Rai Centro Ricerche e Innovazione Tecnologica

Rai Way

RaiWay contribution and distribution network migrating towards NG-SDH

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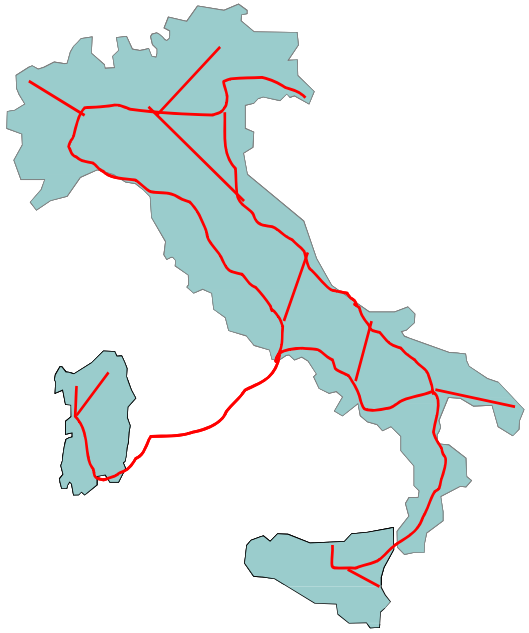
Rai contribution and distribution network
Topology and transported services

- The Rai transport network for audio/video contribution and distribution services (WayNet) is developed on the national territory and it is composed of
  - About 150 nodes
  - 5 main trunks
- Contribution services
  - 4 national Production Centres
  - 21 Regional Centres (regional news)
  - 60 insertion points (OB contribution)
- Distribution services
  - Analogue and DTT
  - To the main transmitting sites

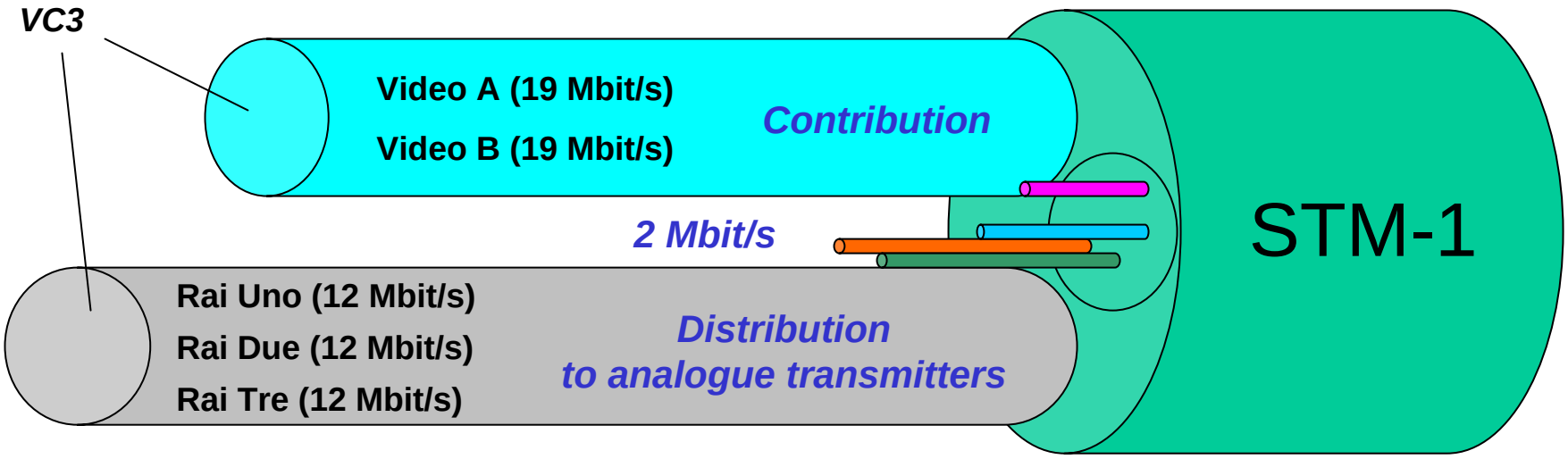


Network technology
Until yesterday

- SDH (Synchronous Digital Hierarchy) radio links
- Up to 3xSTM-1 (3x155 Mbit/s), carrying:
  - Up to 3 VC-3 containers (45 Mbit/s) for TV signals
    - 2 or 3 video signals multiplexed in a single MPEG-2 TS
  - Up to 21 VC-12 containers (2 Mbit/s) for audio and data streams
- Signal switching carried out by ADMs (Add-Drop Multiplexer) or DXCs (Digital Cross Connect)
  - At VC-3 or VC-12 level
  - Limitation in the network flexibility
    - Video signals carried in the same VC-3 cannot be routed independently

Rai contribution and distribution network

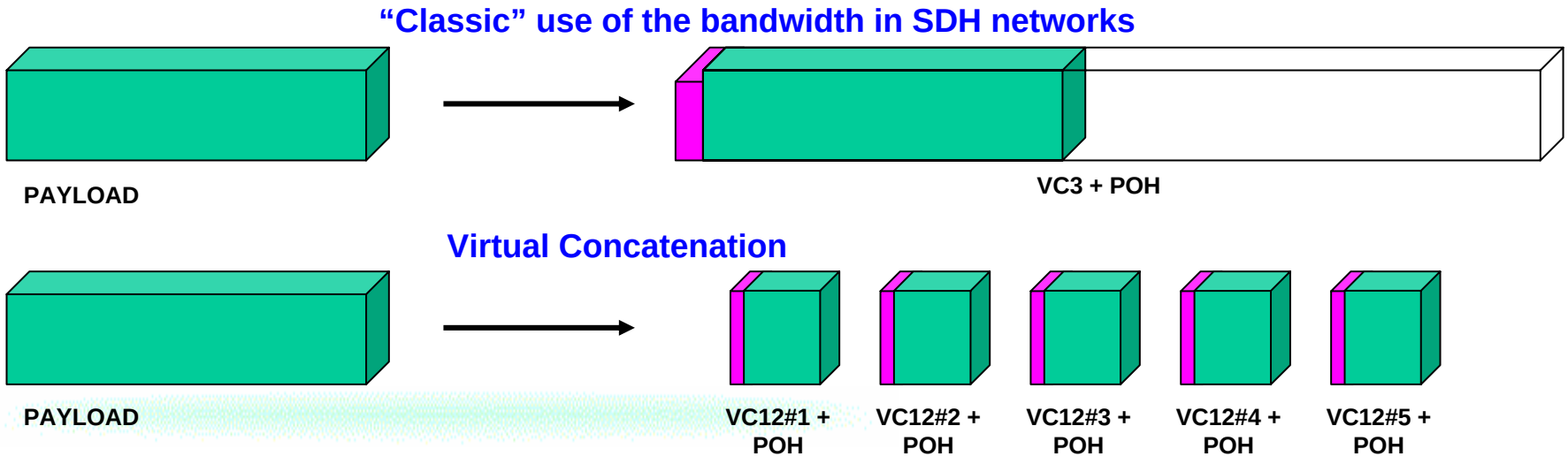
Capacity allocation using standard SDH



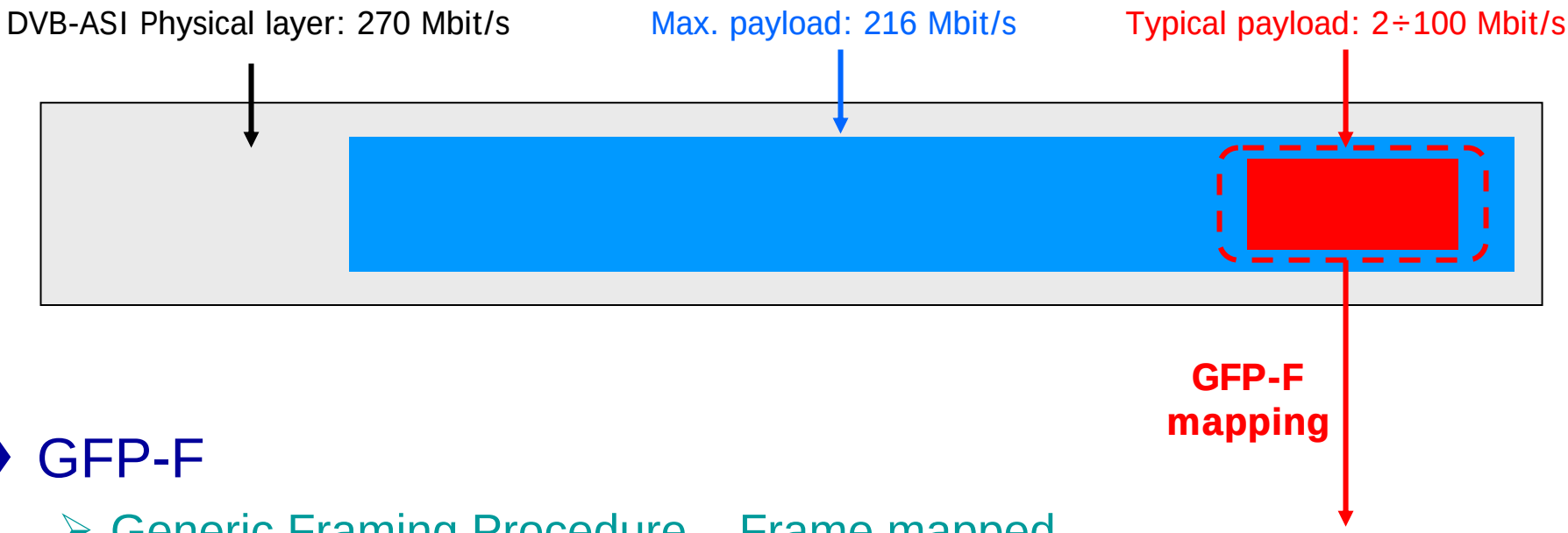
- Video A and Video B have to share source and destination
- A whole VC3 has to be dedicated to 2 Mbit/s circuits, if needed
- A whole VC3 has to be dedicated in case of DTT distribution

NG-SDH
Virtual Concatenation (VCAT)

- SDH was originally designed for the transport of PDH streams
  - Bit-rates of VCs fit to corresponding PDH signals
  - Granularity of VCs may not meet the needs of video and data transport
- With NG-SDH, the payload is mapped into NxVC12 virtually concatenated
  - ITU-T G.707
  - Service allocation with 2 Mbit/s granularity
    - Any bit-rate can be transported with minimum overhead
  - Better exploitation of the available SDH data rate



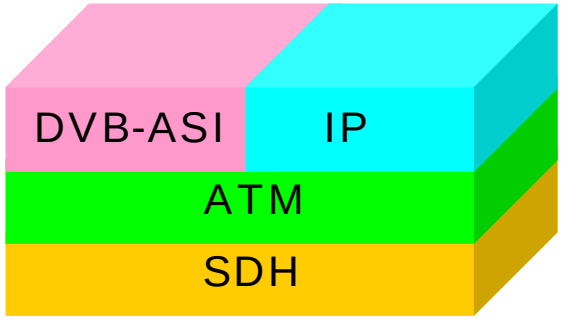
GFP-F mapping of DVB-ASI signals



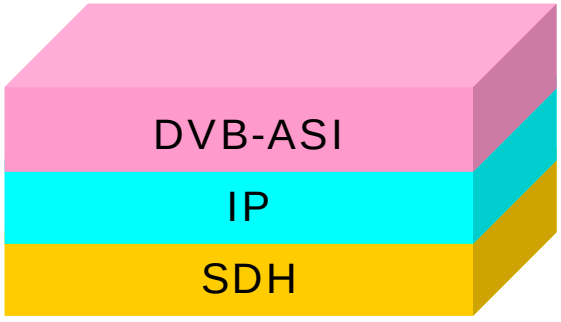
- GFP-F
  - Generic Framing Procedure – Frame mapped
- Only the useful part of the DVB-ASI signal is transported
  - The payload is mapped into NxVC-12-Xv streams (virtually concatenated)

Layer structure
with respect to other technologies

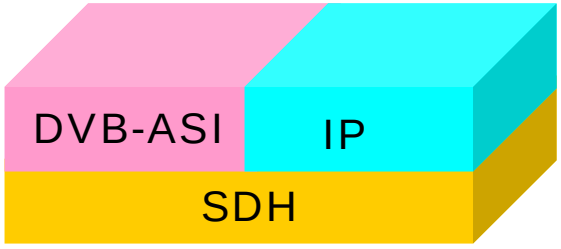
- Many networks use SDH as the lower layer
  - SDH provides reliability and quality of service
- On top of SDH, additional technologies can be used to allow more flexibility (i.e. ATM or IP)
  - Using NG-SDH only one layer is involved
    - Straightforward network management



ATM network



IP network



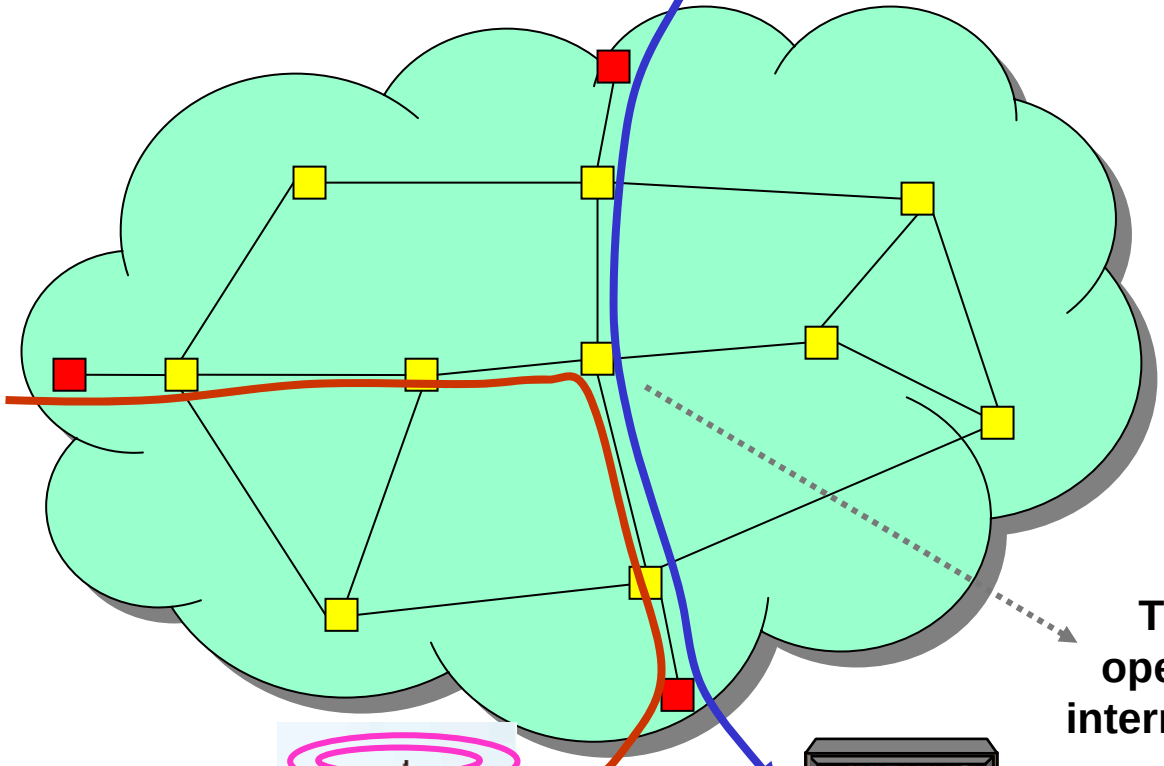
NG-SDH network

Main advantages of the NG-SDH solutions

- Easy and gradual upgrade from SDH networks
  - Changing only the terminal nodes and not the backbone
  - All SDH mechanisms are still available
- The network can be configured by a centralised Network Management System
  - Allowing for a strict control of the circuits and the occupied bandwidth
- Other services can be transported in the same network and with the same bandwidth efficiency
  - E.g. Ethernet links
- Low end-to-end delay and jitter
  - On the contrary, transport of video signals over IP networks introduces a higher latency
    - Delay due to the buffer at the receiving side, to compensate for network jitter
    - Tests on Rai Intranet showed that the minimum latency is about 40 ms for 20 Mbit/s streams
- Easy implementation of new networks
  - Easy implementation of the QoS

Evolution of an SDH network towards NG-SDH

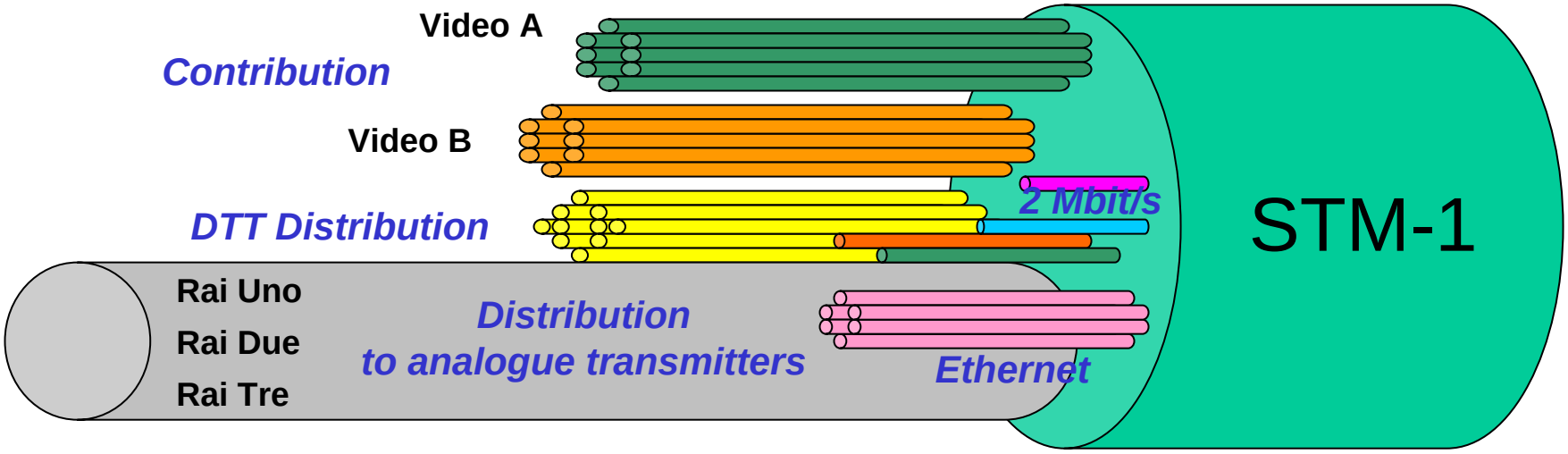
- **“Classical” ADMs**
- **ADMs with VCAT**



Transparent operation in the intermediate nodes

Rai contribution and distribution network

Possible capacity allocation using VCAT



- Video A and Video B can be routed independently
- DTT distribution and 2 Mbit/s streams use only the needed portion of the bandwidth
- Part of the bandwidth can be dedicated to IP (Ethernet)
- VC3 switching can still be used, if needed

Evolution in the services
carried by the network

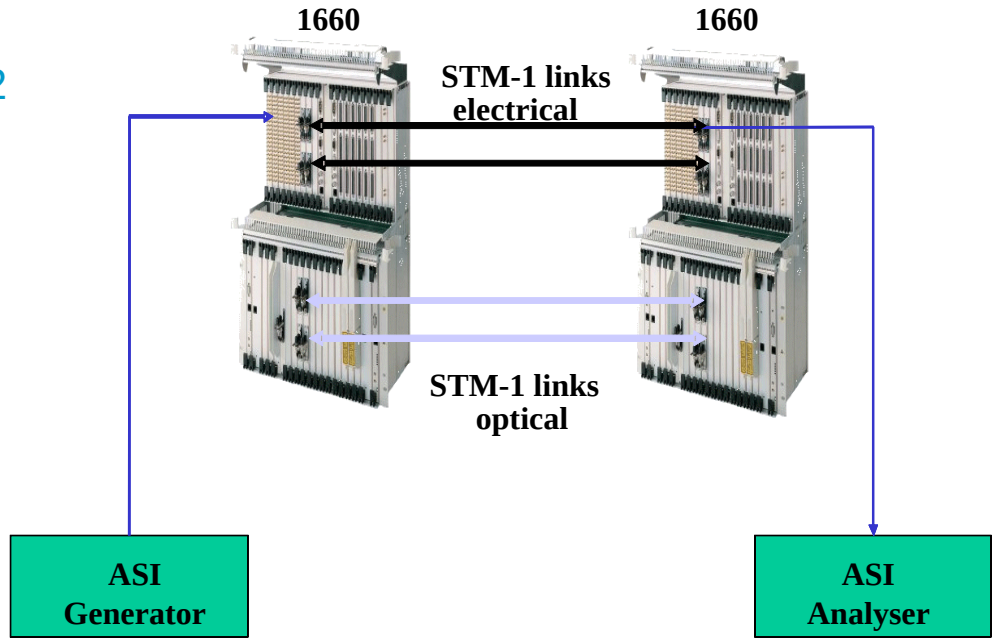
- Transport of DTT MUXes
  - Distribution of the regional bouquets from the Regional Centres to the main DTT transmitters (77 transmitters)
  - Distribution of the national bouquet from Rome to Aosta and Cagliari
- Gradual migration to video-file transfer
  - Increase of IP-based traffic in the future, for non real-time video-file transfer (server-to-server)
    - Accompanied by an increasing emphasis, in the production area, on server-based storage and file-based distribution of media
  - Likely reduction in the real-time video traffic
- Higher network flexibility will be required

NG-SDH solution
chosen for RaiWay network

- ADM Alcatel 1660SM
  - Belonging to OMSN family
  - Fully non-blocking matrix
    - Point-to-point and point-to-multipoint uni-directional and bi-directional cross connections
  - Can be equipped with a number of many kinds of traffic boards and access boards
    - E1, E3, DS3, STM-1
    - ATM, 10/100 / Gbit Ethernet
    - SDI (optical)
- ISA-ASI traffic board developed by Alcatel together with Rai / RaiWay
  - GFP-F mapping of ASI streams over VC12-Xv
  - Uni-directional cross-connections
  - 4 input + 4 output signals
  - Bit-rate up to 139 Mbit/s
  - Maximum total bit rate for each card 622 Mbit/s

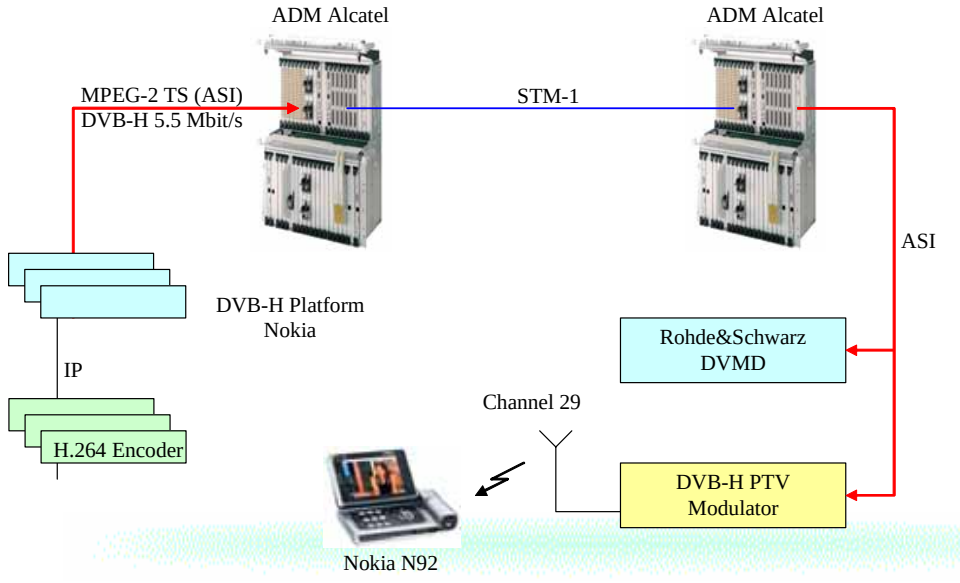
Laboratory validation
Performance of ASI transport

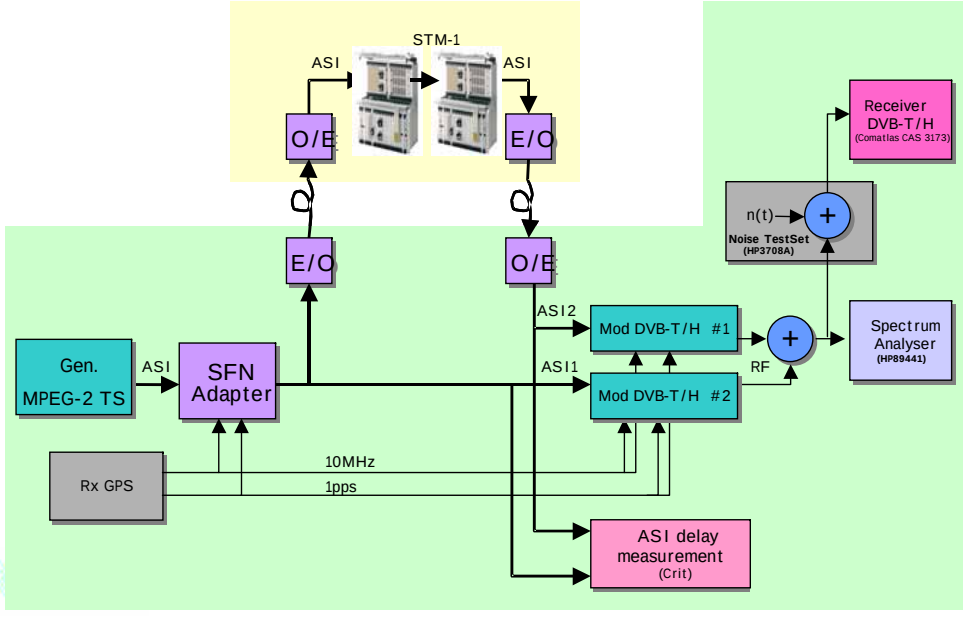
- Trials performed in Alcatel laboratories in Vimercate (Italy)
  - 188/204 byte ASI automatic acquisition
  - Maximum bit-rate at various concatenation rates
    - 25 Mbit/s in case of 12xVC12
  - Network delay
    - About 1.4 ms in case of 12xVC12
  - PCR jitter
    - About 30 ns PCR jitter in case of 12xVC12
  - Effects of BER (without FEC)
    - 1 Sync Byte Error in 1 minute with BER $8 \cdot 10^{-8}$
    - TS KO with BER $2 \cdot 10^{-5}$
  - Switching time to backup circuit
    - Within 200 ms



Laboratory validation
Test on services and applications

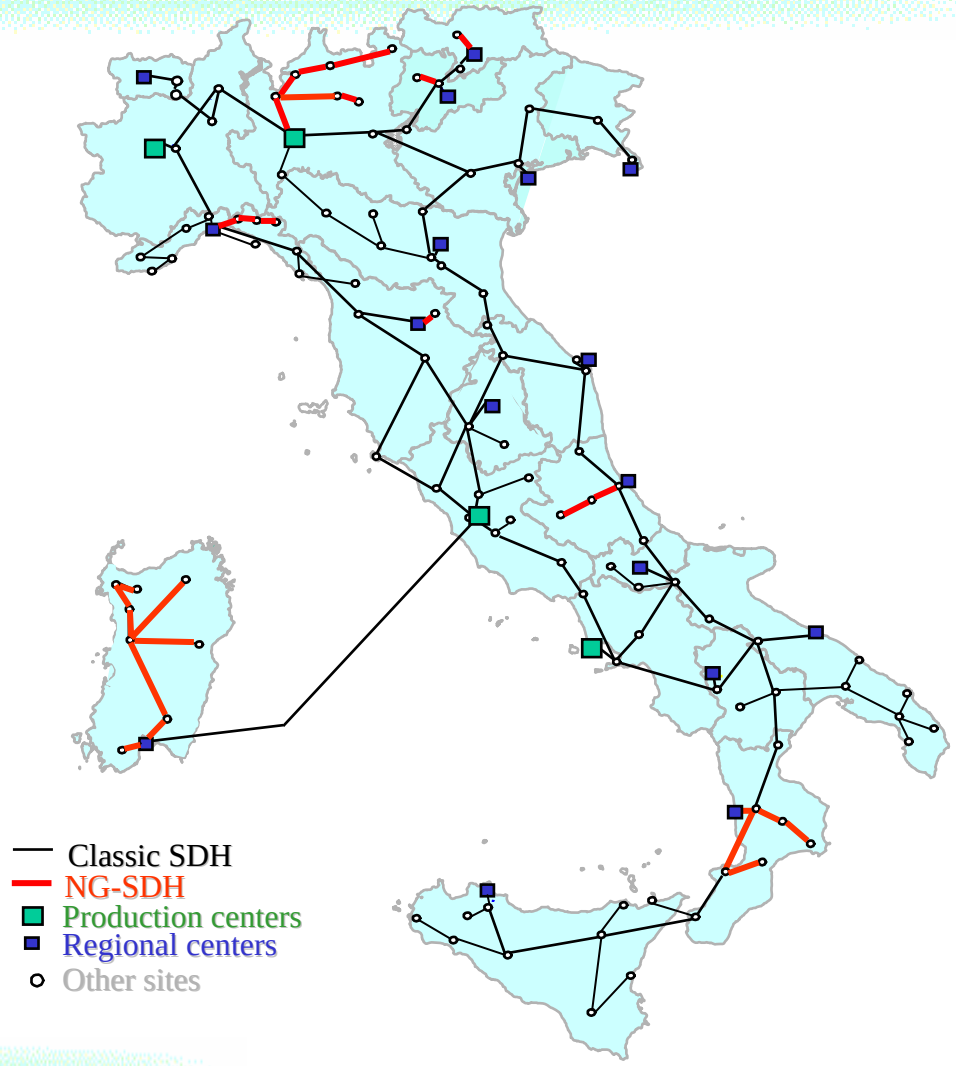
- Trials performed at Rai-CRIT
  - 3 nodes equipped with ISA-ASI, E3 and E1 boards
  - Activation of cross-connections activated via craft terminal
  - Transport of a DVB-H stream
  - Compliance with Single Frequency Network (SFN)
  - Long term measurements





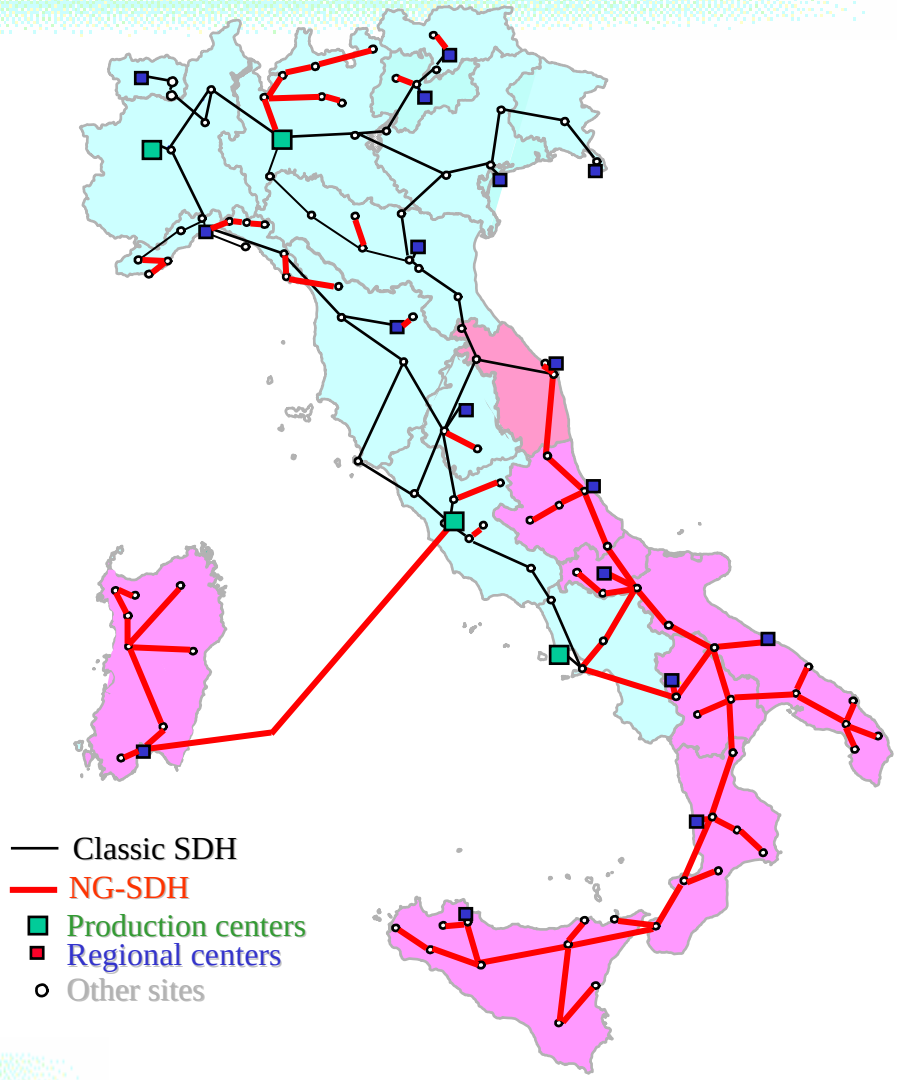
First operational NG-SDH links

- October 2006:
  - First operational link for DTT distribution (near Florence)
- November 2006:
  - Second operational link for DTT distribution (near Varese)
- Winter 2007:
  - Some DTT distribution services in NG-SDH
- May 2007:
  - Many DTT services in NG-SDH



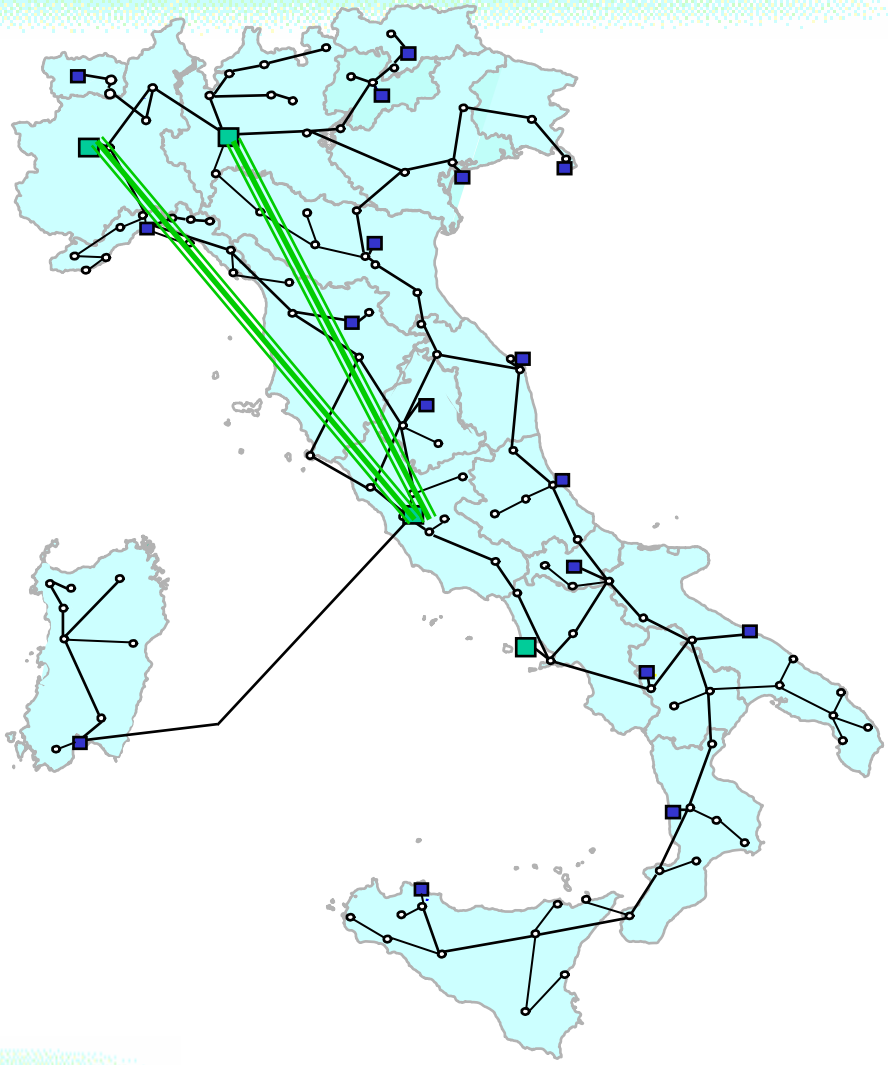
Migration plan towards NG-SDH

- June 2007
  - Sardinia: all contribution and DTT distribution services in NG-SDH
- July 2007
  - Sicily: all contribution and DTT distribution services in NG-SDH
- August 2007
  - All DTT services in NG-SDH
- December 2007
  - South Italy: all contribution and DTT distribution services in NG-SDH



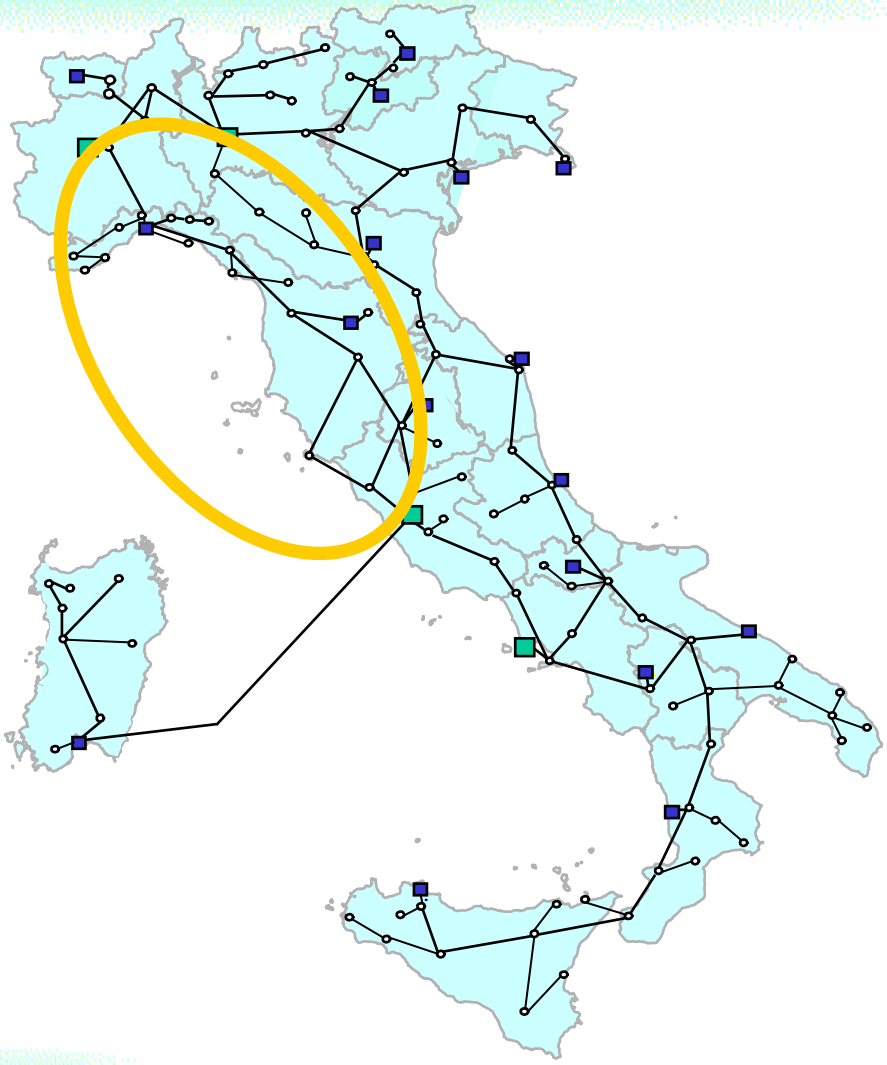
Ethernet connection

- Layer 2 connection (Ethernet)
  - Rome-Turin
  - Rome-Milan
- Interface:
  - Fast Ethernet / Gigabit Ethernet
  - Bit-rate ~50 Mb/s



Project under evaluation

- STM 16 ring among Rome, Milan and Turin
- Services:
  - Direct SDI transparent connection
  - GbE Ethernet connection for FTP or data Services
  - Integration of the traditional contribution network



Migration Plan: conclusion

- The network will gradually include NG-SDH links
  - Distribution of one DTT multiplex on a regional basis
  - Contribution streams
    - Contribution links in South Italy (by end of 2007)
    - Contribution links In the North-East (by end of 2008)
    - Contribution links In the North-West (by end of 2009)
  - New connections will be possibly established among main nodes to increase capacity
    - Including also SDI and Ethernet connections
- Integration of NG-SDH links in the existing Intelligent Network Management System
  - DVB-ASI connections available from March 2007
  - Ethernet connections available by end of July 2007

Conclusions

- RaiWay digital contribution and distribution network is migrating from a traditional SDH technology to NG-SDH
  - Alternative solution to ATM, IP, DTM, providing the same flexibility
  - Easy and gradual evolution from the existing SDH network
    - Only the terminal nodes have to be replaced
    - The existing trunk ADMs are transparent
  - Bandwidth can be shared with new services (e.g. IP streams)
  - Easy way to implement quality of services
- The solution was validated by laboratory tests and field trials
  - Reliable transmission
  - Point-to-point and point-to multipoint circuits
  - Low end-to-end delay and jitter
- The first NG-SDH links are already operational