INTERNATIONAL TELECOMMUNICATION UNION
Telecommunications Development Bureau (BDT)

Network Planning Strategy for Evolving Network Architectures

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Signalling Network Planning and Design

4.6

COMPUTER AIDED PLANNING AND DIMENSIONING OF THE SIGNALLING NETWORK

Main tasks of Signalling Network Planning:

- Determination/optimization of the Signalling Network Structure
- Determination of an optimised design of the routing data of each signalling point (Routing of Signalling Traffic)
- Dimensioning of the signalling link Set under consideration of network failures (failed route sets and Signalling points)
- Determination of Signalling Network Performance

COMPUTER AIDED PLANNING AND DIMENSIONING OF THE SIGNALLING NETWORK

•For Signalling Networks with more than 10 SP's/STP's the planning and dimensioning tasks can only be reasonably achieved by using computer aided planning and dimensioning

•Therefore a tool is required by means of which an optimized Signalling Network Planning can be realized by iterative steps

•Major Benefits

- Stability and efficiency of signalling networks
- Respect to routing and dimensioning
- Solving the problematic of complexity of the CCSS7 routing tables.

COMPUTER AIDED PLANNING AND DIMENSIONING OF THE SIGNALLING NETWORKS

Example of Planning Tool may fulfill the following requirements:

- Hardware:
- Powerful PC or Work Station
- Color screen
- Key board and mouse input
- Simple printer and graphic printer or plotter

COMPUTER AIDED PLANNING AND DIMENSIONING OF THE SIGNALLING NETWORK

-Software:

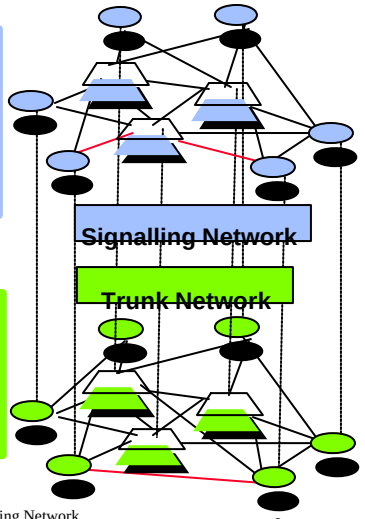
- SW-platform independent on operating system
- object-oriented programming for reuse of codes, simple extensions, easy generation of program variants, easy to maintain, enhanced SW reliability
- Desktop similar to standard (e.g. XWINDOWS)
- Handling language English

Signalling and Trunk Networks

- **Packet**-switched **queuing** system
- Alternate route for CCSS7 **link failure** (changeover/changeback)
- **Transient** and **partial** Signalling Link occupation only during the **signalling events** (e.g. Call Setup, Release)

Different routing in signalling and trunk network

- **Circuit**-switched **loss** system
- Alternate routes for **trunk group blocking** (overflow)
- **Permanent** circuit occupation during the **call holding time**



Concepts and Advantages of CCSS7

- Signalling channel and the associated signalling equipment is time-shared between many speech channels
  - ↳ more efficient signalling
- Datagram mode of operation (like packet-switching) and layered design of CCSS7 protocol
  - ↳ faster, more reliable and more flexible for new applications (e.g. IN services)
- Logical and possibly physical separation between signalling and trunk network
  - ↳ more flexible since signalling network independent from existing trunk network hierarchy

Benefits of CCSS7 Signalling

- Big variety of messages
- High flexibility referring to new services (ISDN, IN, Mobile GSM)
- Secured transmission of signalling messages
- One CCSS7 channel replaces about 80 CAS* channels
- Economical savings referring to channel costs (1/30 = 3%, 16th channel in PCM30)

↳ CCSS7 - a cost-effective, adequate signalling method for modern and future digital networks

* CAS = Channel Associated Signalling

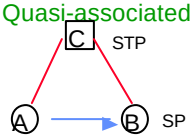
Signalling Operating Modes

Associated mode

Signalling relation
e.g . for speech channels

Signalling link

Quasi-associated mode

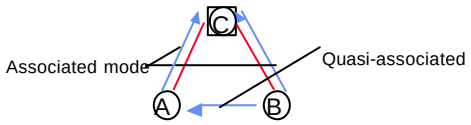


- equal utilization of network
- higher reliability
- smaller end-to-end delay

- more economical for low loaded links
- simpler administration
- simpler for planning

As a consequence there may be given a load-threshold for the decision on the signalling mode for an individual link set which leads to:

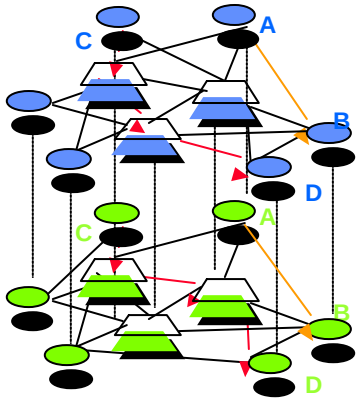
Mixed mode



Routing in Signalling and Trunk Network

Signalling Network

Trunk Network



CCSS7 Operating Mode:

Associated for A → B

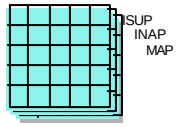
Quasi-associated for C → D

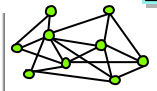
The path used by the Signalling Messages may be different from the path in the trunk network, because *signalling and trunk network are logically independent!*

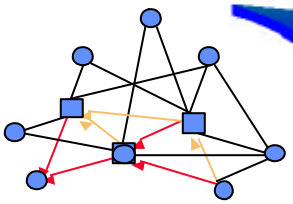
Planning tasks

Definition of user requirements

- Signalling services (application parts) to be provided by the Signalling Network
- Signalling load defined by traffic model and volume per signalling service
- Possible network topology
- Reliability and delay requirements







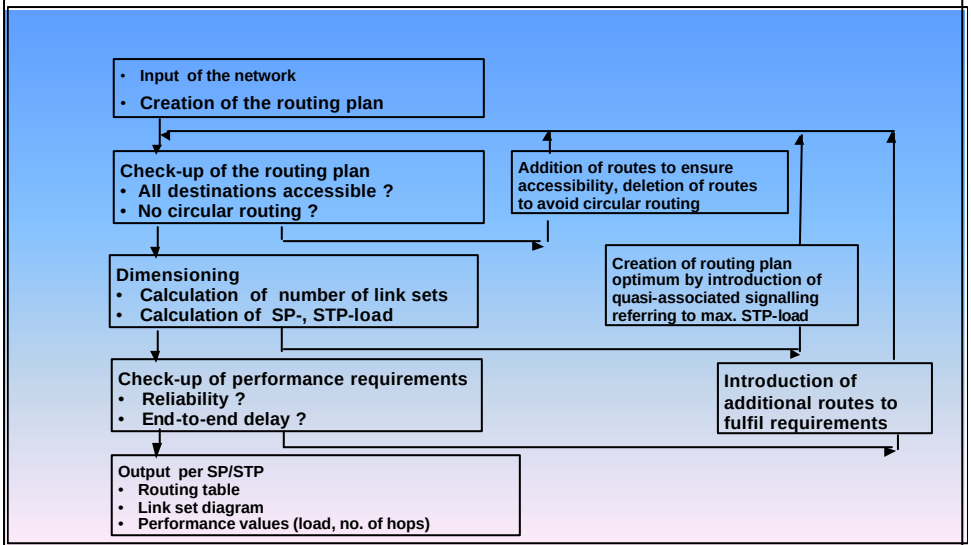
Signalling network planning issues

- Topology & Structure (e.g. no. & location of STPs)
- Signalling Routing Tables
- Dimensioning of Signalling Link Sets
- Calculation of load (link & node)
- Reliability & End to End Signalling delay

CCSS7 Planning Issues

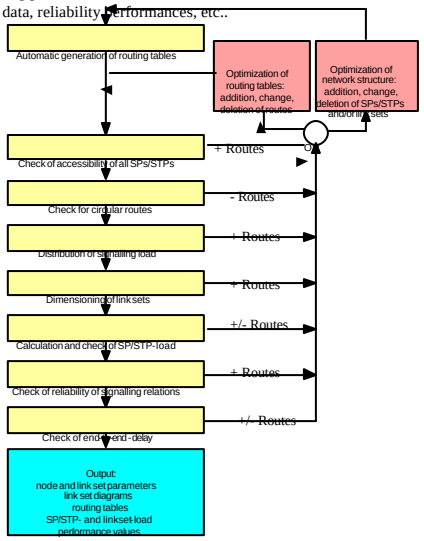
- Determination of target network structure: number and location of STP
- Comparison of several alternative solutions
- Iterative optimisation of the final configuration acc. to criteria referring to security, technical constraints, costs etc.
- Definition of intermediate extension stages and transition strategy
- Generation of routing tables (free from circular routing)
- Definition of appropriate planning parameters , e.g. operating mode threshold, planned load per link, per node etc
- Investigation of failure scenarios (sensitivity analysis)
- Generation of planning results (routing tables, link set diagram)

Signalling Network Planning and Optimization Process (Overview)



PLANNING PROCESS OF SIGNALLING NETWORKS

INPUT: Numbering plan, data structure of host Network, traffic data, reliability performances, etc..



Computer Aided Signalling Network Planning

- **Advantages**
  - Software takes over **time** consuming work (calculations etc.)
  - Fast and easy comparison of scenarios
  - Cost-effective design possibilities
- **Targets of *Computer Aided CCSS7***
  - Quick set up of new planning projects (network structure) changes and extensions, especially if network size > 10 nodes
  - Support for route set creation process (**circular routing**)
  - Use in network management centers
  - Purchase to network operators

Characteristics of Signalling Planning tools

Sophisticated algorithms for

- defining precise amounts of equipment (TS)
- providing assistance in planning of CCSS7 networks

by means of

- Consideration of common characteristics of CCSS7 systems
- Representation of one MTP network with nodes able to serve as SP or integrated SP/STP or exclusive STP
- Allowance for several users (services, e.g. ISUP, IN) with individually related demand and traffic model
- Graphical user interface for network representation
- Intuitive, menu-driven handling
- Iterative activation of functions possible

Input Data of Planning Tool-CCSS7

- Global network parameters (e.g. several numbering structures)
- Modelling of Network elements
  - Signalling points (SP) with/without integrated transfer functionality (SP/STP) and stand-alone (STP)
  - Service matrices with corresponding individual traffic model to define the traffic demand (superposition of several services possible):
    - **Call - matrix (Call/s)**
    - **BHCA - matrix (busy hour call attempts)**
    - **MSU - matrix (MSU/s)**
    - **Trunk group matrix (Number of trunks)**
    - **Traffic value matrix (Erl carried)**
  - Routing table of the signalling points (optional, manual)
  - Trunk groups as actual or potential link sets
- Topology (nodes, link sets)
  - create, select, move, delete, etc.

Signalling Traffic Sources and Modelling

- Signalling of telephony network (ISUP) given as
  - trunk matrix with traffic values
  - trunk matrix with number of trunks (average utilisation)
- Signalling of other services (e.g. IN) given as
  - call matrix
  - BHCA matrix
  - MSU matrix

Traffic model in each case making allowance for:

- MSU length
- percentage of effective (answered) calls (ASR) *
- mean holding time *
- MSU per effective/ineffective call in forward/backward direction *

* where applicable

Routing Functions

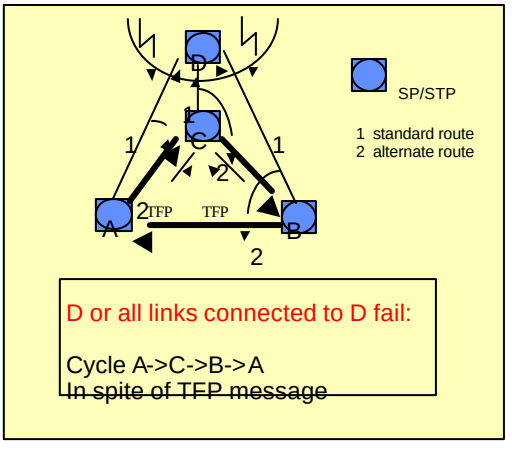
- Automatic creation of route sets (standard and alternate routes)
  - Options: generation for all or only for marked route sets
    load sharing between routes of equal (hop) length
  - Algorithm: search for shortest path routes
  - Route search restrictions: consideration of homing definitions (in quasi-associated operating mode)
- Import of already existing/implemented routing data
- Check of circular routing
- Check of full accessibility of nodes
- Allowance for maximum number of hops per relation
- Visualisation of route sets (different colours for normal and alternate routes)

Circular Routing: - Loops of Signalling messages

- CCSS7-protocol does not provide any information about code and number of transit-nodes (STPs) which have been already passed.
- CCSS7-routing tables are independent of the origin of a signalling relation.

>> Risk of circular routing! <<

The generation of appropriate routing tables without signalling-message cycling is one of the main tasks of a Signalling Planning Tool



Automatic Creation of Routing Tables

Possible Methods

- **"non-hierarchical"** (shortest path routing)
- **"hierarchical"** (hierarchical multi-plane-routing
- **"enhanced hierarchical"** (shell-routing)

Load Distribution and Dimensioning of Link Sets

- Load distribution due to entries in the route sets (standard routes) and to signalling traffic (service matrices)
- Calculation of total relative load of each node (SP- and STP-function processing performance)
- Dimensioning of link sets with allowance for
  - planned load per link, e.g. 0.2 Erl
  - minimum and maximum no. of links per link set
  - given (fixed) or existing (already installed) number of links
  - threshold for switchover associated/quasi-associated operating mode

Performance Criteria: Reliability and Delay

- **Reliability**

  Calculation of the reliability of each signalling relation with the planning tool via
  - the reliability values of nodes (SP/STP) and links
  - the current routing plan
- **Delay**

  A precise calculation per signalling relation requires
  - the calculation of delay of signalling links (see ITU-T Q.706)
  - knowledge of processing times in SP/STP (perhaps of different providers)

  ITU-T recommendation E.721 only contains **target values** of maximum number of passed network elements (nodes, links)

Presentation of Results

- **On the screen**
  - Coloured presentation of load situation
  - Precise load values per
    - » SP/STP (MSU/s, Byte/s sent and received) Link Set (MSU/s, Byte/s forward and backward direction)
  - Statistical overview of mean, minimum and maximum values
- **On the paper or in a file**
  - Protocol of input data
  - Link set diagrams
  - Graphical plot of network
  - Statistical data