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.

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
  \((1/30 = 3\%, 16\text{th channel in PCM30})\)

\(\text{CCSS7 - a cost-effective, adequate signalling method for modern and future digital networks}\)

* CAS = Channel Associated Signalling
**Signalling Operating Modes**

Associated mode

- Signalling relation: e.g., for speech channels
- Signalling link

Quasi-associated mode

- STP
- SP

**Mixed mode**

- Associated mode
- Quasi-associated

**Equal utilization of network**

- **More economical for low loaded links**
- **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:

**Routing in Signalling and Trunk Network**

CCS7 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)

- Input of the network
- Creation of the routing plan

Check-up of the routing plan
- All destinations accessible?
- No circular routing?

Addition of routes to ensure accessibility, deletion of routes to avoid circular routing

Dimensioning
- Calculation of number of link sets
- Calculation of SP-, STP-load

Creation of routing plan optimum by introduction of quasi-associated signalling referring to max. STP-load

Check-up of performance requirements
- Reliability?
- End-to-end delay?

Introduction of additional routes to fulfill requirements

Output per SP/STP
- Routing table
- Link set diagram
- Performance values (load, no. of hops)

PLANNING PROCESS OF SIGNALLING NETWORKS

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

Automatic generation of routing tables
Check of accessibility of all SPs/STPs
Check for circular routes
Distribution of signalling load
Dimensioning of link sets
Calculation and check of SP/STP-load
Check of reliability of signalling relations
Check of end-to-end-delay

Output:
- node and link set parameters
- link set diagrams
- routing tables
- SP/STP- and linkset-load
- performance values

Optimization of routing tables:
addition, change, deletion of routes

Optimization of network structure:
addition, change, deletion of SPs/STPs and/or link sets

+ Routes
- Routes
+ Routes
+/- Routes
+ Routes
+/- Routes

Bangkok, 11-15 November 2002
Seminar on Network Planning for Evolving Network Architectures, 4.6 - Riccardo Passerini, ITU-BDT
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.

D or all links connected to D fail:
Cycle A->C->B->A
In spite of TFP message
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