AriaNetworks
Virtualize. Optimize. Monetize.

Solving “real world” problems using software defined business driven objectives.

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Motivation

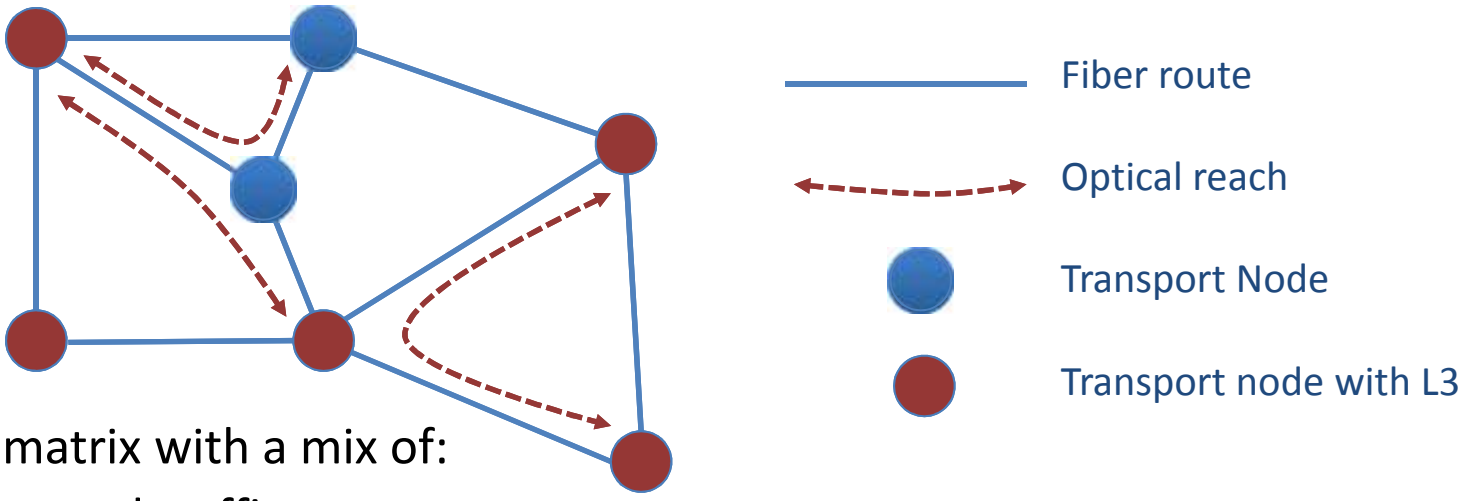
- Content providers see value in owning both Layer 1 and Layer3 topology to support massive traffic growth
  - Construction of IP topology is then dictated by known optical reach
    - Not by price of lease circuits available in the market
  - IP topology can evolve based on traffic

- Significant portion of inter-datacenter traffic can be scheduled
  - Mainly, large bulk transfers across data-centers for replication
  - Can be tagged as low priority
  - does not require sub-50msec restoration under failure
    - Essentially ROADM layer restoration is possible for this traffic

- Objective: Can we reduce Capex assuming restoration under sub-50msec is not mandatory for majority of

Problem Formulation

- Given fiber topology that consists of
  - Fiber routes with known optical “reach”
  - ROADMs that allows waves to be re-routed
  - Capacity per fiber pair on each route
  - Known transport nodes with layer 3 capability



- Traffic matrix with a mix of:
  - Unprotected traffic
  - Protected in L3 and should not suffer more than 50msec under failure
  - Restorable in either L1 or L3; its acceptable if they are restored few seconds after failure
  - Latency constraint on flows under steady state an

Problem Formulation

- Given (contd)
  - Some known leased circuits in the network that are at no cost
  - Latency constraint on flows
    - under steady state and failures
  - Cost of hardware
    - $/port for L3
    - $/port for L1
  - Flow splitting granularity
  - Known shared failures (SRLGs) for which network is planned for
  - Standard and special rules around optical reach
    - Optical reach: Ability to optically close a circuit wit

Problem Formulation

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- Objective:
  - Identify optimal IP topology with given traffic requirements and SRLGs
  - For L1 restorable demand, identify the optimal placement of regen-ponders
  - Report the following:
    - Multilayer (L1 and L3) network topology
    - For each link in the solution on each layer:
      - Required capacity per link
      - Monetary cost
      - Steady-state and Worst case utilisation
      - SRLG causing worst-case utilisation
      - Cost $
      - Demands traversing link
      - Light path details
    - Location and number of regens for dedicated lightpaths and L1 restoration

Solution : General Approach

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Five key analysis principles:-

1. **Must be objective driven**

2. **Objective is a composite of financial and technical**
   1. **Tech : Node Degree, Protection, Optical Reach, Regeneration**
   2. **$: Network Cost, Cost under failure**
   3. **SLA : Latency, Protection, restoration time**

3. **Network must be abstracted – Virtualised !**

4. **Have flexibility to change/revisit objectives/Policies and cost models**

5. **Have a measure of optimality**

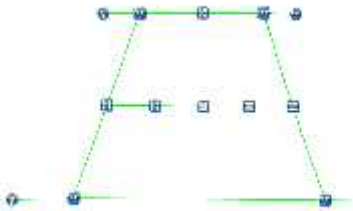
Software Defined Business Objective

General Approach

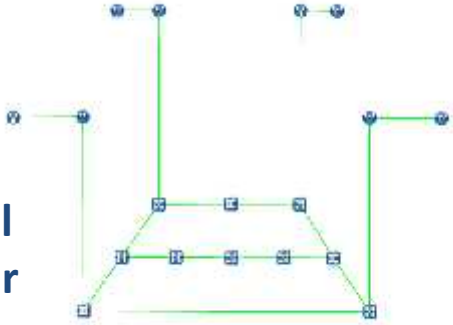
- Transform network into a virtual / abstract model
  - Can compute alternatives quickly in
    - Pop / Network Architecture
    - Apply different Cost Models
    - Lends itself to AI and Graph techniques
    - Apply different technology constraints
    - Apply different policies
    - WHAT-IF …
- Can incorporate, using a flexible data model,
  - a hybrid VNF/PNF network and or
  - Brownfield network components
  - Modelling different components/vendors/bus models simultaneously

How complex is the problem if we want to get an optimal business solution?

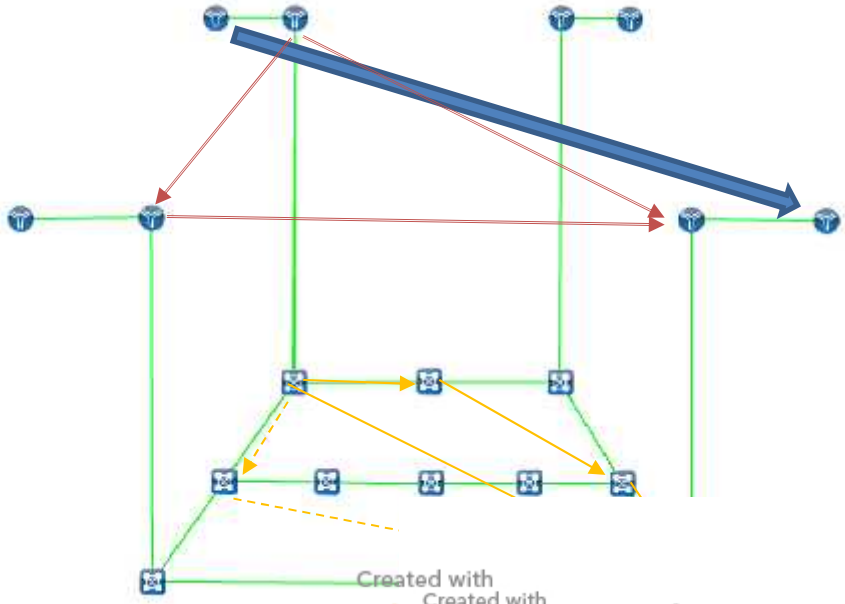
1 : Virtual Instantiation



2 : Virtual Multilayer Model



3 : Test Business Objective against options



Assuming a working and protected path
(Ignoring for now design under failure)

Options ….

- **1.1 thousand billion (1.1×10^{12})**
- **10.6 Million valid multilayer paths**
- **104 thousand valid optical paths**

Intelligently search options

- **10 solutions at < Optimal + 5%**
- **2 optimal solutions with lowest cost**

Optimisation Process

(*Intelligently search options*)

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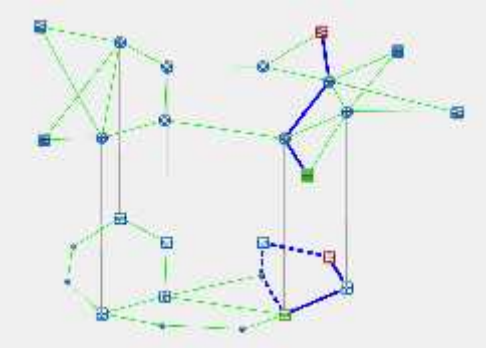
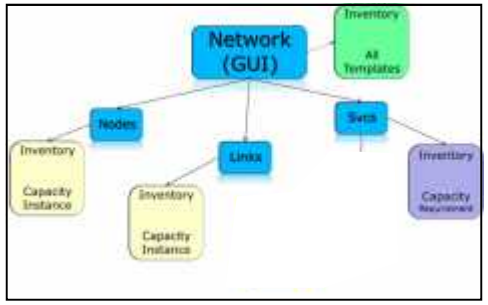


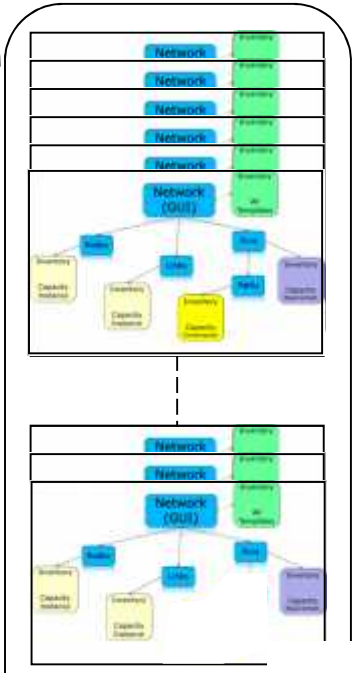
Virtual Model Instantiation



"Mutated"
(+ objective fitness computed)

"Good Enough"
(Optimality)

<= + "Mated"



Gene pool

Seeding
(Deterministic)

- Dijkstra
- Spanning Tree
- Guide Path
- Random
- Directory of suitable paths
- Others !

"Fitness Computed"
(based on objective)

Done

?

Results : Comparison

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Brute force : Nearly 35 years (@1000/s)

Simple Genetic Algorithms : 2.9 Hours

SDBO : Demo ……

Realtime Video Capture of SBDO

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Conclusion

- Best Conclusion is to advertise our AT&T/NTT sponsored catalyst. End to End … DC – WAN – POP

Aria – Ericsson – JDSU - M

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