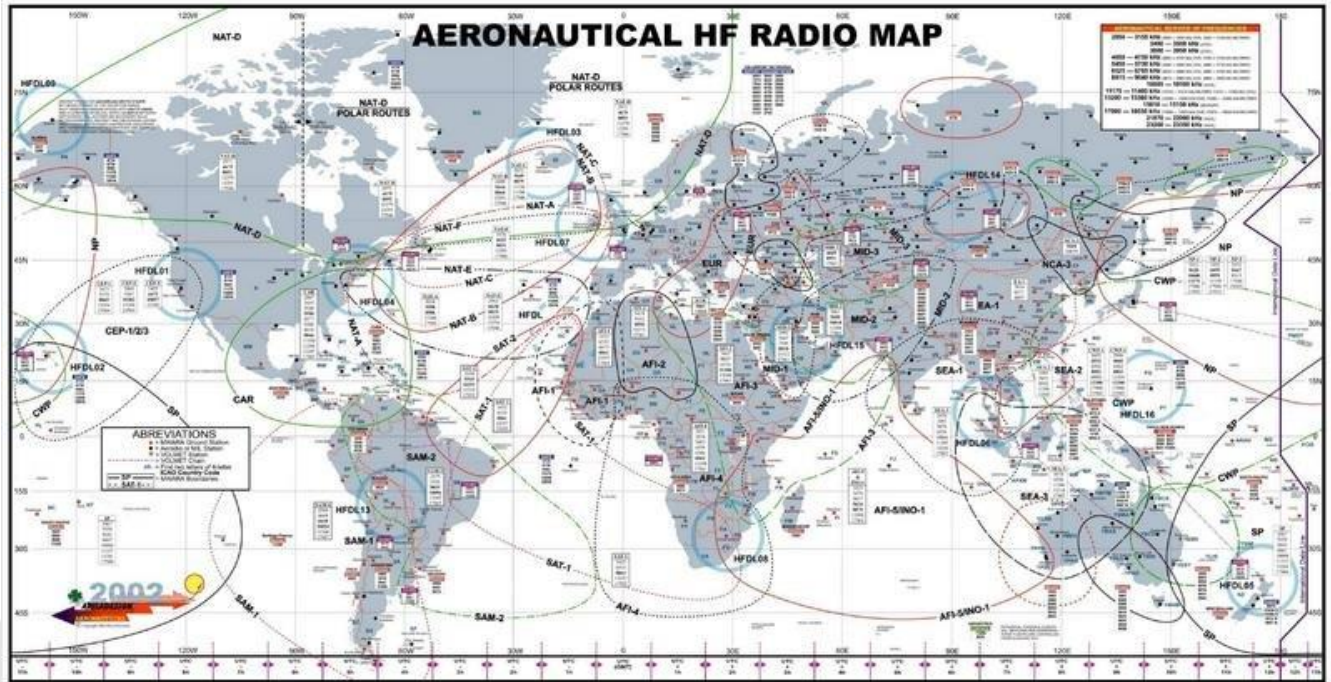


# **Air Traffic Control and company communications**

- **Frequency allocations correspond to major air routes**
- **High traffic density regions use many frequency families**
- **"Company Communications" or LDOC have their own world-wide coordinated "Route" spectrum allocations**
- **Military aircraft usually operate on "Off-Route" frequencies**



# Global frequency families





## **STO Radio background**

- **Mid-1960s, airlines SAS and Transair wanted to establish their own HF stations**
- **Request was denied for spectrum economy reasons**
- **Instead, the Royal Board of Telecommunications established its own HF Air/Ground operations in 1967**
- **Invited other airlines to participate**



# Point-to-Point station in the 50s





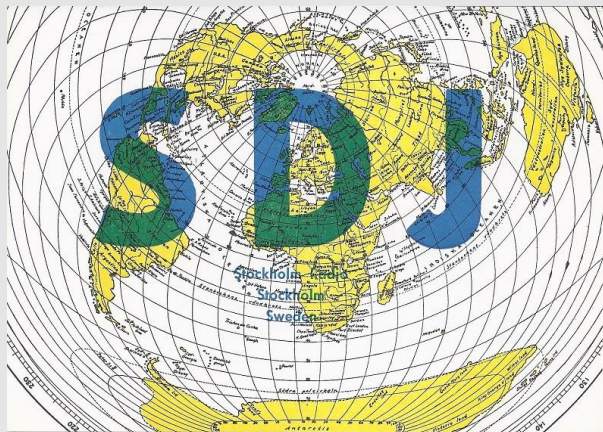
## **Early implementation**

- **System built around existing HF Point-to-Point infrastructure**
- **Operational centre at Enköping WNW of Stockholm**
- **Transmitter site at Hörby, 350 km S of Stockholm**
- **Manned by Point-to-Point crew**
- **Very limited hardware resources**





# Stockholm Radio SDJ QSL



DATE: 03DEC86  
TIME: 1323z  
FREQ: 11345 kHz  
MODE: USB  
PWR : 7kW  
ANT : Log Periodic

We have the pleasure to acknowledge receipt of your listening report, which we have checked and found to be correct.

Thank you for your information.

STOCKHOLM RADIO  
Örjan Thor & Raop

TELEVERKET RADIO  
Östra Radioområdet

STOCKHOLM RADIO  
Box 43 022  
100 72 STOCKHOLM



RUDY VAN DALEN

BOSPOLDERSTRAAT 30

2912 PD NIEUWERKERK a/d YSSEL

HOLLAND



## **The first years**

- **Most traffic generated by airline, primarily SAS, company messages**
- **Second were crew personal calls**
- **Volume increased rapidly**
- **In 1970, the single SSB transmitter at Hörby was worn out**
- **Transmitter site moved to Karlsborg where more transmitters were available**



# Transmitter site 1971-2014



*10 kW Collins effektsteg efter installationen 1988*



*Sändarstationen i Karlsborg*





## **First generation equipment**

- **Receivers: Collins 51S-1 and Drake R-4**
- **Transmitter(s): 20 kW Telefunken**
- **Receive antennas: Rhombics**
- **Transmitter antennas:  
Monopoles and rhombics**
- **In-house built operator console**
- **Relay-based transmitter remote control  
Telefunken "Fernwirksystem"**



## **Station evolution**

- **Point-to-Point HF traffic decreased**
- **Air/Ground traffic increased**
- **Rationalisation efforts**
- **Threat in 1975 to either close the operations or move to Gothenburg. Trial period of remote operation of Point-to-Point circuits from Gothenburg did not work out, so a "grace period" was given**
- **Final decision to move to Stockholm in 1978**



# Receiver site interior

**Left to right: Antenna multicoupler, antenna switch, watchkeeping receivers, traffic receivers**





# Infrastructure development

- **Expanded TX resources; 5 20 kW transmitters, 8 antennas; dipoles, log-periodics and rhombics inherited from fixed services**
- **6 watchkeeping HF receivers, 4 frequency agile HF receivers, access to 6 more in the MF coast radio network**
- **Very responsive receive antenna selection matrix**



# Receiver site antennas Vertical log-periodic 3-28 MHz



*Bild 8. TCI vertikalpolariserat log-periodiskt antennsystem vid Enköping Radio*





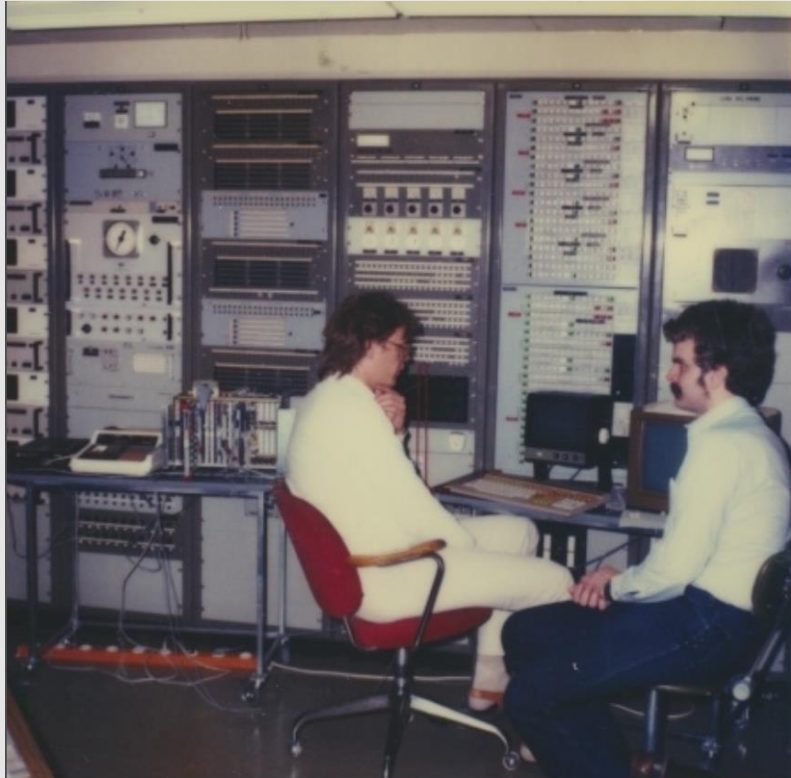
## **1980s developments**

- **Improvement using a frequency-agile Rohde&Schwarz 1 kW transmitter**
- **1960s Collins receivers started to wear out, replaced in 1984 with solid-state gear**
- **As part of "contingency network" upgrade the transmitter drive units and remote control system were renewed**
- **Traffic still increased, and the Telefunken transmitters showed serious signs of wear**
- **Four 10 kW Collins transmitters were inherited from the Air Force in 1988**



# Remote control upgrade

A 40 year younger "Yours Truly" at the right





# 10 kW Collins transmitters "saved the day"





## The "roaring 90s"

- **Mini-computer based (PDP-11) operator support and SITA/AFTN message handling system in 1988**
- **Point-to-point traffic resurged with small HF stations in developing countries "STATEX"**
- **Traffic volumes surged during the "Gulf Wars"**
- **New operator consoles and switching system built in 1990, patterned after the very successful VHF coast radio traffic system**



## Early-90s operating position



*Bild 7. Operatörsbord från 90-talets början. Bo Walter, ex-SM0FOV, vid kontrollerna.*



# Consolidation

- **Both receiver and transmitter resources were expanded due to other users downsizing. GMDSS changed coast radio**
- **Traffic volume peaked**
- **Generation change, several of the older crew retired**
- **Competition from satellites became noticeable**
- **Pilot project for HF Datalink was launched**

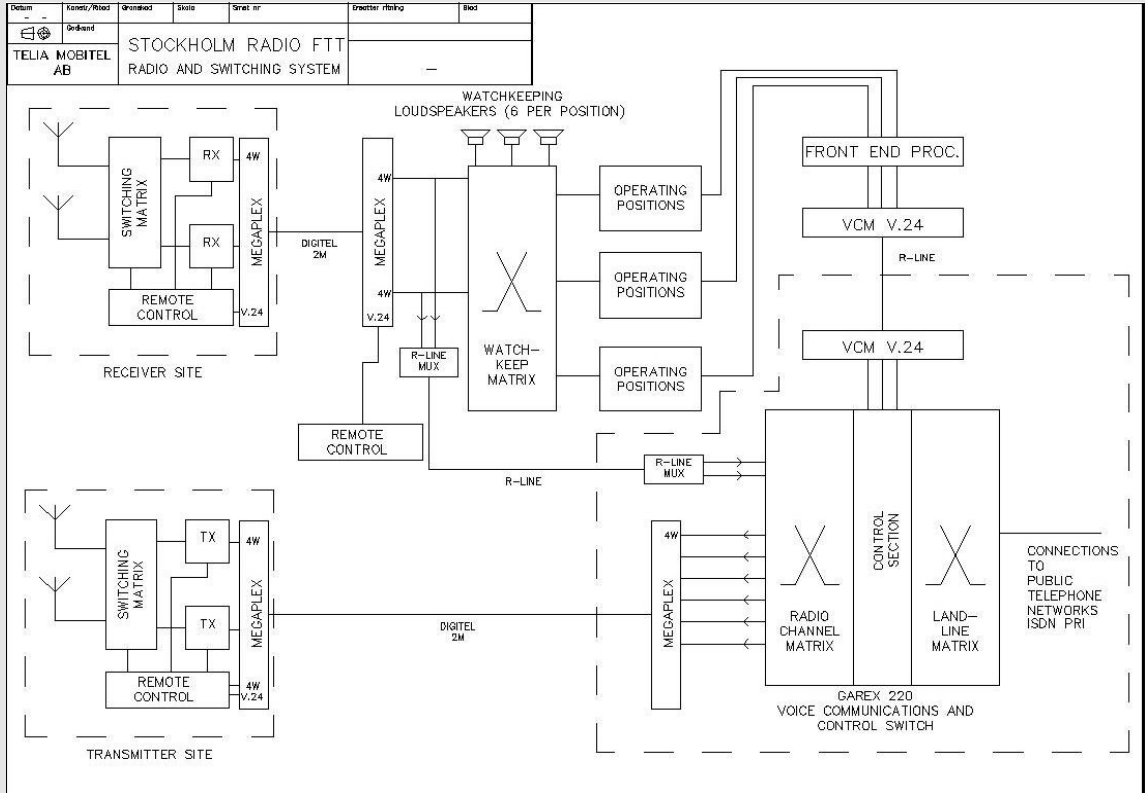


## **New system kernel and move in 1993**

- **Split-up of the company caused a move to new premises**
- **New generation of coast radio switching system purchased from Nerion A/S Norway**
- **Total reorganisation of network structure**
- **Moving operation in late 1993 without disrupting operations**
- **HF operator consoles were re-used in the new system**
- **Six 3 kW solid-state Collins transmitters purchased in 1996**



# Block diagram of the system







# Transmitter upgrade project





## Another move

- **Due to company restructuring, the operational centre moved again in 2001**
- **Both operational centre and switching system moved without disrupting operations (!)**
- **"Clouds at the horizon" regarding the receiver and transmitter sites together with other infrastructure**



# General purpose operating position

Reconfigurable for different system applications





# Transmitter site move in 2014





## **"Drama" in 2014**

- **Support for the switching system was announced to end**
- **A new in-house developed system was done in record time by one (1) software developer**
- **The transmitter site military owners did not renew the lease contract**
- **A new site had to be found, and the historic Grimeton site was available**
- **The moving operations were done in two installments, without disrupting traffic**



# Re-location to Grimeton

Trust-owned historic VLF and HF transmitter site and landmark  
Unesco World Heritage In operation since 1924





# New touch-screen based operating positions

## Position layout







# New touch-screen based operating positions

## Man-Machine Interface

The interface is displayed on a black background with white and green elements. At the top, there are navigation buttons: START, SETTINGS, MODULES, LOG, and EXIT. Below these are several control panels:

- Top Row:** A series of 10 vertical sliders, each with a green bar and a yellow/orange indicator. To the right are buttons for 'Mute' and 'Max RF Gain'.
- Frequency/Channel Row:** A row of buttons labeled with channel numbers and frequencies: 5 (5541), 8 (8930), 11 (11345), 13 (13342), 17 (17916), 3/23 (23210), E1 (13342), E2 (8930), E3 (11345), E4, E5, and GTN. Each button has a yellow/orange indicator and a small graph.
- Module Selection:** A grid of buttons for 'Tx' and 'Rc' (Transmit/Receive) for 'Module 4', 'Module 5', and 'Module 6'. The 'Radio' button for Module 4 is highlighted in green.
- Phone/Call Control:** A 'Phone' section with a 'Send' button and a 'Dial' button. The 'Send' button shows 'AB-CD' and the 'Dial' button shows '15551234567'.
- Group Selection:** A 'Group' section with buttons for G1 through G6, each with a frequency and a small red square icon.
- Antenna and Frequency Control:** A 'Tx Antenna' section with a 3x3 grid of buttons (1-9) and a yellow/orange indicator. To its right is a 'Tx Frequency' section with buttons for 3, 5, 8, 11, 13, 17, and 23.
- Mute Controls:** A 'Mute' section with two vertical sliders and 'Mute' buttons.





# Transmitter site 2014 - present



*Vy över sändarna under igångkörning.*



# "The times they are a'changing"

- **Competitors closed;  
Portishead, Berna, St. Lys, Speedbird**
- **Change in customer habits**
- **Generation change, younger aircrew have less HF understanding**
- **New aircraft usually have SATCOM installed**
- **Pandemic caused a huge blow to traffic volume**
- **Diversification with Flight Following and Crew Dispatch services have distributed the risks somewhat**
- **Perhaps the system will be around for some more years**



# Sources

- **75-year Anniversary book  
"Stockholm Radio 1914-1989"**
- **Conference presentations by myself,  
Rolf Folkesson SM5HP and Carl-Johan Mjöberg**
- **"Design Considerations in a Coast Radio System for  
the Next Decade" RTCM Annual Symposium 1993**
- **"Besuch bei Stockholm Radio/SDJ"  
Funkamateurl 9/2002**
- **Trade journal articles**
- **Oral tradition from past and present colleagues**
- **Own memories of using and integrating a large  
inventory of equipment into various system  
architectures**



**Thank you for your attention!**