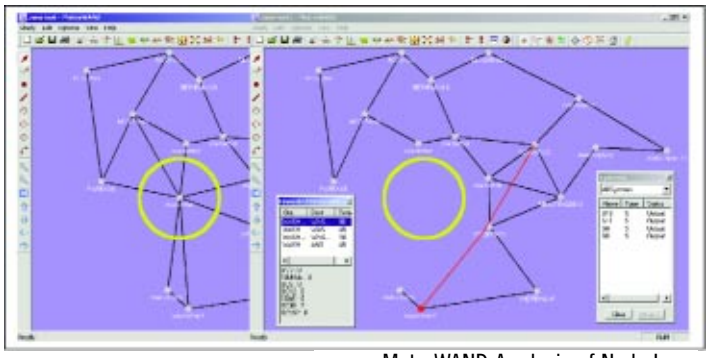
RSOFT Design Group

REVIEW

Volume 1 Number 2

Disaster Recovery:

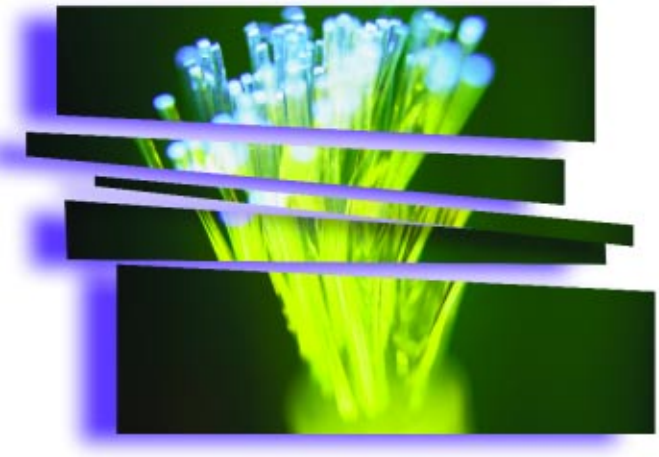
Preparation is the shortest path to reconnect two points



MetroWAND Analysis of Node Loss

You don't know where or when or how it will happen: the permanent loss of a node or link in the network…followed quickly by the flurry of questions: What if we splice some fiber at the old node location? What if traffic spikes in non-affected areas? What if we add a planned ring to handle the unrouted demands?

To date, some of these questions took precious days to answer. Some insiders have blamed the problem, in part, on a lack of readily-available information required to answer these "What-If" questions.



Part of the information needed for disaster recovery is real-time, situational data: what systems were actually lost, which alarms are truly incident-related, and how will loss of grid power affect the electronics around the network, to name a few.

A significant amount of the baseline network data, however, can be organized, analyzed, and modeled on a laptop computer. But to be useful during a time of need, in-depth network models—which can take several days to enter—must be developed **before** an incident occurs.

Using a network design tool, such as RSoft's *MetroWAND*™, planners can model optical networks for new services and capacity growth. These very same models can be utilized as well when disaster strikes. As illustrated, a planner can use existing cost-optimization models to analyze the impact of a node loss by simply removing the node in the tool and quickly re-running the analysis. In minutes (versus days), an automated tool can determine the effect of permanent node or link loss on network demand routing and system placement, and test strategies to handle any unrouted demands.

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WHAT'S INSIDE

Sophisticated Tool Analyzes Network Investments

Gail Lalk

CEO, RSoft Design Group, Inc.

There is a new approach to developing technology-based business cases which can dramatically reduce the risk and improve the ROI for global companies seeking to upgrade their networks and make new investments. In the 1990's, most global telecommunications companies invested in communications infrastructures in developing countries. These investments were based largely on wireless technologies that supported voice services, as this provided the fastest path to basic connectivity in diverse geographic areas. Both the pace of technological change and the demand for more sophisticated data services have increased dramatically in the last 5 years.

Today, all of these organizations are faced with a huge challenge as they either upgrade their original investments or risk losing their global reach. These companies can't afford to waste time or money figuring out how to improve their global properties. At RSoft Design Group, we have found that the typical telecommunications company has a small staff of frustrated business developers who are taking responsibility for these multi-billion dollar decisions. The frustration arises because the processes that are in place to assist in developing the business cases are too basic to deal with the complexities of the problems they are intended to address.

In a typical scenario, one person acts as the business-case development coordinator for several organizations, including Engineering, Services, Marketing and Finance. Engineering provides a view of how the network in question should be updated based on which technologies can be used to meet the traffic and capacity forecasts. The Services organization tries to position the networks to gracefully evolve from dialtone services to data services. Marketing provides input on how market dynamics are affected by pricing policies and expectations of churn. Finance provides input on what resources are available to support the investment. All of these organizations provide their input on spreadsheets

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Case Study:

MAKING MONEY WITH DSL

During the late 1990's analysts were predicting double-digit annual growth of broadband access technologies, in particular DSL (digital subscriber line). Given the healthy competition from cable companies and emerging fixed wireless access companies (using 802.11 wi-fi technologies), many DSL providers are asking how they can develop their DSL offering into a thriving, profitable business.

The answer to that question starts with careful up-front planning that considers all of the interrelated marketing, engineering and financial factors that impact the bottom line. Key factors to consider in a multi-year planning activity include:

- Target markets (residence or business)
- Serving area (metro, suburban, rural)
- Service mix (voice, data, video) and pricing plans (fixed rate versus usage based; tiered pricing for different service levels)

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Thoughts on the Multi Service Provisioning Platform

RSoft Review (RR): What exactly is MSPP and why is it creating such a buzz?

Cardwell: The Multi Service Provisioning Platform is an exciting new way to provide multiple new services—voice, data, video, ATM, SONET—on a common platform. MSPP is particularly interesting because it is compatible with the existing network. Because you don't have to commit to one technology, MSPP can help to insulate you from some of the vagaries in the market.

RR: Sounds like a panacea of sorts. Why is the jury still out on MSPP?

Cardwell: Well, the flexibility offered by MSPP also comes with a plethora of possible solutions, cost scenarios, and vendors to analyze and choose from. Add to that the horrendous complexity of metropolitan networks, and some planners may think there are just too many factors to consider, with too many spreadsheets to manage and maintain.

RR: So is MSPP worth looking at?

Cardwell: Absolutely. MSPP has all the attributes of a viable technology, but you still need to quantify the economics for a particular network scenario. We have analyzed cases where MSPP has demonstrated a 15% savings, but the choice between legacy and MSPP depends on the network scenario in question.

RR: How might a network planner miss the boat on MSPP?

Cardwell: A few ways. First, you could presuppose that MSPP just won't work in your network, that the embedded equipment won't plug in or it won't be cost-effective to upgrade. Second, you might assume that what's been working in your network will continue to keep working as services change and the network grows in size and complexity. Lastly, you could go with MSPP because it's working elsewhere … without matching the MSPP solution to your specific network demands. Sizing MSPPs, and the associated plug-ins can be complex.

RR: Given the complexity you've described, how can network planners be confident in their analysis?

Cardwell: Confidence comes from the ability to ask "What If," in an organized, comprehensive way. RSoft offers an automated network design tool, called *MetroWAND*™, to help network planners answer the question: "Under what conditions is MSPP cost-effective for my network?" *MetroWAND* was built specifically for metro networks, and is the only tool to offer an integrated MSPP feature.

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MEET RICH:

Richard Cardwell, Director of Network Optimization Tools at RSoft Design Group, has more than 30 years of experience in algorithm development, network management, control strategies and facility network management. Rich has two patents for dynamic routing and designing DWDM rings. We discussed the challenges of introducing MSPP into complex metro networks.

Making Money with DSL continued

- Financing (cost of capital/cost of debt, debt ratio, tax rates)
- Technology choice (modularity of equipment, technology constraints, engineering rules, facility and equipment costs)
- First installed costs, as well as lifecycle operations expense (OPEX) and capital expense (CAPEX).

A good example of the importance of careful up-front planning is best illustrated by looking at the results of a recent case study conducted using *BroadbandSWAT*™, a strategic analysis tool that captures the interrelationship of the marketing, engineering and financial aspects of a business plan. The study, looking at a 5-year planning horizon, focused on understanding the impacts of widely deploying DSL technology in both urban and suburban areas to support high-speed data services. Real-world assumptions were made regarding market opportunities, service offerings, a multi-tiered pricing structure, and network equipment/facilities. Some intriguing discoveries from the study included:

- Marketing assumptions of a ubiquitous rollout, and engineering assumptions of a fixed set of equipment, resulted in a business case in the suburban areas that never broke even. *BroadbandSWAT* was able to demonstrate how deploying a discrete set of equipment in the suburban area could improve the ROI by 14% and the NPV by over 32%.
- Or, moving to a single-tiered pricing model based on high-end services (that resulted in a loss of about 20% of subscribers), actually improved overall ROI by 18% and NPV by more than 76%.

BroadbandSWAT quickly identifies the factors contributing to the success or failure of potential networks and services. In these DSL cases, challenging assumptions on equipment sizing and pricing models identified a much stronger business case.

Designing dispersion compensating schemes and modules with LinkSIM™

Depending upon the channel plan, power budget, bit-rates and distances involved, the performance of an optical link will be influenced by a variety of transmission impairments. Alleviation of signal distortions due to these linear and nonlinear effects often warrants challenging compromises. Like it or not, dispersion is an omnipresent physical effect that manifests itself as broadening of data pulses along the propagation path, regardless of the bit-rates, distances, channel plan and power budget. On the positive side, the controlled presence of dispersion in wavelength division multiplexed (WDM) systems can help reduce the bit-error-ratio (BER) penalties otherwise imposed by fiber nonlinearities. Since different wavelengths experience different amounts of dispersion, providing wide-band dispersion compensation for multi-wavelength networks while also ensuring minimal non-zero dispersion at any point over the link can be quite challenging. Here we see how *LinkSIM*'s full suite of simulation tools and models can help system architects in achieving their design goals.

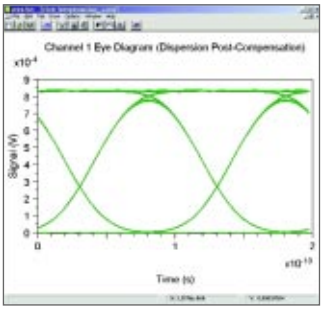

Figure C

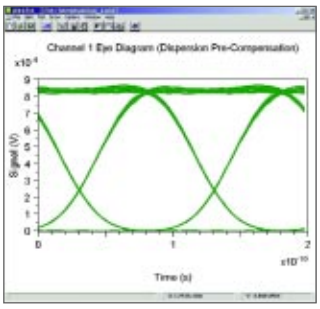

Figure D

The majority of the currently deployed dispersion compensating modules (DCMs), as well as promising newer approaches, are based on using dispersion compensating fibers (DCF), dispersion compensating gratings, high order mode (HOM) fibers, and virtually imaged phased arrays (VIPA). The tight integration of *BeamPROP*™ and *GratingMOD*™ with *LinkSIM* helps in designing efficient wide-band fiber Bragg grating-based DCMs. The example shown below was simulated using *LinkSIM*. It uses a DCF-based DCM for providing multi-channel dispersion compensation.

The topology of Figure A depicts a 600km, 4-channel OC-768 WDM link.

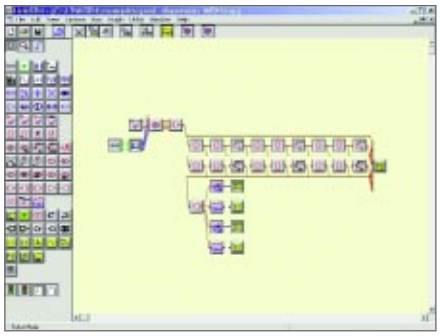

Figure A

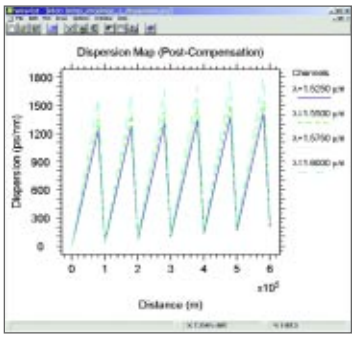

Figure B

Each of the four 100km spans consists of 80km of ITU-T G.652 single mode fiber (SMF) and 20km of DCF with high figure of merit. The placement of the DCM will be different for post-compensation, and for pre-compensation configurations. Figures B and C show dispersion map and receiver eye diagram for the post-compensated system; and Fig. D shows eye diagram for the pre-compensated case. A slight improvement in performance for the pre-compensation scheme can be attributed to reduced four wave mixing (FWM) and modulation instability (MI) effects.

Upcoming articles will discuss how to improve the dispersion immunity using different data modulation schemes like duobinary, and carrier suppressed return to zero (CSRZ) formats.

TOOLS FOR TODAY AND TOMORROW

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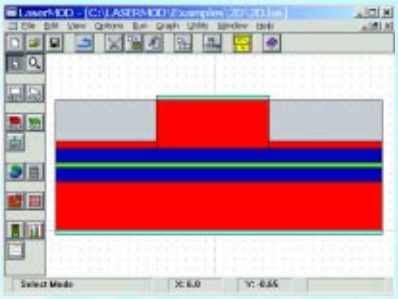
new tools for today

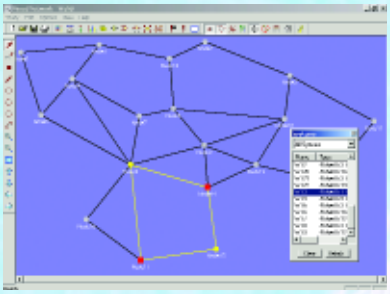
LaserMOD™

An integrated CAD package, *LaserMOD™* is used for laying out active device cross-sections, selecting material parameters, generating nonuniform grids, running simulations, and plotting results. The tool is focused on Fabry-Perot laser cavities, but has been designed to be extendible to VCSEL and DFB structures in the future. Physical models include a comprehensive MQW gain calculation. Both steady-state and time-dependent carrier transport are simulated, for accurate modeling of device dynamics. *LaserMOD* also considers hot-electron effects, incomplete carrier-capture within the quantum wells, current spreading, and spatial and spectral hole burning phenomena. Outputs include L-I and I-V curves, near and far field, charge and current distributions, energy bands and band structure, and transient response.



MetroWAND™

Network modeling tool *MetroWAND™* is built specifically for metro applications. *MetroWAND* is a vendor-neutral strategic network-planning tool that simulates and analyzes SONET/SDH and DWDM systems in metropolitan environments. Its flexible equipment, cost, and demand models are designed to locate cost-effective DWDM and SONET/SDH rings in the network backbone. MetroWAND allows for quick, iterative analysis — running 50 nodes in just minutes, and provides spreadsheet-ready solution and system costs.



BroadbandSWAT™ *WirelessSWAT™*

A family of strategic wired and wireless analysis tools, *SWAT* provides a comprehensive analysis tool designed to help planners, engineers, technologists, business and marketing people rapidly, but thoroughly, develop network and service plans including detailed technical and business analysis. All access networks and services, wired and wireless, are covered via *BroadbandSWAT;* or wireless via *WirelessSWAT*. The program includes the complex interrelated traffic, capacity, propagation, equipment and operations calculations. *SWAT* produces reports covering a variety of key elements, such as discounted cash flow, capital/expense flow, and network loads and typically runs a network study on the order of 15 seconds.

preview tools for tomorrow

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GratingMOD™

Whether you need to analyze a known grating structure or synthesize a structure from a known spectrum, *GratingMOD* can help. The software can model many devices that incorporate gratings, including gratings for laser wavelength stabilizers, pump reflectors, gain equalizers, dispersion compensators and various kinds of filters. This tool can handle gratings with arbitrary cross sections, including optical fiber, channel waveguides, diffused waveguides, and slab waveguides.

BandSOLVE™

A fully integrated add-on component to *BeamPROP* and *FullWAVE, BandSOLVE* automates and simplifies the calculation of photonic band structures for a large class of optical components. *BandSOLVE* deals with a large range of standard crystal lattices in one, two or three dimensions, including FCC, BCC, diamond, logpile and Yablanovite lattices. Using the standard *BeamPROP* CAD interface, users can quickly create lattices of the desired shape and unit cell. The simulation engine automatically determines the appropriate path through the Brillouin zone of the crystal and generates the band structure diagram. The software also allows the study of "reduced band structures", and cavity mode properties to capture the behavior of guided modes in PC waveguides.

LambdaSIM™

Quickly simulate and evaluate the performance of different component design and specifications at the network level using *LambdaSIM*. This tool is based on the wavelength-domain simulation (WDS) approach developed at Telcordia Technologies for large scale optical network modeling. *LambdaSIM* uses a signal representation that is complementary to the conventional time/frequency domain representation used in *LinkSIM* and similar products. It models optical power, noise and crosstalk in the wavelength domain. *LambdaSIM* easily handles both static networks and networks with dynamic changes that are often responsible for transient network impairments. The dynamic simulation capability of the tool allows you to evaluate how the network responds

— continued on page VIII

Richard Cardwell continued

The tool allows you to model a solution in the back office, rather than after you've put the money on the table. Bottom line is that the cost of a planning tool is negligible compared to the cost of a purchasing mistake.

> ***"In long-haul the dollars are in the ditches, but in metro the bucks are in the mux"***

RR: So is there a greater network design lesson to be learned from the MSPP story?

Cardwell: Both service providers and systems suppliers need to focus on finding the right reach, the right capabilities…the right product at the right price. But the connections between price, services, scenarios, and embedded systems aren't always apparent at the beginning of the process. Some solutions can be surprisingly economic for reasons that are revealed only with an in-depth analysis of the numbers. You know it when you see it.

RR: Any parting thoughts?

Cardwell: Just remember that metro has its own unique flavor, and requires an appreciation for its density, complexity, and order-of-magnitude cost differences. In long-haul the dollars are in the ditches, but in metro the bucks are in the mux.

RSoft Design Group Broadens Task Leadership Role with PCAD Consortium

Leads Framework and Tools Development Task Teams

RSoft Design Group has expanded their leadership role in PCAD (Photonics CAD), a consortium of companies that have joined together in a research and development effort to reduce the time and costs associated with manufacturing photonics components, while increasing reliability and productivity.

Although photonics technology is becoming more important in communications, imaging, data storage and other systems, a significant impediment to further advancement is the lack of open development frameworks and integrated simulation tools for the quick and reliable evaluation of photonic components, systems, and networks. PCAD, with the support of a co-investment grant from the Advanced Technology Program (ATP) Office of the National Institute of Standards and Technology (NIST), is creating an integrated simulation environment for photonics manufacturing. The resulting PCAD project will enable designers to predict the impact of multi-level changes before photonic products are built, saving both time and money.

RSoft Design Group already played a central role in the PCAD project by leading the tools development task team. The company is assuming additional leadership responsibility by also heading up the multi-level core framework task team. These two task teams play a crucial role in helping PCAD develop a system to accommodate an expandable library of tools that will generate, validate and optimize photonic designs at the network, system, component and device levels.

> *"We are thrilled that RSoft Design is bringing its multi-level design and modeling expertise to yet another aspect of the PCAD system,"*

said Alfred A. Mondelli, PCAD Consortium Director. "The goal of our completed project is to help the US photonics industry prosper in a growing global market."

In addition to RSoft Design Group, the PCAD project team includes the Science Applications International Corporation (SAIC) and its wholly owned subsidiary Telcordia, Columbia University, and the IBM T.J.Watson Laboratory. The resulting new technology will first be applied to the communications sector, but will also enable new design capabilities that will reduce costs and improve products in many other industries, including medicine, transportation, computers, defense, and entertainment.

Case Study:

ADDING WIRELESS DATA WITH GPRS

Much of the world is familiar with GSM (the Global System for Mobile communications), a standardized, all-digital cellular network that uses TDMA (Time-Division Multiple Access) to provide compressed voice service at 13 kb/s. GSM's popularity has its roots as a pan-European standard that allowed cellular voice users to easily cross borders. Then along came data.

GPRS, or General Packet Radio Services, is an emerging (2.5-generation) technology that offers wireless data on GSM networks, with access speeds of up to 144 kb/s in end-user devices. GPRS accommodates data by allowing one or more of the TDMA time slots to be used for data instead of for voice. GPRS can offer a cost-effective way for GSM operators to provide moderate-rate data, while not having to change out a lot of the existing GSM network, and continuing to support voice customers.

GPRS, or General Packet Radio Services, is an emerging technology that offers wireless data on GSM networks, with access speeds of up to 144 kb/s in end-user devices.

Using RSoft's strategic wireless analysis tool, *WirelessSWAT*™, GSM voice and data models were constructed to analyze the impacts of adding GPRS on traffic, transmission capacity, equipment usage, and cash flows. The baseline model was a successful voice-only GSM network, with service spanning urban and suburban areas.

To study the economics of adding data to a GSM network, we studied two GPRS scenarios: adding data service at a moderately-competitive flat rate price of $17 per month, or at an inexpensive, flat rate price of $10 per month. We considered two levels of customer demand at each monthly rate. *WirelessSWAT* accounts for additional costs for the GPRS equipment, and the additional voice capacity required to compensate for loss of the voice time slots to provide data services. The results of the study are highlighted in the following table.

GPRS Cases	Voice only	Case 1		Case 2	
Data Price	—	$10/month		$17/month	
Data Demand	—	Moderate	Heavy	Moderate	Heavy
NPV Urban	$363	$209 (-42%)	$103 (-72%)	$374 (+3%)	$434 (+20%)
NPV Suburban	$43	$9 (-79%)	-$18 (-142%)	$41 (-5%)	$47 (+9%)

[NPV = Net Present Value over the 10-year study period, in $ millions]

Conclusion: The business case for the less-expensive pricing model (Case 1) with moderate demand was poorer than the voice-only case, getting worse with every new data customer. A more reasonably-priced service resulted in returns similar to the voice network for moderate data demand; increased demand actually yielded improved financial results.

WirelessSWAT demonstrated the business impacts of adding GPRS data to a successful GSM voice network, allowing planners to work quickly through the list of non-productive scenarios. In the GPRS Case 1, the answer is "Opt out." Charge more as in Case 2? The competition will most likely have to charge more as well, or they might not be the competition for long.

Gail Lalk continued

that are typically incompatible and are often created using different basic assumptions.

The coordinator spends most of his time acting as the glue between the various organizations and spreadsheets. The process of providing iterative feedback to refine the business case takes weeks longer than necessary. We have found that the people playing the central-coordinator role generally have little confidence that the business case resulting from this process is really providing the "right" answer. So what's the solution?

The two basic elements that are missing from the typical business-case development process of today are a common framework within which different organizations can work, and an automated feedback loop to force consistency and to facilitate rapid iterative analysis. RSoft Design Group has recently introduced two sophisticated business-case analysis tools called *BroadbandSWAT* and *WirelessSWAT* that provides a platform for developing return-on-investment analysis for the access network. These tools present a unique and sophisticated approach to technology investment analysis that can't be matched by the use of spreadsheets. If you recognize the scenario described above in your organization, I encourage you to contact us to learn more about how *BroadbandSWAT* and *WirelessSWAT* can improve your technology investment decisions.

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NFOEC Papers/Chairs:

Paper: Session B9 – WDM & DWDM Systems

Presenter: Richard Cardwell
Title: "Relative Economics of Amplified Versus Unamplified WDM Systems in Metropolitan Areas"

Session Chair: B1 – Optimization Analysis, Ondria Wassem, Ph.D.

Session Chair: D9 – Simulation & Modeling, Robert Scarmozzino, Ph.D.

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BeamPROP/FullWAVE

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Disaster Recovery continued

While it may be hard to expect the unexpected, the ability to react with confidence may depend on work done well before disaster strikes: restoration is based in preparation. Adding automation, provided by a network design tool, can take the guesswork out of recovery.

LambdaSIM continued

to changes, such as channel add/drop, channel reconfiguration, fiber cuts, changing power levels, and protection switching in transparent optical networks. *LambdaSIM* can rapidly simulate networks with thousands of components. The tool has undergone substantial validation as part of its use in the designing and understanding of the Multiwavelength Optical Network (MONET) project in Washington DC. *LambdaSIM* is built on a new Ptolemy-based dataflow simulation framework.

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