# Path Design for Traffic Engineering and Protection

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# DEMO Evolution

- **Path Design without Protection**
  - Routing (SP, CSP, Global Optimization using K-shortest paths)
- **Path Design with Protection**
  - Routing (DCSPP, KDCSPP)
  - Protection modes (No Protection, Dedicated Protection, Shared Protection and Shared Protection on Mesh)
- **Joint Network design and Path routing**
  - Use Spare capacity first and, if needed, add additional capacity in an optimum way
- **Network Design**
  - Greenfield design

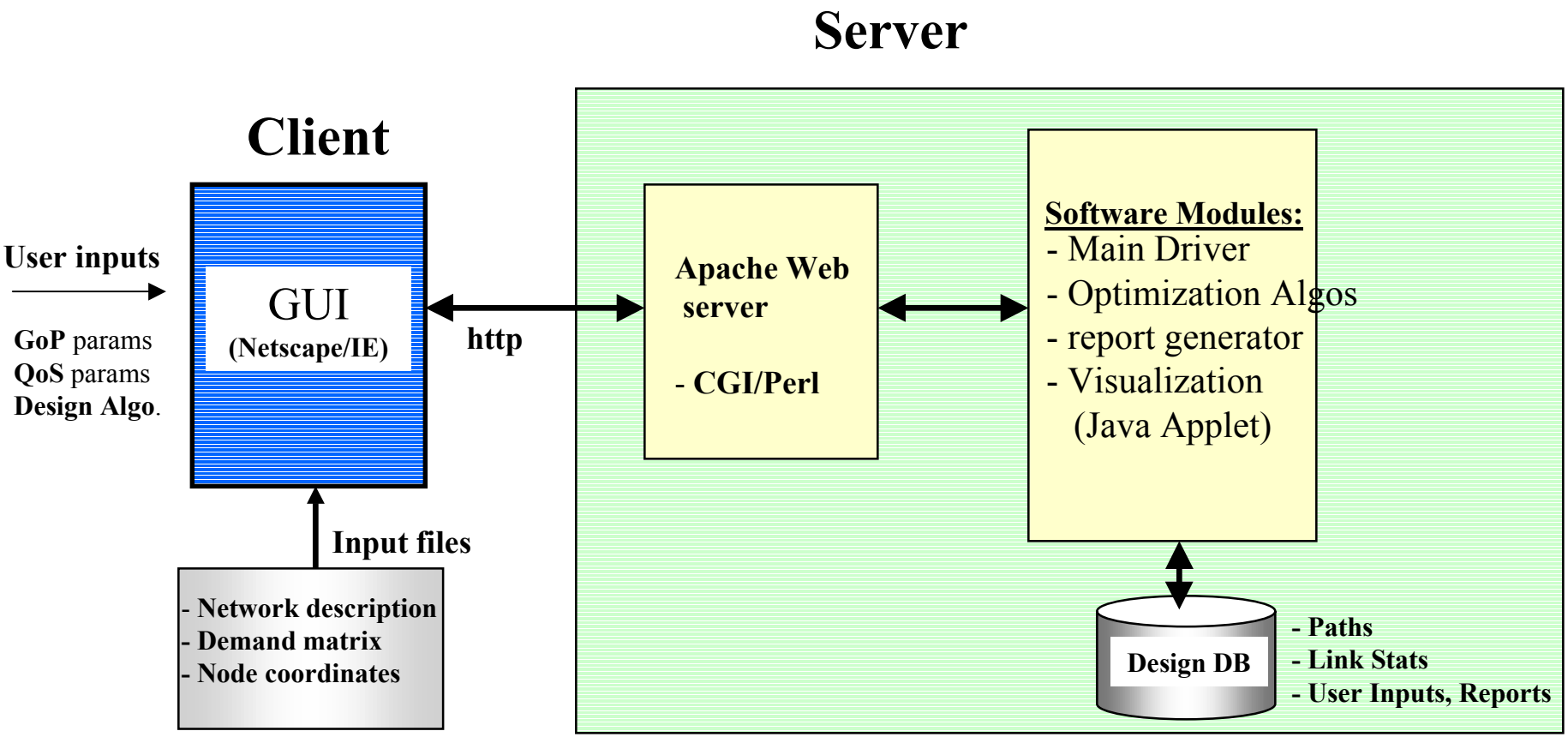
# DEMO Evolution

- Objective: A web-based path design tool for the demo.
- Overview of the system
  - Architecture
  - Software modules
  - Input data,Outputs
  - Visualization of paths



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# Software Architecture




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# Software Modules

- **GUI (Perl, Java):**
  - •Allows Users to input
    - -network topology and resources description (files)
    - -demand matrix, GoP parameters, QoS parameters, design algo. selection
  - •Visualization of results/network
    - -Paths, Link statistics, summary statistics and user inputs
    - -Network topology, load on each links, routes of paths
- **Plug-able Algorithms (implemented in C, CPLEX)**
  - •Unprotected design (SP and CSP, Global Optimization)
  - •Dedicated protection design (1+1 protection)
  - •Shared protection design (1:N and Shared mesh protection)
- **Pre-processing of input data for cleaning and validation (Perl, C)**
- **Post-processing to interpret and generate various statistics and reports (Perl,C)**



# Outputs

## Reports generated:

- Path table: set of all routed (primary and backup) Paths are listed for each source-destination node pairs.

| Path | Source - Dest. | Bandwidth | Explicit Path | | |
|---|---|---|---|---|---|
| Primary | WashingtonDC - SanDiago | 20GB | WashingtonDC, SanDiago | | |
| Protection | WashingtonDC - SanDiago | 20GB | WashingtonDC,Houston,KansasCity,Denver,SanDiago | | |

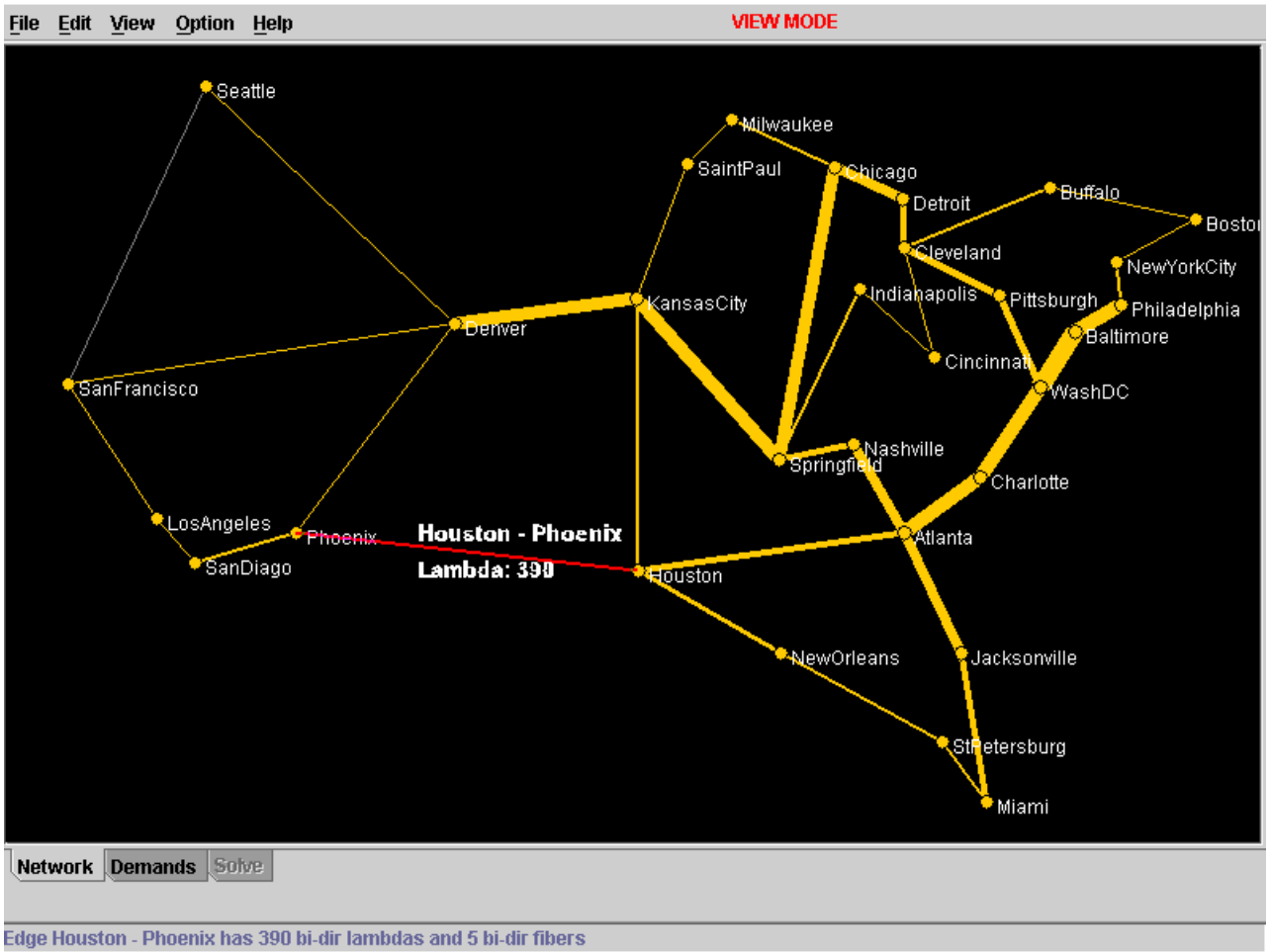
- Link Usage table: gives a summary of Paths along each link in the network.

| Link | Tot. Bandwidth | Used | Primary Path | Protection Path |
|---|---|---|---|---|
| WashingtonDC - New York | 20GB | 10GB | 10 | 5 |

- Summary statistics : aggregate bandwidth utilization, hotspots, etc.

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# Visualization of Paths




**A Generic US Network:**

**30 Nodes**

**38 Links**

**435 Demands**

**each 1-79 λs**

**average ~8 λs**

**3495 λs in total**

**4.3 Average hops per primary path**

**11.9 Average per primary + protection path**

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# Challenges and Solutions

- **Design parameters:**
  - **Priority classes (Expedited Forwarding, Assured Forwarding, Best Effort; Iterative design approach)**
  - **Routing choices (SP, CSP, KSP, DCSPP, KDCSPP)**
  - **QoS (e.g.,in terms of hop counts, effective bandwidth)**
  - **Protection modes (No protection, dedicated protection, Shared protection)**
- **Implementation :**
  - **Path generation:**
    - **SP, KCSP (Surrabelle-Tarjan) , KSP (modified Eppstien's algorithm) and KCSDPP (A*Prune, Bell Labs).**
  - **Optimization Algorithms**
    - **Homegrown algorithms to address different protection objectives**
  - **Demand matrix**
- **Scalability of design algorithms for larger networks**