Network Planning and Path Computation for Next Generation Networks

ARIA Networks

Intelligence for Next Generation Networks

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Agenda

- Introduction to Aria Networks
- Next Generation Networks
- Solving NGN Problems
- What is complex path computation?
- Existing path computation techniques
- Holistic Path Computation
- Non-Heuristic Solutions
- What does the future hold?
- Conclusion

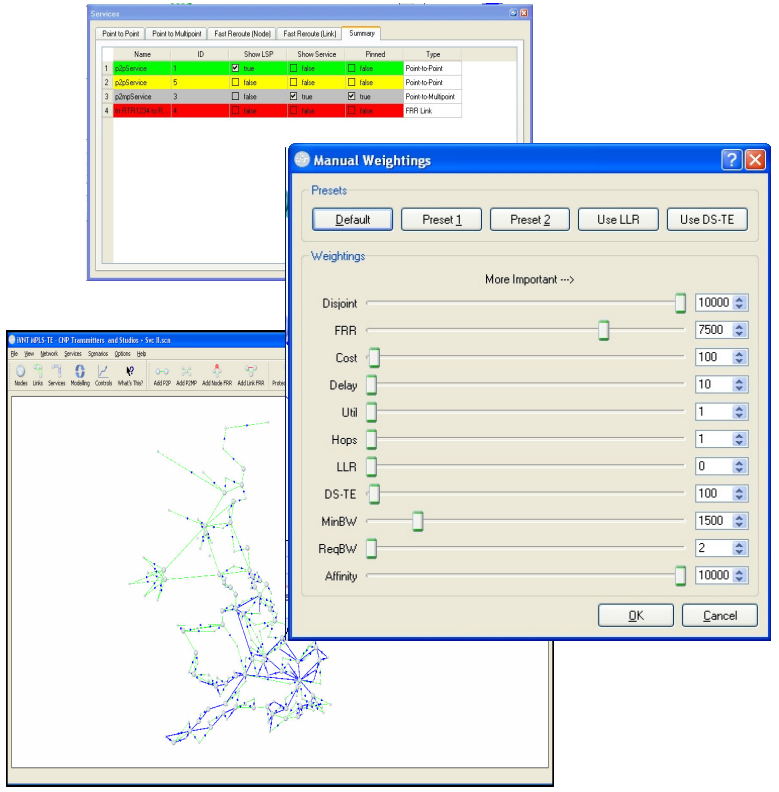
What does Aria do?

- Founded to fundamentally change the way complex, converged networks are designed, planned and operated

- Develops ***intelligent*** software solutions
  - Based on proven Artificial Intelligence
  - Distributed software architecture
  - Offline and online (real-time) capable

- ***iVNT*** provides **fast** and **assured deployment** of Next-Generation networks and services, **reduces complexity** and **total cost of NGN ownership**, and enables network operators to **guarantee delivery of customer service level agreements**

intelligent Virtual Network Topologies (iVNT)



Next Generation Networks

- Convergence means the integration of these services over a common infrastructure and provision through a single point of attachment
- Voice, Video, and Internet
  - Why stop at triple play? Quad-play, Multi-play, Gaming, etc.
- The customer expects:
  - Rapid delivery of new services
  - Greater bandwidth
  - Higher QoS
  - More sophisticated SLAs
- The provider needs to:
  - Drive up income from deployed resources
  - Provide more complex services within existing networks
  - Find a way to deliver QoS and meet SLAs
  - ***Whilst reducing operational costs***

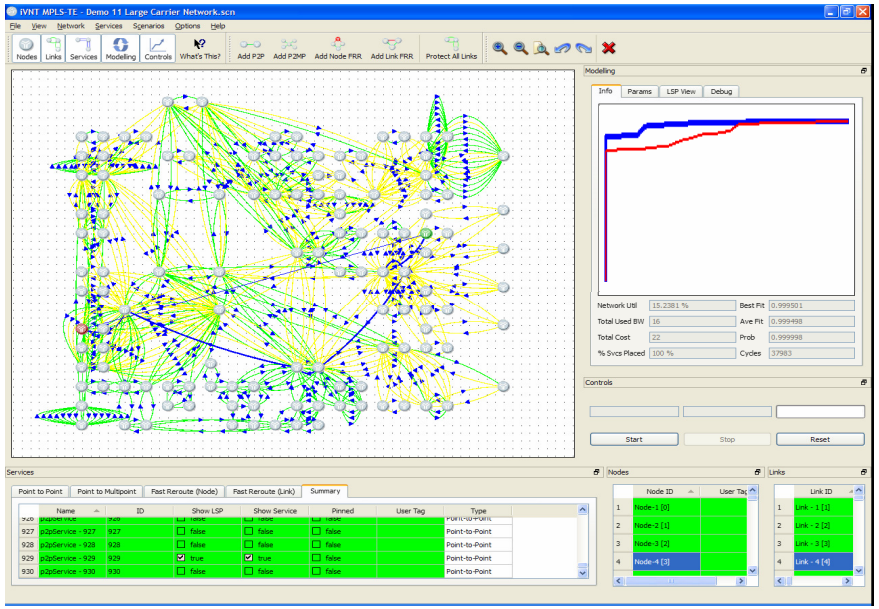
Solving NGN Problems

- Throwing bandwidth at the problem?
  - A guaranteed fat pipe is a good way to deliver quality
    - High-speed delivery addresses delay problems
    - Jitter can be handled in buffering
  - But bandwidth may be expensive and impractical and doesn't solve all issues
    - Inevitably, even in a lightly used network, some links reach critical utilisation
    - It can be hard to predict which links these will be in failure scenarios
    - New customers can cause unforeseen congestion points
    - Increasing capacity cannot be done on demand
- Better network planning and appropriate reoptimisation of services
  - Requires complex path computation capabilities
  - Model the entire network (multi-layer modelling)
  - Consider all current services and compute in parallel not serial
- Respond to network events and deliver services in real-time
  - Requires online path computation capabilities

What is Complex Path Computation?

- Support of complex services:
  - P2P and P2MP based service types
  - High levels of QoS demand multiple constraints
    - Minimal cost, minimal delay, high bandwidth,
    - Constraints may be conflicting
  - Multiple connections (LSPs) to support one service
    - VCAT, load-sharing, protection
  - Resource continuity issues
    - Transparent or semi-transparent optical networks
    - MS-SPRing timeslot continuity
- Path diversity or congruence:
  - End-to-end Protection
  - VCAT
  - Mesh protection resource sharing
  - m:n protection
- Concurrent network-wide optimisation and re-optimisation

Solving Complex Network Problems



- Where is my traffic flowing today?
- Where do I place new resources, such as links and switches?
- What resource capacities do I require?
- How do I design my network to minimise or negate the impact of resource failures?
- What configuration metrics do I place on the network equipment that will influence traffic flows and quality of service?
- Where is the most cost-effective place to add new resources to accommodate anticipated traffic growth?
- What is the most effect mechanism for carrying new types of services?
- Which protection mechanism is most effective for network topology and service types I currently have?
- **What if…?**

Existing Computation Techniques

- Single-service computations
  - CSPF is perfectly functional
    - Optimal paths for single LSPs with multiple constraints
  - Modified CSPF can compute multiple paths
    - Good for solving k-disjoint paths
  - Conventionally used to satisfy real-time requirements

- Linear programming can optimise a whole network
  - Can take long periods to develop
  - Not flexible to changing demands, new topologies, new constraints, or new service types

- But can it do it fast enough?
  - More constraints mean slower computation times
  - More paths mean more complex computation
  - Larger networks are phenomenally complicated

Holistic Path Computation

- Solving the whole network is hard
  - Balance conflicting constraints for different services
  - Consider all services at once to avoid trap conditions
  - Huge networks with thousands of services
- Holistic path computation solves the entire network in one pass
  - Necessary for full optimisation
  - Needs to be adaptive to changes in topology and services
  - Must be flexible to mixes of service types (P2P, P2MP, etc.)
- Evolution to multilayer path computation
  - IP over MPLS over Optical

Non-Heuristic Solutions

- Conventional algorithms are deterministic
  - Same solution every time
  - Normally tuned to the specific topologies
  - Cannot handle multiple service types
  - Generally slow when handling large networks with many elements

- Non-heuristic processes assess the network and derive an optimal solution
  - May produce a different, but correct solution each time
  - Is able to handle a variety of topologies
  - Is able to manage different service types

What are Non-Heuristic Solutions?

- Artificial Intelligence
- Evolutionary/Genetic programming
  - Good at learning new problems and modifying existing algorithms.
  - Lend themselves to parallel computation
- Neural Networks
  - Very good at complex problems
  - Need to be designed and trained for the specific problem
  - Inflexible to changes in networks and services
- Next generation Spiking Neural Networks
  - For example, Aria's Darwinian Neural Networks (DNNs)
    - Self-modifying, self-training, multi-dimensional NNs
    - Dramatic speed and power
    - Highly flexible
- Algorithm hosting platforms
  - Why choose one algorithm to solve all problems?

What does the future hold?

- Highly sophisticated planning and modelling tools
  - Network failure analysis
  - Capacity planning
  - Rapid turn-around of network experiments
  - Multilayer network modelling
  - Concurrent network re-optimisation

- Online and integrated planning and activation
  - NMS & OSS
  - Path Computation Elements (PCE)

- On-line automated reoptimisation
  - Dynamic reconfiguration of networks within configured parameters

Conclusions

- **Currently:**
  - There is a demand for more sophisticated network services
  - Increasing pressure on carriers to make money from limited resources
  - Most computation tools are sub-optimal
  - Conventional linear programming techniques are powerful, but not flexible enough

- **But**
  - Non-deterministic algorithms are able to solve complex problems
  - Need to use multiple constraints for efficient network utilisation and service placement
  - Consider network wide concurrent optimisation
  - True multilayer path computation is achievable

Questions?

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