PRODUCT BROCHURE

Cost-Optimized Network Implementation

Link Engineering

KEYSIGHT

Cost-Optimized Network Implementation

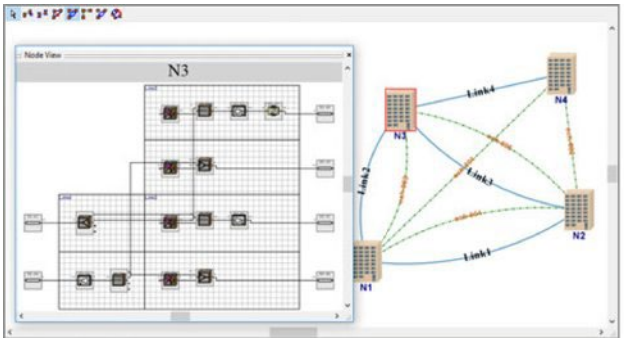
Keysight Optical Network Planning (VPIlinkConfigurator) and Optical Network Design (VPIlinkDesigner) provide an intuitive graphical user interface and powerful algorithms for optical network engineering, including automatic equipment placement and a thorough systemwide performance assessment. These Link Engineering tools support equipment configuration of complex networks, including ROADMs and detailed performance calculation of true ring topologies.

Recent innovations to photonic systems design necessitate a break from overly conservative design rules. Operators continue to apply new technologies and methodologies to extract the maximum capacity from their networks for the minimum possible cost.

However, the engineering cost of transferring these innovations from experiments in the laboratory to thousands of real communications links, each of them different and most using installed fiber, is beyond the usual Excel spreadsheet approach and should be managed to ensure that the associated cost benefits are not lost.

Keysight's Link Engineering tools capture innovations as link design rules and equipment libraries, and help network engineers respond more quickly and easily to optical network design tasks, product application requests and RFQs.

Benefits



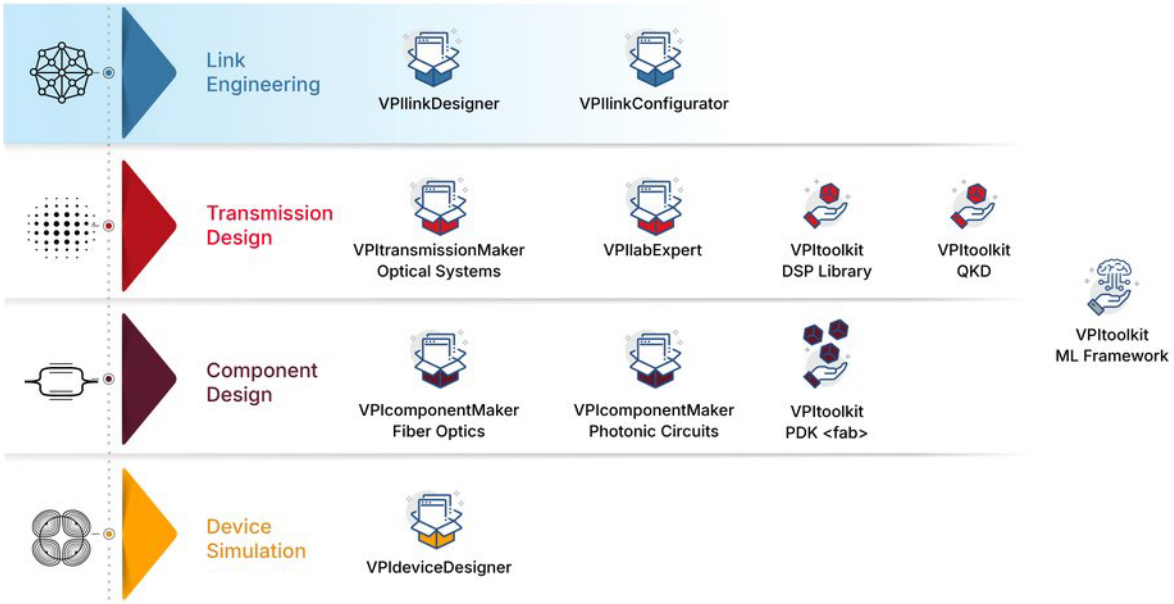


- Optical link engineering with easy equipment placement and configuration
- Systemwide performance analysis, including fiber impairments and equipment limitations
- Built-in reporting tools providing bill of materials and performance reports
- A future-proof platform utilizing a fully expandable technology-agnostic approach
- Uniform results across an organization by using controlled equipment libraries and link design methodologies

Link Engineering

VPIlinkConfigurator and *VPIlinkDesigner* offer GUI capabilities, sophisticated and robust algorithms for efficient design of various WDM networks, including linear, ring and mesh networks. *VPIlinkConfigurator* provides an Application Programming Interface (API) to implement custom algorithms.

- Provide advanced algorithms to deliver the cost-effective configuration of WDM network
- Simplify WDM network design via GUI capabilities
- Accelerate network planning and design through the powerful API of *VPIlinkConfigurator*
- Provide common and uniform approach to network design process and documentation



Applications

- Define libraries representing characteristics of equipment families based on generic templates for all common component types
- Route primary and protection optical channels for a given traffic matrix
- Define regeneration points for long distance logical connections
- Allocate lightpath(s) to a traffic demand taking into account linear and nonlinear impairments of the transmission line
- Configure systems by optimizing node and hut locations, fiber types and equipment
- Design green/brown fields for WDM networks of various topologies, e.g., branched networks, linear ADM/OADM, hub rings and mesh networks
- Support cascaded OADMs, Mux/Demux, WSS ROADMs and port-based transceivers
- Design multi-degree nodes in optical networks using colorless, directionless and contention less (CDC) configurations

- Allocate wavelengths in the C, L and S bands using a fixed or flex grid approach
- Synthesize alternative solutions using real terminal equipment and vendor components
- Optimize equipment allocation, including minimization of spectrum utilization, signal degradation and equipment cost
- Predict limitations on system performance, including optical amplifier characteristics, dispersion, crosstalk, PMD, nonlinearities and inter-channel power transfer
- Formulate and test design strategies to account for component interworking restrictions, proprietary design techniques and configuration rules
- Chart signal power, and other signal metrics with equipment limits along a selected transmission line
- Reconfigure designs and adjust parameters manually, investigate automatically updated charts
- Generate bill of materials and performance reports

Features / Functionalities

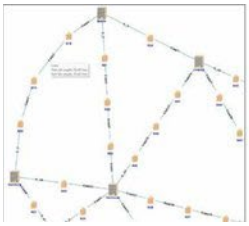


Figure 1. Physical topology

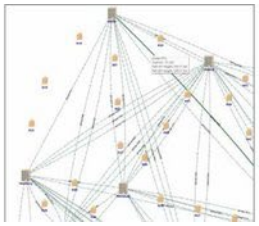


Figure 2. Logical topology and channel assignment

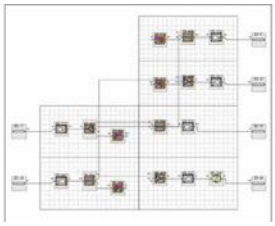


Figure 3. Equipment configuration

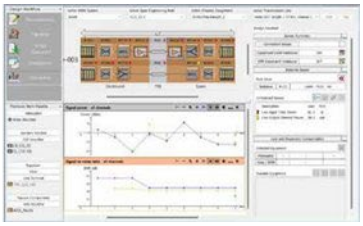


Figure 4. Design assistant and performance charts

- Equipment library creation and maintenance
- Intuitive design workflow
- GUI based capture of network topology and traffic demands
- Support for import and export of topology data
- Automated or manual definition of regeneration points
- Automatic or manual routing of primary and protection optical channels
- Topology constraints failure reporting
- Automatic wavelength allocation and configuration of add/drop equipment, including WSS ROADMs
- Support for flex grid and CDC-configurations
- Automated selection of transceivers accounting for bit rate, compatibility and dispersion limitations
- Support for high bitrate transceivers with advanced modulation formats

- Automated amplifier and DCM placement, and power level selection with manual refinement
- Manual design with automatically updated charts
- Design assistant for automated link loss and dispersion compensation with instant performance evaluation
- Target power mode accelerating the manual design of mesh network topologies
- Problem area visualization reporting violations of equipment operating ranges and design rules constraints
- Comparison of system performance for different solutions designed manually and/or generated automatically
- Customizable reporting templates
- Automatic reporting of chassis and auxiliary devices required to mount photonic equipment
- Interoperability with third-party software via a powerful API

Inputs

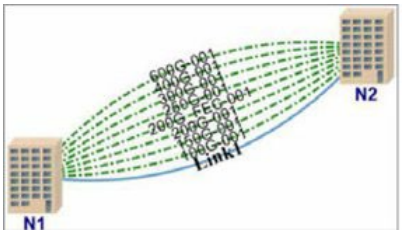
- Network topology and traffic demands imported from a file or specified manually
- Equipment library and characteristics
- Design constraints and equipment operating limits

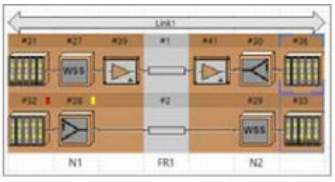
Outputs

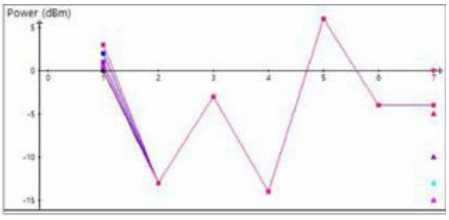
- Overall network design, including passive and active optical equipment configuration
- Performance assessment, including nonlinear interference noise (NLIN) and Inter Channel Stimulated Raman Scattering (ISRS)
- Performance visualization, including OSNR, Power and Chromatic Dispersion maps per selected transmission line or lightpath
- Bill of materials reporting
- System performance reporting
- Equipment configuration reporting

Design Examples

Transceivers



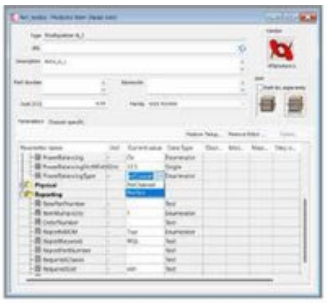




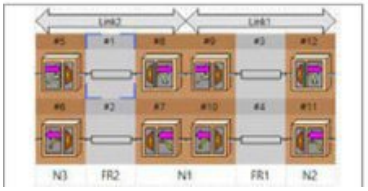
- Multiple modulation formats for varying bandwidth demand and signal metrics
- Technology agnostic approach to receiver sensitivity modeling, including operating limits such as Power and OSNR thresholds
- Support for various modulation formats, e.g., NRZ, QPSK, M-QAM, etc.
- Support for multiple form factors, chassis and power supply requirements

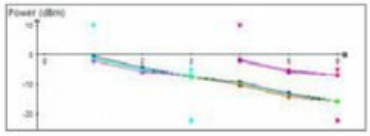
Add/Drop Equipment







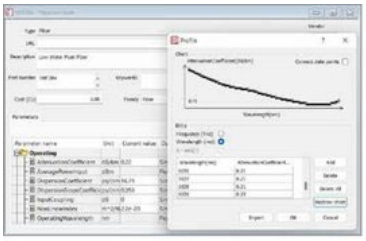


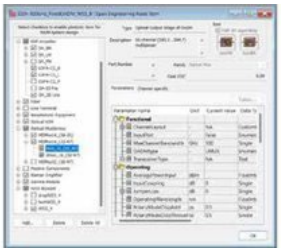


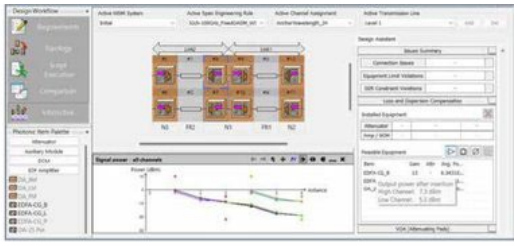


- Model equipment operating on flex or fixed frequency grid
- Create tunable or fixed multi-port OADMs with port specific loss
- Model transceiver aggregators, multi-port splitter/combiners and WSS ROADMs to design a CDC-configuration of multi-degree nodes
- Create WSS ROADMs with different equalization modes to set channel specific power

Equipment Library

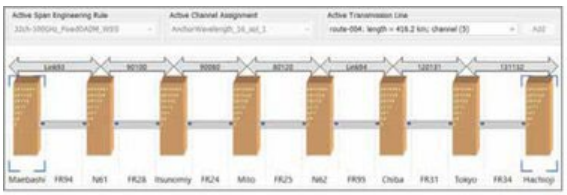


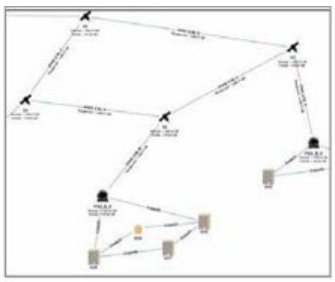


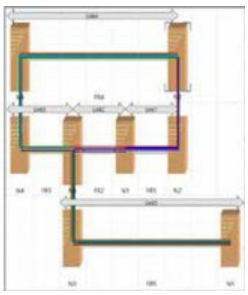


- Create equipment libraries using various device templates
- Update ready-to-use devices from an exemplary library to account for actual vendor data-sheets
- Group devices along with parameters controlling a network design within one package
- Modify the device availability and design constraints within each design
- Create several solutions with different equipment availability and design constraints settings

Optical Network Topologies

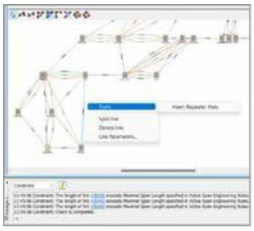


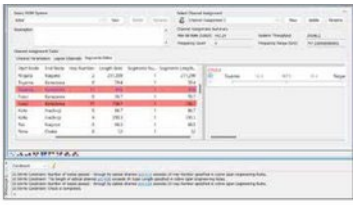




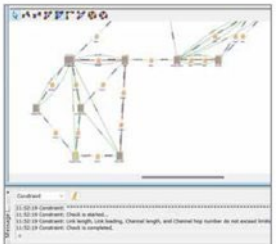
- Specify custom parameters, e.g., location and power consumption of facilities
- Establish manually or import from a file the physical and logical topology of optical networks, i.e., traffic demands, add/drop nodes, repeater huts and fiber ducts
- Design various types of optical networks, either linear, ring or mesh networks
- Establish primary and protection lightpaths in core and metro networks

Topology Optimization



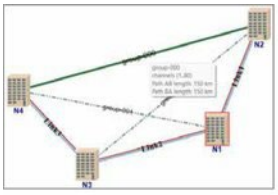


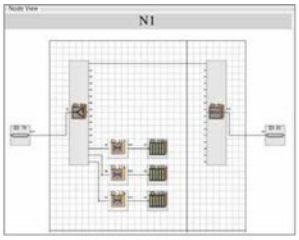




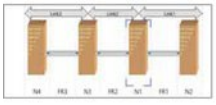
- Route traffic demands minimizing the route length, the number of wavelengths in use, or the amplifier noise accumulated along the route
- Assess the network topology concerning design constraints such as the maximum span length or lightpath length
- Insert repeater huts and regeneration points to meet topology constraints

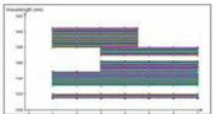
Spectrum Utilization





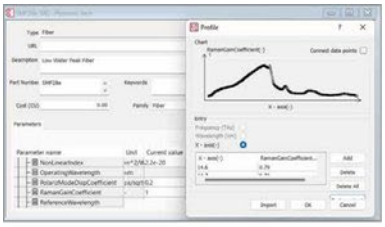


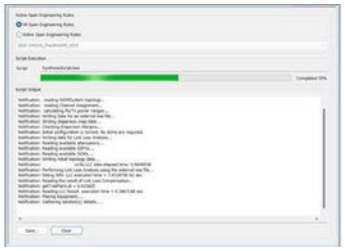




- Validation of OADM capabilities accounting for parameters of transceivers and traffic demands
- Support for fixed or flex grid and multiple frequency bands
- Optimal wavelength assignment and cost effective Add/Drop equipment allocation
- Support for multiple transceiver aggregators connected to one WSS ROADM through multi-port splitter/combiners

Optical Link Budget & Loss Compensation

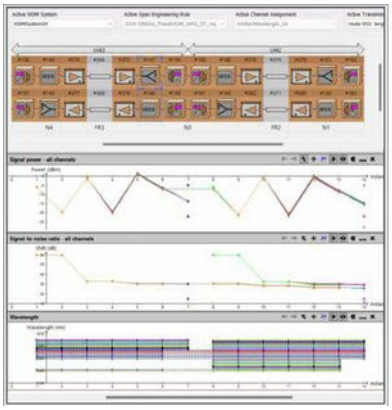


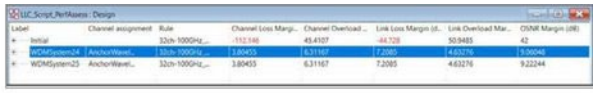




- Support for wavelength dependent parameters of optical fibers such as attenuation, dispersion and Raman gain
- Support for wavelength dependent gain and noise figure of amplifiers
- Support for fixed gain and variable gain amplifiers, including gain dependent noise figure for the latter one
- Various power settings are available in WSS ROADM, including per channel or per frequency slot equalization
- Design Assistant streamlines and accelerates Link Loss and Dispersion Compensation (LLC)
- Support for custom automatic LLC via the powerful API of VPIlinkConfigurator

Performance Assessment





- Assess the performance of flexible optical networks by comparing optical signal metrics with device operating limits and design constraints
- Plot maps along the selected transmission line for different signal metrics such as optical power, OSNR, chromatic dispersion or DGD
- Evaluate nonlinear impairments such as NLIN and ISRS
- Compare several solutions in the performance summary table

Customized Workflow & Optimization

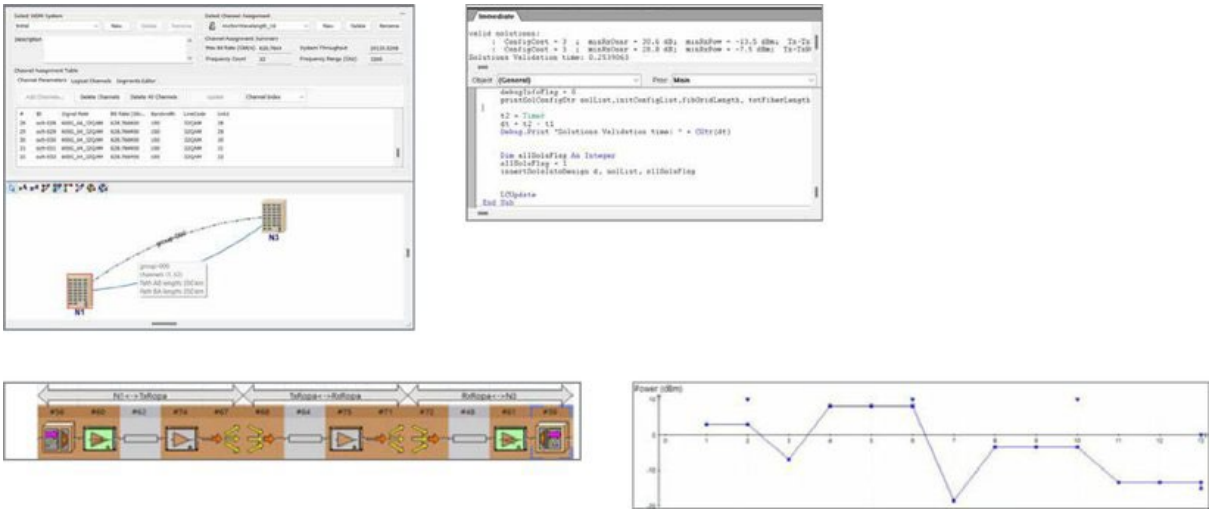
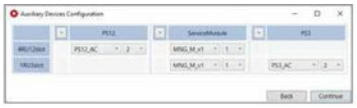


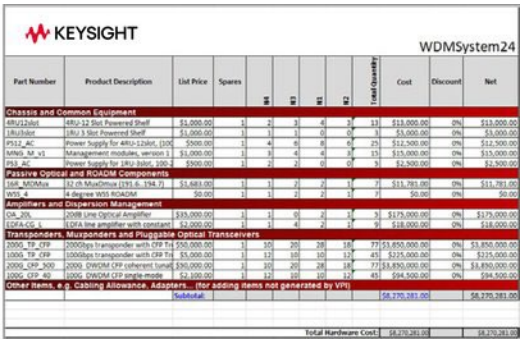
Figure 5. ROPA optimization

- Comprehensive API of VPIlinkConfigurator provides access to various attributes of network topology, devices and optical signals
- COM-based API permits for writing optimization scripts using various languages such as C#, Python or Visual Basic
- User defined optimization algorithms such as client-side traffic grooming, optimization of Remote Optically Pumped Amplifier (ROPA) location or transmission aware lightpath configuration
- Interoperability between VPIlinkConfigurator and Keysight Photonic Simulation Environment (VPIphotonics Design Suite) through the API

Reporting







KEYSIGHT

WDMSystem24

Part Number	Product Description	List Price	Spares	N4	N3	N1	N2	Total Quantity	Cost	Discount	Net
Chassis and Common Equipment											
4RU/12slot	4RU-12 Slot Powered Shelf	$1,000.00	1	2	3	4	3	13	$13,000.00	0%	$13,000.00
1RU/3slot	1RU 3 Slot Powered Shelf	$1,000.00	1	1	1	0	0	3	$3,000.00	0%	$3,000.00
PS12_AC	Power Supply for 4RU-12slot, (10(	$500.00	1	4	6	8	6	25	$12,500.00	0%	$12,500.00
MNG_M_v1	Management modules, version 1	$1,000.00	1	3	4	4	3	15	$15,000.00	0%	$15,000.00
PS3_AC	Power Supply for 1RU-3slot, 100-2	$500.00	1	2	2	0	0	5	$2,500.00	0%	$2,500.00
Passive Optical and ROADM Components											
16K_MOMux	32 ch Mux/Dmux (191.6 -194.7)	$1,681.00	1	1	2	2	1	7	$11,781.00	0%	$11,781.00
WSS_4	4-degree WSS ROADM	$0.00	1	1	2	2	1	7	$0.00	0%	$0.00
Amplifiers and Dispersion Management											
OA_20L	20dB Line Optical Amplifier	$35,000.00	1	1	0	2	1	5	$175,000.00	0%	$175,000.00
EDFA-CG_L	EDFA line amplifier with constant	$2,000.00	1	1	4	2	1	9	$18,000.00	0%	$18,000.00
Transponders, Muxponders and Pluggable Optical Transceivers											
200G_TP_CFP	200Gbps transponder with CFP Tx(	$50,000.00	1	10	20	28	18	77	$3,850,000.00	0%	$3,850,000.00
100G_TP_CFP	100Gbps transponder with CFP Tx(	$5,000.00	1	12	10	10	12	45	$225,000.00	0%	$225,000.00
200G_CFP_500	200G DWDM CFP coherent tunat	$30,000.00	1	10	20	28	18	77	$3,850,000.00	0%	$3,850,000.00
100G_CFP_40	100G DWDM CFP single-mode	$2,100.00	1	12	10	10	12	45	$94,500.00	0%	$94,500.00
Other Items, e.g. Cabling Allowance, Adapters... (for adding items not generated by VPI)											
	Subtotal:								$8,270,281.00		$8,270,281.00
								Total Hardware Cost:	$8,270,281.00		$8,270,281.00

- Bill of materials reporting, including chassis and auxiliary devices required to mount photonic equipment
- System performance reporting
- Configuration reporting
- Customizable reporting templates

As a mission-critical design enablement partner, Keysight connects design, emulation, and test so customers can solve the world's most complex engineering challenges. Accelerate innovation at www.keysight.com.

KEYSIGHT

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