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Co-Engineering a Complete Financial Services Infrastructure: Lucera, Perseus, and Intel

Intel® Network Platforms Group

"An SDN allows market participants of all shapes and sizes to operate as if they have built their own sprawling worldwide trading network."

- Jacob Loveless, CEO, Lucera

Executive Summary

Capitalizing on the latest advances in software-defined networking (SDN) and network functions virtualization (NFV), Lucera and Perseus have partnered to create a powerful, agile infrastructure for delivering managed services to financial institutions around the world. Underlying this infrastructure, Intel® architecture-based processors and network components provide a solid hardware foundation for building a virtualized SDN/NFV environment. The characteristics of this type of network environment include support for self-provisioning, single-point network control, low-latency connectivity, interoperability with a wide range of open-source ingredients, and proven reliability

Lucera offers an infrastructure-as-service (IaaS) framework and software-defined wide-area network (SD-WAN) capabilities aligned with financial service requirements. This offering complements the worldwide managed services Perseus provides for delivering high-precision, high-speed connectivity with exceptional service continuity to all major liquidity centers around the globe. This paper explores the ways in which the expertise of Lucera, Perseus, and Intel enables financial service institutions to increase return on investment (ROI), enter new markets rapidly, introduce new services easily, and deliver on-demand connectivity and responsive performance to their customers globally.

Virtualizing Network Infrastructures for Efficiency and Manageability

For decades, the design architectures of the enterprise have been anchored in physical hardware: racks of servers; network devices, including routers, switches, and appliances; and cabling and patch cords. This decentralized, monolithic approach to providing network services relied on manual provisioning of components and tedious setup and ongoing maintenance tasks. Visibility into the full range of network operations was limited, and network topology and device identity were determined by fixed network addresses assigned to each device.

Legacy enterprise financial systems—deployed on conventional hardware infrastructures—typically rely on technologies that limit the speed and agility of enterprise operations. These systems are not able to effectively meet the demands of today's global trading community. Owners and operators of legacy systems face substantial capital expenditures in fast-moving markets where product launches need to be implemented quickly and scaled or shuttered rapidly

Table of Contents

to ensure profitability. The SDN/NFV architectural model helps overcome many of the challenges experienced by owners and operators of legacy systems. By building a network on SDN/NFV components, financial services companies can reduce capital expenditures required to keep systems current, eliminate lengthy provisioning cycles to deploy or update network components and servers, and minimize the difficulties in developing and deploying new services rapidly.

Virtualization provides a useful mechanism for making maximum use of compute, networking, and storage resources.   Virtualization for wide-area networking began at the server level with virtual machines (VMs) making maximum use of available server compute resources. With the growing popularity of SDN and NFV, virtualization has been expanded to accommodate the need for frequent, rapid changes within cloud computing environments. SDN and NFV play complementary roles. SDN establishes a framework to configure virtualized classes of network node functions. NFV enables implementation of the network at a software level, establishing a network implementation that supports dynamic management and flexible reconfiguration of network resources.

The centralized manageability and rapid provisioning of resources afforded by SDN and NFV unlock opportunities for serving the financial services industry, which by nature requires network agility to respond to sudden fluctuations in market conditions and widely varying transaction volumes. Lucera built its business around the advantages of providing an on-demand infrastructure accommodate electronic trading, using the principles of SDN and NFV

to construct its service offerings and increase the responsiveness of network transactions. Perseus approached the challenge by enabling faster, more reliable financial services networks by enhancing high-speed connectivity and managed services that support the complete trading life cycle.

The partnership between Perseus and Lucera extends Lucera's on-demand infrastructure into all of the important global market sites through point-of-presence locations. Processors based on Intel® architecture and Intel's long-standing expertise in network technologies provide the underlying platform for the Perseus and Lucera endeavor.

The individual contributions of each of the participants in this co-engineered solution are discussed in the following sections, as well as the ways in which the Perseus network complements the Lucera platform, impacting the financial services industry in a number of positive ways.

Introduction to the Individual Infrastructure Components

Lucera, Perseus, and Intel each offer unique contributions to the financial services network infrastructure discussed in this paper. The managed services and network capabilities that are enabled by the jointly engineered approach would not be possible without the SDN and NFV underpinning.

"Right now, trading assets electronically is not as easy as, say, ordering books online, but maybe it should be. At this point in time, shouldn't asset managers, commodity traders, FX market players, and the like be provided a similar level of transaction capability when moving assets electronically?"

– Jacob Loveless, CEO, Lucera

Lucera: Responding to the Rapid Evolution of Online Trading

The expectations of trading firms and financial institutions have risen as an era of low-latency network operations has taken hold across the industry. Lucera has capitalized on these expectations by building a multi-tenant-based service that allows clients to self-provision resources through a customer portal and gain high-speed connectivity to exchanges and market data with co-location offered in prime data centers worldwide.

In describing the company's mission, Jacob Loveless, the founder of Lucera, said, *"Lucera's on-demand infrastructure model offers a cost-effective, secure, and scalable platform to help firms combat challenges related to infrastructure transparency, connectivity costs, speed to market, and balance sheet efficiency. Financial institutions can use the platform to design, procure, test, manage, and monitor infrastructure components quickly and outperform in compute-intensive, multi-asset trading environments."[1]*

The Lucera® Connect™ platform, based on a proprietary software stack, ingests current data from the Federal Reserve and a number of additional sources in real time. This approach adds a degree of immediacy and relevancy to the data on which decision making is based, in comparison to the ways in which this type of data is handled traditionally in financial systems. Therefore, collecting and analyzing real-time data and historical data on systems partitioned into the traditional silos—compute, storage, and network—presents provisioning difficulties and configuration challenges.

The inflexible nature of fixed hardware networks is a key reason why SDN/NFV deployments are on the rise across the financial services industry. Networks in financial services

organizations are subject to traditional deployment requirements and often require up to 90 days to reprovision components. Adding physical routers and switches becomes part of a long program management cycle that involves hardware requisitioning and installment, as well as a network shutdown to complete the deployment process.

Self-provisioning, as supported by Lucera Connect, equips customers with a portal that provides an view of the network configuration and support for self-provisioning, enabling them to meet immediate needs and requirements. By replacing physical components with virtualized components implemented on standard high-volume servers, Lucera Connect makes it possible to leverage the latest server hardware advances and more easily capitalize on current technologies.

As shown in Figure 1, Lucera Connect supports a central portal to a stack of compute resources, which are also accessible through Internet clients (both direct and VPN-based), supporting remote access through smartphones, tablets, and other devices.

The partnership with Perseus makes it possible to increase connectivity in areas where Lucera has not been able to provide services cost-effectively at the levels of performance expected by its customers. With this partnership, the drive to extend the network edge to hundreds of counterparties can be accomplished far more easily.

"The partnership that we have signed with Perseus gives us the ability to be in 53 data centers across 6 continents, extending our footprint from 3 to 53 data centers. We've basically created the largest software-defined network in financial services."
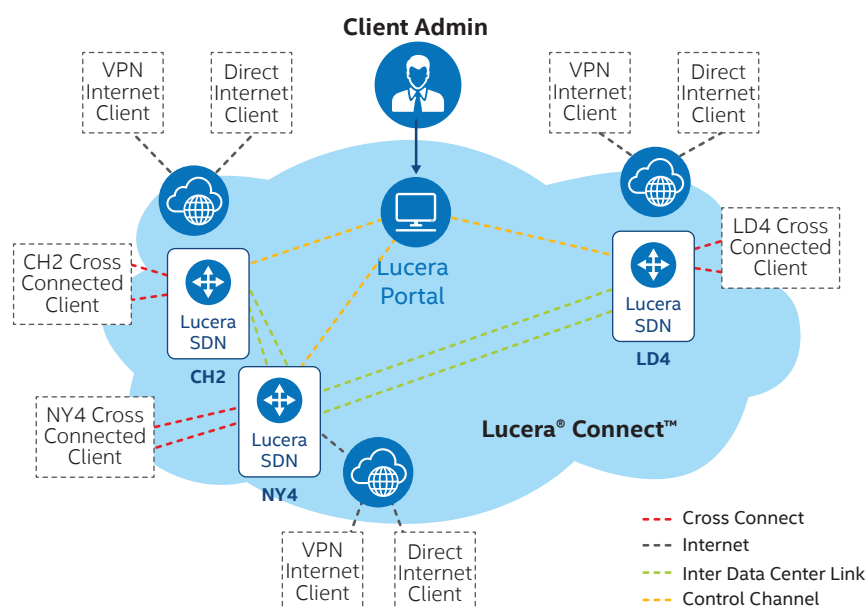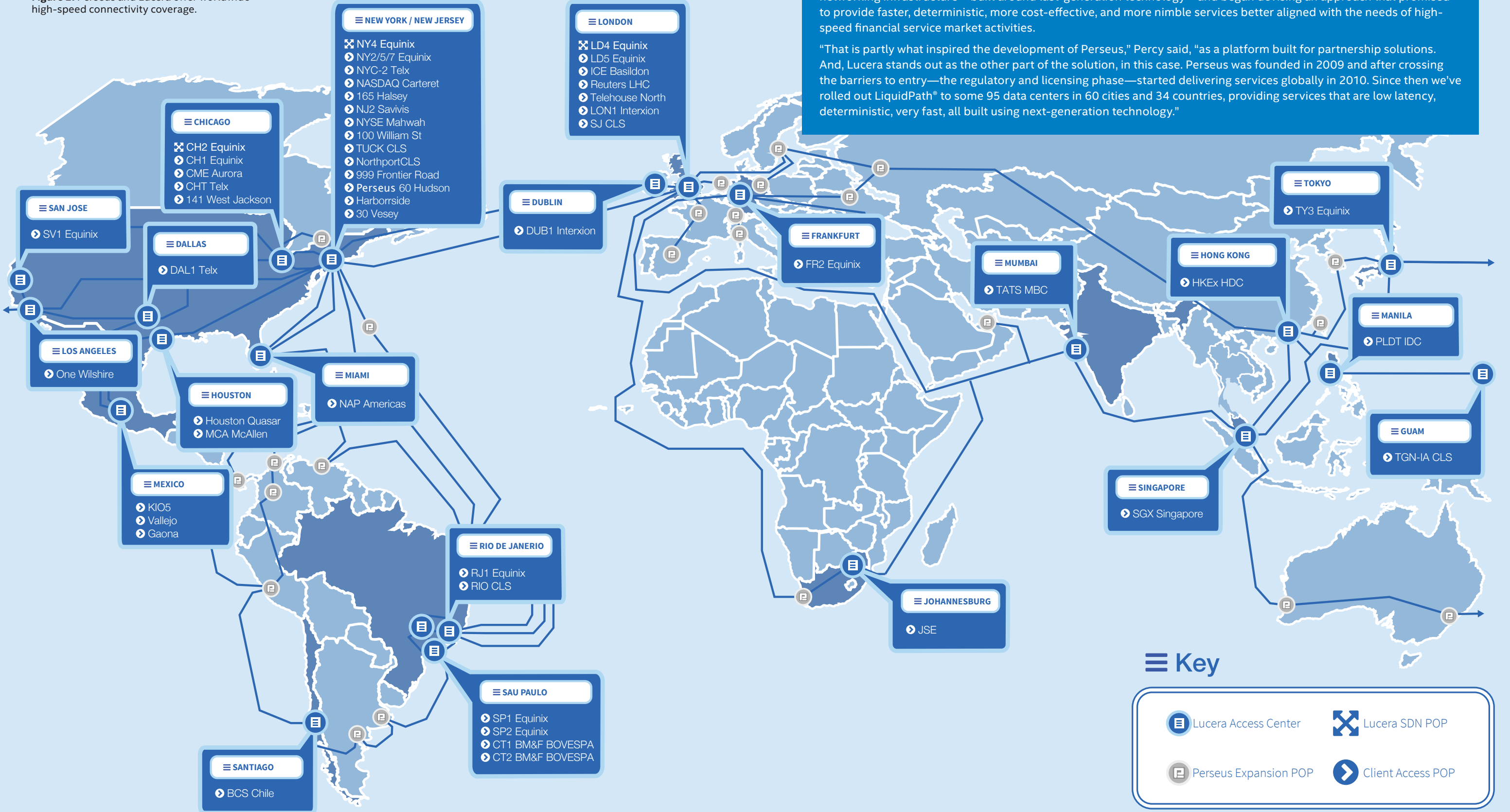
- Jacob Loveless, CEO, Lucera

Figure 1. Lucera® Connect™ architecture gives clients a central management portal.

Figure 2. Perseus and Lucera offer worldwide high-speed connectivity coverage.

Perseus: Meeting the Challenge of High-Speed Connectivity

Perseus delivers services and connectivity to a wide span of industry sectors, including financial services, eCommerce, media, and iGaming. The company recognized the challenges and failings of the traditional financial services networking infrastructure—built around last-generation technology—and began devising an approach that promised to provide faster, deterministic, more cost-effective, and more nimble services better aligned with the needs of high-speed financial service market activities.

"That is partly what inspired the development of Perseus," Percy said, "as a platform built for partnership solutions. And, Lucera stands out as the other part of the solution, in this case. Perseus was founded in 2009 and after crossing the barriers to entry—the regulatory and licensing phase—started delivering services globally in 2010. Since then we've rolled out LiquidPath® to some 95 data centers in 60 cities and 34 countries, providing services that are low latency, deterministic, very fast, all built using next-generation technology."

NEW YORK / NEW JERSEY
- NY4 Equinix
- NY2/5/7 Equinix
- NYC-2 Telx
- NASDAQ Carteret
- 165 Halsey
- NJ2 Savivis
- NYSE Mahwah
- 100 William St
- TUCK CLS
- NorthportCLS
- 999 Frontier Road
- Perseus 60 Hudson
- Harborside
- 30 Vesey

LONDON
- LD4 Equinix
- LD5 Equinix
- ICE Basildon
- Reuters LHC
- Telehouse North
- LON1 Interxion
- SJ CLS

CHICAGO
- CH2 Equinix
- CH1 Equinix
- CME Aurora
- CHT Telx
- 141 West Jackson

SAN JOSE
- SV1 Equinix

DALLAS
- DAL1 Telx

DUBLIN
- DUB1 Interxion

FRANKFURT
- FR2 Equinix

TOKYO
- TY3 Equinix

MUMBAI
- TATS MBC

HONG KONG
- HKEx HDC

MANILA
- PLDT IDC

LOS ANGELES
- One Wilshire

MIAMI
- NAP Americas

HOUSTON
- Houston Quasar
- MCA McAllen

GUAM
- TGN-IA CLS

MEXICO
- KIO5
- Vallejo
- Gaona

SINGAPORE
- SGX Singapore

RIO DE JANERIO
- RJ1 Equinix
- RIO CLS

JOHANNESBURG
- JSE

SAU PAULO
- SP1 Equinix
- SP2 Equinix
- CT1 BM&F BOVESPA
- CT2 BM&F BOVESPA

SANTIAGO
- BCS Chile

Key
- Lucera Access Center
- Lucera SDN POP
- Perseus Expansion POP
- Client Access POP

"As Perseus and Lucera come together, Lucera with its SDN and with its client edge connection, the Perseus core value proposition LiquidPath extends that all the way to the desktop of the trading firms. So that control of the network and parties to connect to goes back to the trader, the exchange, and the banker."

– Jock Percy, CEO, Perseus

Intel: Providing the Hardware and Expertise for SDN/NFV Networking

Lucera draws on Intel's expertise during product development, performing prerelease testing of upcoming processors and using Intel road maps as a planning tool for engineering developments. Platform components for Lucera Connect are engineered to take advantages of processor advances and the availability of new features, building on the steady cadence of Moore's Law to ensure customers a degree of performance to meet the high expectations of the financial services industry.

To fully support the scalability and flexibility required in high-performance cloud environments, the Lucera Connect Platform includes the Intel® Xeon® processor E5 v3 family and Intel® Ethernet Converged Network Adapters. Intel and Lucera worked together to implement solution features that incorporate Intel® Data Direct I/O Technology and the Data Plane Development Kit. Lucera also created the custom SDN software that is part of the infrastructure. The two companies continue to explore future solutions and engage in projects to make optimal use of the Intel architecture framework on which Lucera Connect runs.

Benefits of a Converged, Virtualized Financial Services Infrastructure

The benefits of a converged, virtualized network infrastructure tailored to financial services applications include:

- Centralized control of network resources and assets with the capability of ramping up or ramping down network services and resources as needed, dynamically and automatically

- The ability to deploy on the latest hardware to take advantage of technology advances in processing and networking

- Ease of provisioning that allows financial service firms to strategize, develop, and deploy new innovations and products in a short time

- Freedom from extreme capital expenditures associated with traditional network infrastructures that are more physical than virtual

- The agility and flexibility to redefine and restructure the boundaries of a wide-area network in real time to correspond to client and customers needs, entering new geographies and engaging cross-connects with prime data centers in support of financial services missions

SDN and NFV are an important part of the industry-wide movement toward greater virtualization and converged infrastructures. The success of SDN and NFV is largely due to the speed at which it is possible to provision a strategy, test the strategy, deploy the strategy, and then execute globally. If the approach does not work—does not earn sufficient revenues—it is easy to close down the operations, rethink the approach, make changes globally with low or no penalty, and then continue to iterate until the revenue opportunities are realized. The tradeoff is that integrating SDN and NFV into a financial services infrastructure can be a complex challenge. Bringing together the necessary expertise to accomplish this—as was the case with the Lucera, Perseus, and Intel engagement—minimizes the difficulties.

The kinds of scenarios that are well suited to the SDN/NFV model involve rapid planning and deployment. Visualize a trading firm evaluating IT investments that requires 20 servers in 20 countries. Ideally, all of the servers should be available the next day, but with traditional networking it will take three months—not including the time it takes to get the circuits connected. With the immediate provisioning and availability of resources through SDN, the firm can go global with new servers in a matter of days. The Lucera and Perseus partnership is enabling democratization of trading through SDN. With Lucera's SDN platform and Perseus connectivity, a company does not have to be a large, global enterprise to be able to trade globally.

In response to a question about the challenges and unmet needs that the converged Lucera and Perseus solution addresses, Percy responded: "For us, there are primarily two kinds of users. First, there is the broker/dealer or the market participant. Then, there is the trader, who is often the end-user of our customer. Imagine that we are talking about a large, nationwide bank. The bank pays to connect to upwards of hundreds, if not thousands, of connections to broker/dealers and traders, institutional investors, and so on. They pay to connect to those

folks in order to get their business. By choosing Lucera Connect, the bank is a winner in this because their costs are an order of magnitude lower, time to market is near instantaneous, and they can pivot and change if that customer's trade flow does not amount to profit. The end users, those buy-side investors, those traders, those institutions that connect to the bank and several other end users—whatever institutions are involved—they win as well. Because it is easier for them to do business, and they are not beholden to the physical, "nailed-up" type of services that have been in place for many years. Those services are hard to change, and it requires months of change control. So there are a couple categories of winners. This changes the way anyone can connect in Capital Markets and addresses the challenges across the breadth of the financial market."

Clock Synchronization Considerations

The accuracy of time stamps across trading markets has powerful implications in an era where high-frequency trading has caused a fundamental rethinking of the level of precision that is necessary to effectively support operations. Perseus offers clock synchronization services that help prevent badly timed trades, support auditing and analysis of log files, ensure compliance with newly introduced regulations, and provide precision of time stamping ranging from 50 microseconds to 1 nanosecond, depending on the selected service. Clock synchronization provided by Perseus PrecisionSync™ Time Services operates as a utility with servers located in widely separated locations around the world remaining in sync with each other.

Proposed industry regulations associated with MiFID II can also be supported. However, attempting to implement nanosecond-level time stamping when current industry requirements are delineated in full seconds could be counterproductive. Perseus notes that most firms are not well-equipped currently to handle this level of precision throughout their operations.

Typically, if a firm has a requirement to deploy high-precision time appliances at a global location, it is locked into the traditional, archaic CapEx model, which means investing in expensive equipment that has a limited lifespan and that requires a complex setup process and ongoing maintenance. Perseus addresses this limitation by providing precision clock services that can be implemented through the same physical cross-connect that provides high-performance access to prime data centers.

Jock Percy commented, "Keep in mind that a lot of these types of services are essentially utility functions. This is not secret sauce. This is not trading software. This is utility functionality that should be democratized. That is what we are able to do with our time synchronization services. Without the availability of this service, firms need to have a very skilled specialist and a rather rare PDP engineer on staff, or more likely three of these specialist to manage a 24/7 global trading business. Do-it-yourself is a serious danger zone that Perseus and Lucera help firms avoid."

Alex Viall, board adviser for Perseus, summarized the issue: "The whole basis for this is that the markets are increasingly complex and deep. There is a real need around the monitoring of those markets for extreme accuracy. People on the regulatory side, people on the legal side, and people on the audit side all need to be able to go back and reconstruct a trading situation. That's why they are not going to tolerate any inaccuracy beyond what is allowed within the rules."[2]

"The reality of time synchronization will prove to be a benefit for the firms," Viall continued. "I think a lot of them have some bad legacy systems that need changing. I think it's just another thing that will make their lives easier, certainly in terms of being able to record and report to the regulators."

Conclusion

The scaling of data centers over previous decades was accomplished by adding hardware to increase the physical capacity. Server sprawl, inefficient use of resources, maintenance headaches, slow provisioning, and excessive capital expenditures were all byproducts of this approach. SDN and NFV, as used by Perseus and Lucera to develop a high-performance financial services infrastructure, provides a more agile, manageable approach, establishing a different model for enterprise networking that is better equipped for innovation and rapid delivery of services. Built on an Intel architecture-based framework, technology advances can be incorporated into the infrastructure as quickly as new generations of processors and network devices are introduced.

With the infrastructure and services described in this paper, financial service companies can reduce operational expenses and reach new markets faster at a much lower cost, capitalizing on the ease of provisioning, reliance on standard high-volume servers, virtualized network components, and centralized management tools that provide a clear view of network resources and operations.

Lucera's on-demand IaaS takes full advantage of the technology advances derived from Intel architecture-based servers. The global connectivity, precision clock services, and other offerings provided by Perseus complement the Lucera IaaS and make it possible to compete across the diverse financial services marketplace, leveling the playing field to allow mid-sized firms to match or exceed the reach and capabilities of the major players in the industry.

LEARN MORE

Learn more about Lucera Connect:
https://lucera.com/connect.html

Learn more about Perseus:
http://perseus.co/#focus

Learn more about Intel® Network Builders:
https://networkbuilders.intel.com/

[1] Cantor Fitzgerald. "Jacob Loveless Comments: Lucera Details On-Demand Infrastructure for Electronic Trading" (2014). http://www.cantor.com/press_releases/Lucera_Details_On-Demand_Infrastructure_for_Electronic_Trading.html

[2] DeFrancesco, Dan. "Sell-Side Technology - Tough Time: MiFID II Clock Synchronization Proposals Seen as Too Harsh," September 2015. http://perseus.co/sell-side-technology-tough-time-mifid-ii-clock-synchronization-proposals-seen-as-too-harsh-by-dan-defrancesco/