TEKNILLINEN KORKEAKOULU
Tietoverkkolaboratorio

Lic.(Tech.) Marko Luoma (1/16)

S-38.3192 Verkkopalvelujen tuotanto

S-38.3192 Network Service Provisioning

Lecture 1: Network design principles

TEKNILLINEN KORKEAKOULU
Tietoverkkolaboratorio

Lic.(Tech.) Marko Luoma (2/16)

General Course Matter

- Schedule
  - Lectures thursdays 9-11 and 12-14
    - Not next week
  - Exercises fridays 12-14
    - Not this week
- Theme
  - Service provider business
    - From business goals to technical implementations
      - Focus on how big networks are designed and operated

TEKNILLINEN KORKEAKOULU
Tietoverkkolaboratorio

Lic.(Tech.) Marko Luoma (3/16)

General Course Matter

- Exercise
  - Design and verification (simulation) with ITGuru simulator
    - Provider network generalization
      - Topology
      - Technology
      - Routing
- Grading
  - Both exercise and exam needs to be passed
  - Course grade weighted combination of both grades
    - 40% exercise and 60% exam

TEKNILLINEN KORKEAKOULU
Tietoverkkolaboratorio

Lic.(Tech.) Marko Luoma (4/16)

Network Design Cycle

- **Business Analysis**
- **Demand Analysis**
- **Technology Selection**
- **Topology Design**
- **Dimensioning**
- **Construction**
- **Commissioning**
- **Deployment**
- **Auditing**

TEKNILLINEN KORKEAKOULU
Tietoverkkolaboratorio

Lic.(Tech.) Marko Luoma (5/16)

Business Analysis

- What is the network build for
- What is the revenue logic
- How secure is the revenue
- What is the estimated capex for the network
- How much opex is bound to the network (and services)
- How long is the depreciation time
- What will be life span for the network
- What will be the effect of investement to the ebit level
- What is the value of network investement to company value and/or strategy

TEKNILLINEN KORKEAKOULU
Tietoverkkolaboratorio

Lic.(Tech.) Marko Luoma (6/16)

Demand Analysis

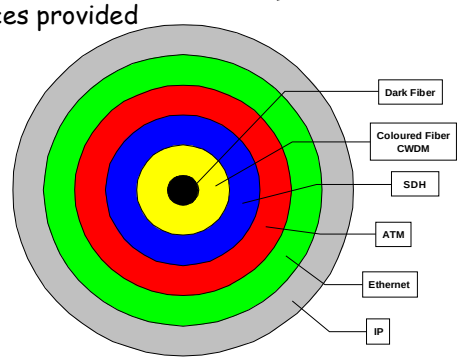
- For who and for what is the network build
  - Who are served by the network
  - What are the services provided by the network
  - Where are the users located
  - How are users connected to the network
  - What are the connections to other networks
- What are the hypotheses for the usage
  - How much traffic is going to be delivered over the network
  - How many users are to be serviced
  - What is the required grade of service
  - What is the demanded resiliency

TEKNILLINEN KORKEAKOULU
Tietoverkkolaboratorio

Lic.(Tech.) Marko Luoma (7/16)

Technology Selection

- What are the most suitable technology to satisfy demand
  - From which layer are the services provided
    - IP, MPLS, L2, L1
  - Core technologies
    - Ethernet, ATM, SDH, RPR
  - Access tehcnologies
    - Ethernet, DSL, CaTV, PLC



TEKNILLINEN KORKEAKOULU
Tietoverkkolaboratorio

Lic.(Tech.) Marko Luoma (8/16)

Topology Design

1. Define minimal design to connect all customers
2. Define the required connectivity level to achieve required resiliency level
3. Add required amount of loops to create defined connectivity level

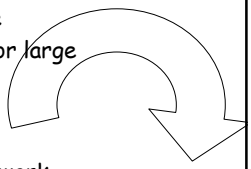
- **Physical topology**
  - Transmission links
    - Resiliency build upon different physical connections
- **Logical topology**
  - Transport tunnels
    - Resiliency build upon different logical connections

TEKNILLINEN KORKEAKOULU
Tietoverkkolaboratorio

Lic.(Tech.) Marko Luoma (9/16)

Dimensioning

- Calculate offered load level for each link on the network
  - Take into account different routing behaviors
    - Distribution of traffic within the network depends on
      - Location of information sources and sinks
      - Routing topology during particular time
  - Error margins for these calculations are usually very large
    - There is no sophisticated queueing analysis methods for large networks and variable demands
    - Coarse approximations
- Select link capacity that fulfils the dimensioning goal
  - What will be acceptable overbooking ration within the network
    - Indirect influence to potential availability figure

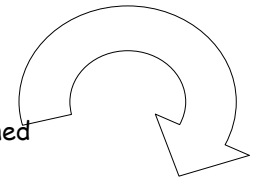


TEKNILLINEN KORKEAKOULU
Tietoverkkolaboratorio

Lic.(Tech.) Marko Luoma (10/16)

Addressing

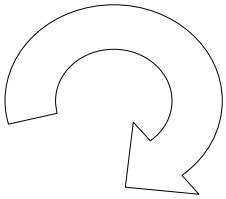
- There are several **naming conventions** that need to be decided
  - Identitities: AD, SIP, ENUM
  - Canonical names: DNS, WINS
  - Network addressing: routing addresses, link addresses
  - Access point addresses: customer access networks
  - Customer addresses: end user addresses
  - Translations: NAT, ENUM
- Overall **subnetting and naming** needs to be well designed



TEKNILLINEN KORKEAKOULU
Tietoverkkolaboratorio
Lic.(Tech.) Marko Luoma (11/16)

Security

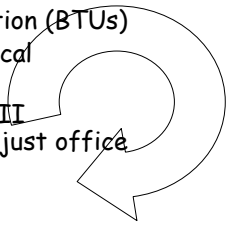
- **How is the network secured** from
  - Unintentional DoS attacks
  - Malicious traffic
  - False customer routing configurations
  - Unvanted traffic
  - Overload situations
- Access control lists / Firewall filters / **Routing policies**
- Traffic monitoring / **Traffic policing** / QoS control
- Syslog monitoring



TEKNILLINEN KORKEAKOULU
Tietoverkkolaboratorio
Lic.(Tech.) Marko Luoma (12/16)

Construction

- Aquire neccessary transmission infrastructure
  - Dark / colored fibers
  - Framed transmission connections
- Measure each and every link separately
  - Joints and weldings of fibers
  - Electrical characteristics of copper cablings
  - Properties of transmission paths
- **Take into account environmental issues**
  - Power consumption
    - Backup energy source
  - Cooling
    - Heat dissipation (BTUs)
  - Electro/magnetical protection
    - Is network CII classified or just office network ;-)

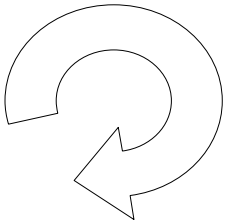


TEKNILLINEN KORKEAKOULU
Tietoverkkolaboratorio

Lic.(Tech.) Marko Luoma (13/16)

Construction

- Configure each device protocol per protocol and test
  - There are several causalities between protocols
    - It is good to test them separately
- Make some form of version control
  - It is good to know what you have changed and when

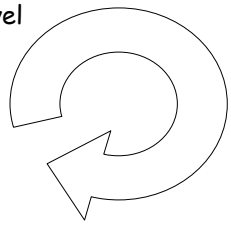


TEKNILLINEN KORKEAKOULU
Tietoverkkolaboratorio

Lic.(Tech.) Marko Luoma (14/16)

Comissioning

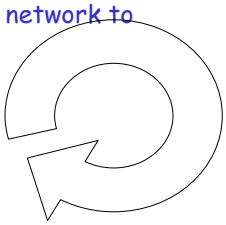
- **Is the final testing before ramping up the real services**
  - Define the operational area where network services are usable
    - Resiliency and grade of service levels are met
  - Usually reguires huge amount of iterations between
    - Protocol configurations and different service level parameters
- Pilot the network with real services
  - To see if they work the way you want



TEKNILLINEN KORKEAKOULU
Tietoverkkolaboratorio
Lic.(Tech.) Marko Luoma (15/16)

Deployment

- **Ramp-up services and customers slowly to see how network operates**
  - Also this phase is good to learn and teach operative personel about tricks and corners of the new network
- Worst case scenario is the overnight roll-over from old network to a new
  - Uncontrolled load increase
  - Uncontrolled routing behavior
    - New customers are added frequently



TEKNILLINEN KORKEAKOULU
Tietoverkkolaboratorio
Lic.(Tech.) Marko Luoma (16/16)

Auditing

- **Continuous auditing guarantees that traffic estimate and network are walking hand in hand**
  - New traffic estimate is fed into network design process to produce new dimensioning (and based on the new capacity values also construction and comissioning)
- Auditing is also important for the customers satisfaction
  - Delivered service is within Service Level Agreement