

Crossing the Disaggregation Chasm

White Paper

Executive Summary

The Software Defined Networking revolution catalyzed a paradigm shift in thinking and approach, realizing the vision of open networking. An integral element of SDN is network disaggregation, which offers unprecedented agility while redefining TCO as well.

This white paper addresses the What, Why, and How of network disaggregation, beginning with a concise definition, followed by a compelling business case, and definitive examples that illustrate the essential role that disaggregation is playing for 5G. No longer theoretical, network disaggregation has crossed the chasm, and is poised to alter the course for networking and telecommunications, while yielding compelling near-term benefits.

Introduction

Open networking has evolved dramatically from a decade ago, when Software Defined Networking (SDN) and Network Functions Virtualization (NFV) were conceived. From the outset, the open networking movement was catalyzed by a strong desire to break free from the proprietary strong-hold incumbent vendors exerted on all segments in the network.

SDN and NFV catalyzed a paradigm shift away from vertical integration, which has unleashed a wave of innovation yielding network virtualization, powerful processors and networking silicon, and unprecedented automation. Network disaggregation ensued, ushering in a new era of agility and choice, at dramatically lower price points.

In this report, we will examine the important role that network disaggregation is playing in transforming the entire networking and telecommunications industry, and why the timing is right to begin the journey.

What?

Open networking has been characterized by a series of highly ambiguous terms – virtualization, automation, and openness, among them. At an October, 2020 webinar on the topic: [Transforming 5G Networks With Disaggregated Cell Site Gateways](#), industry analyst firm [Heavy Reading](#) defined network disaggregation as:

The separation of networking equipment into functional components and allowing each component to be individually deployed:

- *Encompasses separation of software OS from underlying hardware*
- *Requires open APIs to enable SDN control*

Figure 1 depicts a high-level disaggregated networking device. Fundamental to network disaggregation is properly selected abstractions that decouple software and hardware components, making them much simpler to swap and replace. Standardized open APIs and interfaces facilitate integration internal to and external to the device. From the Media to Application layers, disaggregation offers many opportunities for transformation, at the operator's pace (vs. that of their vendors).

Another perspective is that disaggregation enables network operators to regain control of their networks from incumbent vendors who have dominated the industry for decades. Their proprietary architectures have hindered innovation, constrained availability of required features, and significantly driven up costs.

Like any successful networking innovation, disaggregation substantially reduces costs through liberal adoption of standards, introduction of white box hardware, and open source. Even more compelling, disaggregation offers a better way to build networks. By allowing operators to capitalize upon virtually any new technology, on their own timeframe, disaggregation replaces purpose-built appliances with common platforms that may be tailored to support a wide range of use cases.

Far more than a new architecture, disaggregation motivates open, and inclusive ecosystems, that removes barriers to entry and encourages participation. Each stakeholder is afforded choice, up and down the stack to stimulate even a greater degree of invention and experimentation, leading to disruptive change.

Furthermore, disaggregated networking begins and ends with network operators, who have been forced to compromise for far too long. Vendor lock-in, will be steadily eroded.

Why?

There is an old adage that ‘No one was ever fired for selecting <add your favorite> incumbent vendor’. That antiquated view originated in the early days of computing (with IBM), was sustained with the advent of networking, and incurred a huge penalty on cost and agility.

Disaggregation unshackles operators from proprietary, vertical networking stacks that characterized the mainstream for decades. Once hardware and software are decoupled, operators are empowered to exploit Best-of-Breed technology that can be adapted to meet specific goals and priorities. Major benefits include:

Avoid Vendor Lock-in: For many network operators, reliance on incumbent vendor(s) has yielded familiarity, procurement simplicity, and mitigation of risks. The tradeoffs include proprietary data formats and interfaces designed to constrain migration, stratified feature sets to coerce purchase of higher-end (and more expensive) hardware, and significantly higher TCO.

Furthermore, vendor lock-in converges on mediocrity as incumbent vendors are constrained by:

- Outdated architectures saddled by long-term technical debt
- Huge investments in aging ASICs and operating systems platforms
- Need for multi-generation, backward compatibility
- Proliferation of purpose-built platforms

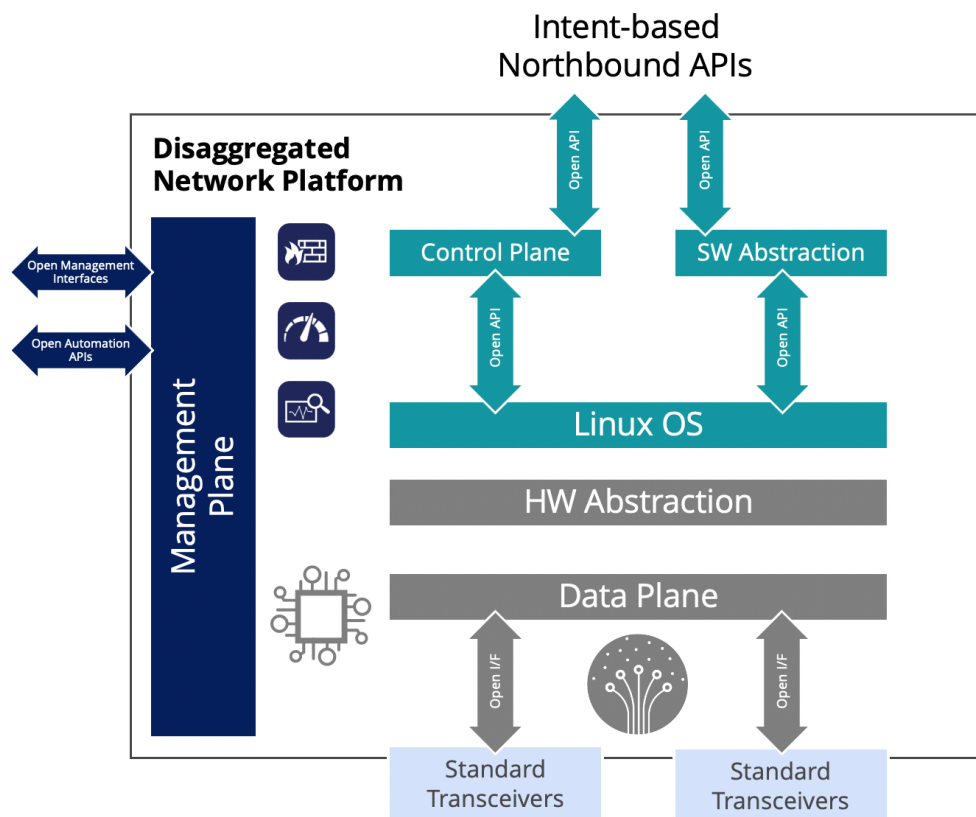


Figure 1: Network Disaggregation – Functional Components

There is a better way. Network disaggregation frees operators from the many restrictions imposed by vendor lock-in, offering:

- **Choice** – instead of over-reliance on a single vendor, network operators are afforded a wide range of alternatives, that may be readily integrated through open interfaces.
- **Advanced Technologies** – New technologies may be readily adopted as needed based on operator and not vendor priorities.
- **Pace of Innovation** – Operators control when new technologies and products are introduced in the network based on their individual needs.
- **Business Continuity** – Operators may readily swap not only components, but vendors as well, to mitigate exposure to disruptions in the supply chain.
- **Access to Open Ecosystems** – Operators may exploit inclusive and open ecosystems that are governed by a broad community vs. controlled a single incumbent vendor.

For example, a particularly innovative alternative to incumbent vendor hardware was driven by the Open Compute Project ([OCP](#)). OCP introduced open source hardware, and serves as an ideal platform for operators to adopt advanced optical technologies, state-of-the-art advances in silicon, and hardware enhancements. Literally hundreds of [OCP-qualified solution, products, and modules](#) are available from dozens of vendors around the globe.

Another more recent example may be illustrated for the next generation of mobile communications. Mobile operators are increasingly turning to standardized hardware for 5G. Figure 2 illustrates the importance operators are attaching to white box hardware, because of the flexibility to address a wide range of requirements, scalability and significant cost reduction. [AT&T is already deploying white boxes in their mobile network](#) and [identified Disaggregation and White Boxes as fundamental to their digital transformation](#).

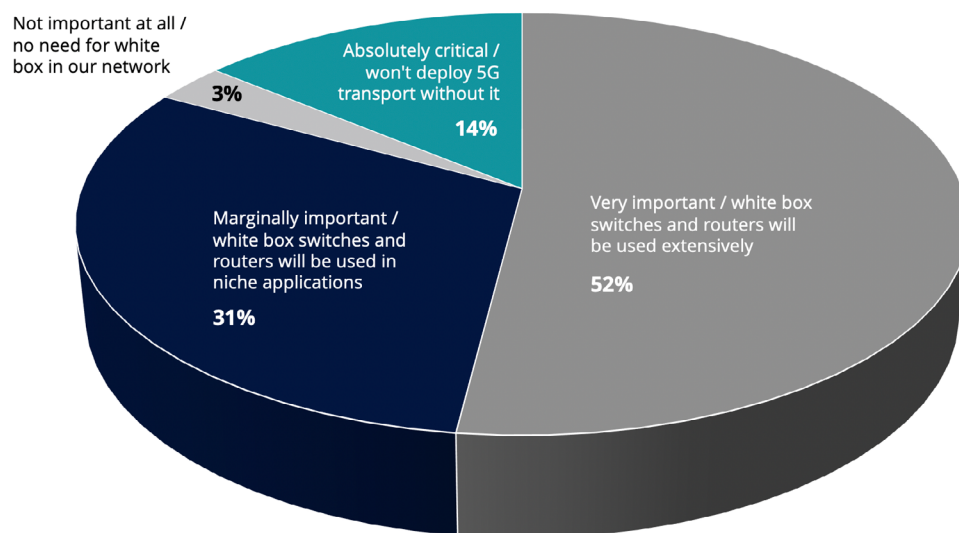


Figure 2: Importance of White Boxes for 5G Transport

Source: [Operator Strategies for 5G Transport: 2020 Heavy Reading Survey](#)
Sterling Perrin, Principal Analyst, July, 2020

Enables the common platform: Network disaggregation fosters common platforms that address a much broader set of target use cases than purpose-built appliances. Open platforms empower operators to minimize the purpose-built platforms in their networks, and associated carrying costs.

Key benefits of a common platform include:

- **Agility** – A single common hardware or software platform may support a wide range of use cases.
- **Best-of-Breed** – Open platforms are designed for extensibility and accelerate adoption of new products and technologies through open interfaces
- **Scalability** – Common software platforms may be readily deployed in a range of hardware platforms featuring orders of magnitude of interface and switching bandwidth.
- **Openness** – Adoption of open source software, hardware, and open APIs drive down CapEx and OpEx costs through standards, and ease of integration.
- **Streamlined Operations** – Minimize hardware, sparing, training, and deployment costs. In addition, open management interfaces and common network management systems significantly reduce ongoing operational costs.

One example of an open platform is the Disaggregated Cell Site Gateway ([DCSG](#)), defined by the Telecom Infra Project ([TIP](#)) Open Optical Packet Transport ([OOPT](#)) group. The DCSG specifies a low-cost platform for mobile network transport as illustrated in Figure 3. DCSG platforms may support 3G, 4G, and 5G architectures for mobile transport. DCSGs have been adopted by major mobile operators around the globe, exceeding tens of thousands of installations.

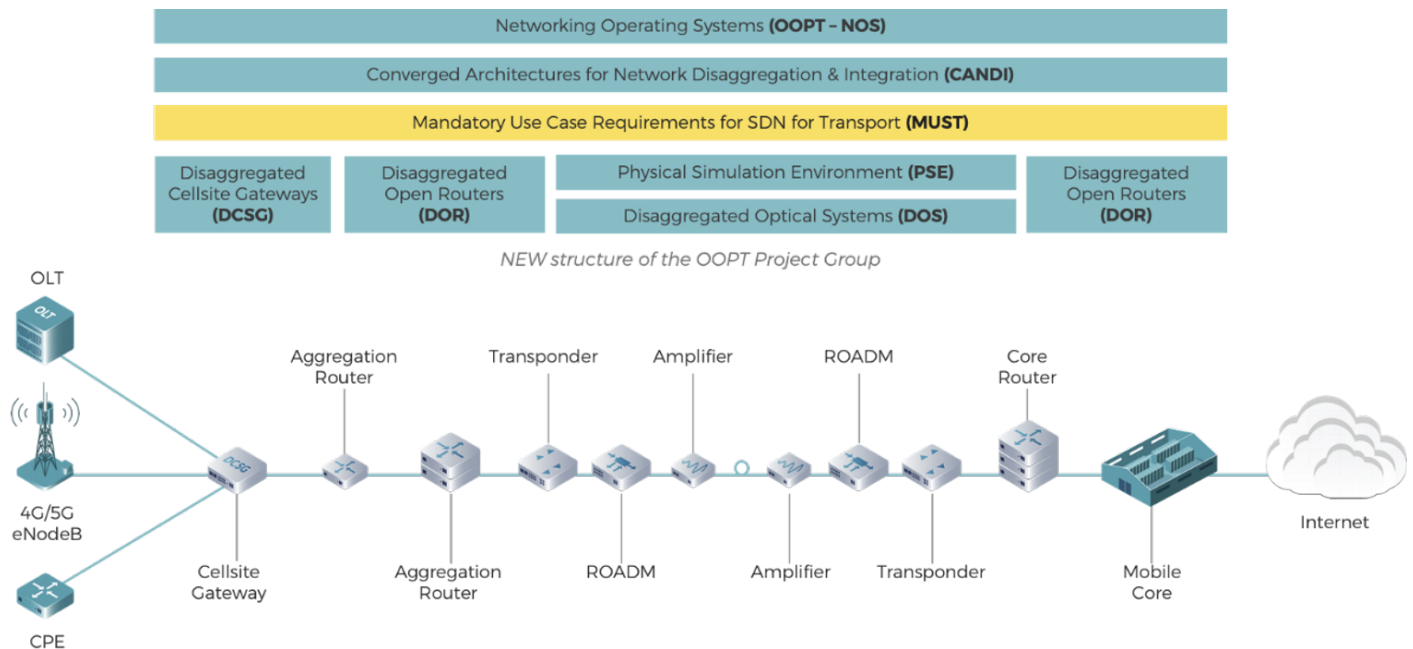


Figure 3: TIP Mobile Transport Segmentation and Standards

Source: [Telecom Infra Project Open Optical and Packet Transport group](#)

IP Infusion has realized the vision for the 5G DCSG and Cell Site Routers (CSRs) with a common [NOS platform](#) that empowers mobile operators to migrate at their own pace. IP Infusion's powerful Control and Management Planes allow a single device to address many diverse use cases by offering a comprehensive set of communications services. Open platforms offers many benefits for disaggregating the 5G network:

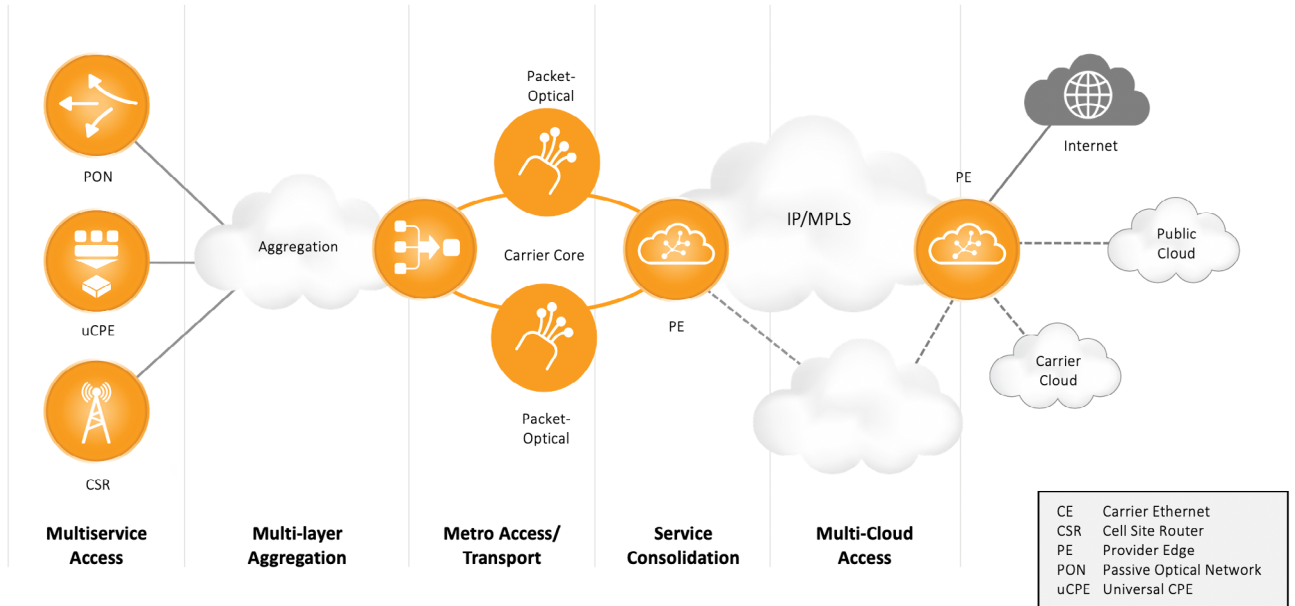
- **Common hardware platform:** Provide orders of magnitude of scalability, using a range of third-party hardware
- **Common software platform:** Enable migration from legacy 4G and 3G services to the software-defined future that 5G represents, with minimal disruption
- **Broad features:** 5G mobile transport requires an extensive communications services, and features (e.g., timing and synchronization) that may be provide by the NOS platform to obviate the need to rip and replace hardware
- **Multi-Vendor Interoperability:** Disaggregated hardware is inherently easy to integrate based on open architectures designed for integration, open APIs, open source software, and open standards.
- **Extensibility:** 5G networking was designed for disaggregation, necessitating a new degree of flexibility. As the RAN is virtualized, mobile transport must be highly configurable, necessitating low-cost disaggregated platforms capable of supporting Front-, Mid-, and Backhaul transport, along with adjacent segments, such as transport, aggregation, and the mobile core.

One mobile operator that is exploiting disaggregation to enable 5G is [Asia Pacific Telecom](#) (APT), who intends to deploy thousands of Cell Site Routers based on [IP Infusion's CSR platform](#), hosted on White Box hardware. APT expects to "[accelerate network transformation, expand the depth and breadth of 5G applications, and realize more business opportunities in a more flexible manner.](#)" Such agility do not compromise the extensive cost savings that APT expects to achieve as well.

Drive Down Total Cost of Ownership: No networking technology innovation may be implemented at scale without significant cost reduction on both the CapEx and OpEx sides of the ledger. Network disaggregation offers compelling Total Cost of Ownership (TCO) advantages, as summarized below:

- **Reduce Hardware costs:** Disaggregation offers a broad range of cost savings through the use of general purpose, open hardware. Open hardware achieves the highest performance at each price point, based on merchant silicon, and standardized designs. In addition, Best-of-Breed components (e.g., optical transceivers, or network silicon) further drive down costs and enhance performance and functionality as well. Virtualization further drives down OpEx, by reducing stranded capacity, along with space and energy costs.

- **Reduce Software costs:** Network disaggregation are typically built upon an open software platform that is designed to be integrated with components from multiple vendors. Open APIs significantly reduce the cost and time to orchestrate and automate the platform in a broader back-end environment, and reduces OpEx as well. Open source software components also drives down development and support costs.
- **Reduce operational costs:**
 - **Adoption of common platform, vs. purpose-built elements:** The fundamental macro-building block for disaggregation, the common platform, drives down TCO by minimizing the need for purpose-built devices, simplifies inventory by supporting far more use cases, require far fewer spare parts, and streamlines training and support costs.
 - **Migration costs:** For operators large and small, most networks are hybrid networks, and required to sustain legacy and existing revenue-producing services, while offer enabling migration to new architectures. Disaggregated platforms provide comprehensive communications and may be adopted with minimum disruption to the existing network.
 - **Open architecture:** Many of the benefits of openness have already been introduced, such as the advantages of merchant silicon and open hardware platforms, standardized management interfaces and Open APIs to facilitate integration.
- **Additional Considerations:** TCO may also be driven down by flexible pricing and licensing, where fewer options equate to greater agility. Open ecosystems foster development of many new components, tools, and additional value-added services, and the innate ability to future-proof investments through unprecedented expandability over the long-term.



ip IP Infusion Use Case

Figure 4: IP Infusion NOS platform is deployed throughout the network.

How?

IP Infusion is realizing the vision of network disaggregation through a family of industry-leading Network Operating Systems platforms that have been widely deployed throughout Service Provider networks (see Figure 4), and are designed to substantially decrease TCO.

IP NOS Platforms embrace open standards and APIs, and have pioneered open source routing since the earliest days. Major open source routing projects including [Zebra](#) (started by [IP Infusion's founder Kunihiro Ishiguro](#) in the mid-1990s), [Quagga](#), [FRR](#) among them.

In fact, IP Infusion's business has evolved over the years to enable OEMs with a highly modular, carrier-grade software stack to architect network elements- arguably the first viable network disaggregation solution.

IP Infusion has overcome many of the major challenges of disaggregation:

Offer Common Platforms: At the core of IP Infusion's solutions are open NOS Platforms that realize the vision of network disaggregation (see Figure 5). Both [OcNOS](#) and DANOS vyatta Edition ([DvE](#)) are available in both software and bundled configuration, pre-integrated in a range of white box hardware sourced by leading ODMs. The IP Infusion Control Plane provides a broad range of Layer 1-7 protocols and services on par with the leading incumbent vendors, while carrier-grade availability and robustness are delivered by IP Infusion's Management stack.

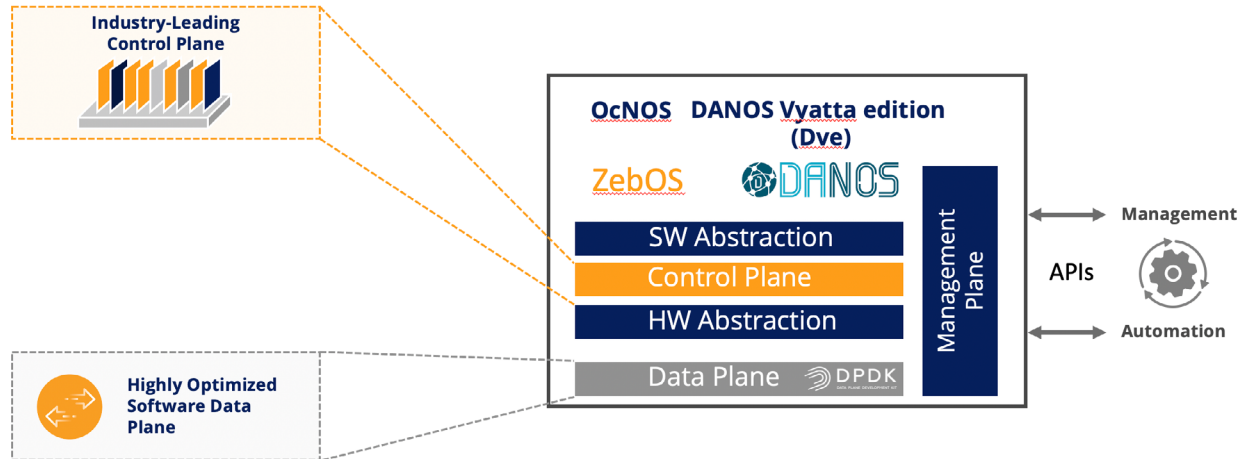


Figure 5: IP Infusion NOS Platform Architecture.

Embrace Openness: IP Infusion’s entire product portfolio is built upon an open architecture that exposes open APIs and interfaces to readily integrate into existing management and orchestration frameworks. Open source building blocks have been liberally adopted, and [AT&T selected IP Infusion](#) as the exclusive integrator to offer the [only commercial distribution for DANOS](#), the Linux Foundation Networking ([LFN](#)) Distributed Aggregated Network Operating System project ([DANOS](#)) project.

Enhance Agility: Agility is the essential element to achieve effective managed services delivery as enterprises have been conditioned to expect cloud-like responsiveness. The IP Infusion Control Plane provides a broad range of protocols and services on par with incumbent vendors to facilitate migration from legacy services to software defined services for optical and mobile transport, aggregation, and carrier-grade routing.

Manage Risks: Among the primary concerns about network disaggregation is how solutions may be designed, integrated, and supported. Operators are not receptive to replacing vendor lock-in, with Systems Integrator lock-in and the need for another third party. Thus, IP Infusion offers a fully integrated and qualified product portfolio in conjunction with our open ecosystem partners. All IP Infusion products are backed by one-stop maintenance and support services, including carrier-grade, 7x24 telephone/email support.

Buyer Beware...

While network disaggregation offers compelling advantages, there are numerous misconceptions, which are addressed below.

Who is responsible for support? While Hyperscalers have built their cloud infrastructure based on disaggregated devices, network disaggregation appears to be a scary proposition to some networking operators. Ability to mix/match virtually any network silicon, transceivers, hardware, and software represents too much of a good thing. Many operators are not motivated nor equipped to develop their own integrated devices, and prefer integrated solutions. Operators are seeking ‘one throat to choke’ to ensure that problems are rapidly detected, isolated, and remediated.

Disaggregation does not necessarily imply disorder. For instance, IP Infusion not only enables disaggregation of network elements, but offers fully qualified network platforms backed by comprehensive, carrier-grade support.

What about Legacy Support? For most operators, deployment of new technologies must address migration from existing services. Moving to disaggregated platforms must preserve the tens of millions (USD\$) of investments in legacy infrastructure and services that have already been deployed.

The benefits of disaggregation may be realized without compromising essential communications functionality. IP Infusion's platforms feature an industry-leading control plane on par with incumbent vendors' that provides the extensive communications services necessary to support revenue-producing end-customers.

How does it scale? By exploiting the tremendous advancements in merchant silicon, acceleration, and optical technology, disaggregated platforms scale from virtualized CPE to core routing (and many use cases in between). Long ago the Hyperscalers discovered they could leverage disaggregated platforms to build carrier-scale, global networks, which serve as the backbone for the cloud. Availability of standard, white box hardware actually provides more choices than any incumbent vendor, scaling orders of magnitude of performance.

Disaggregated platforms, however, must be enhanced for the carrier environment. Capabilities such as packet-based timing and synchronization, network protection, extensive monitoring, hardware-based security, etc. are essential. [IP Infusion's CSR product family](#) shares common software platform that scales from Gbps to 100s of Gbps, with the functionality to be deployed in the Front-haul, Mid-haul, or Backhaul networks.

The Breadth of the Ecosystem? Incumbent vendors invest millions (USD\$) to establish ecosystems to augment their products and solutions with extensive channel, Systems Integrator (SI), technology, and training partners, along with additional products and services that complement their offerings. While major vendors have done an admirable job in building their ecosystems over the years, they also suffer from one overwhelming deficiency. Such ecosystems place the incumbent vendor at the center of the ecosystem, and partners large and small are subordinated.

Disaggregation reverses the dynamics, placing the operator at the center. Open ecosystems are self-selecting – those who deliver compelling value thrive, and others fall by the wayside. Partnering for partnering sake is precluded; only alliances that unleash innovation, accelerate and enhance new service offerings, and drive down costs will endure.

Because of the widespread proliferation of core technologies and products, other operators commonly have overcome the issues at hand for a particular operator. And for those issues that have not been addressed, vendors are incentivized to overcome them, in anticipation of providing solution to multiple operators.

IP Infusion is building a [growing open ecosystem](#) of market leaders that offer operators choice, value, and confidence.

Is it future-proofed? An important advantage of network disaggregation is the ability to efficiently exploit ever-advancing technologies, both now and in the future. As network disaggregation gains momentum in the broader marketplace, technology suppliers are motivated to commercialize new technologies and associated products, based on open standards to facilitate integration into disaggregated platforms.

Incumbent vendors cannot out-invest the broader open networking community over the long term. Over time, operators will increasingly demand disaggregated equipment to attain the choice and agility they are seeking. Such products must be architected to accommodate rapid change, for both hardware and software components. Future-proofing investments is especially important considering the projected lifetime of network infrastructure.

Reliance on open platforms is essential, especially as the entire stack is virtualized. Extensibility may only be realized when the appropriate abstractions are implemented to accommodate advances in silicon, management, or data plane technologies.

For instance, IP Infusion has meticulously architected NOS platforms that readily accommodate new technologies at any layer in the stack, and whether delivered by upstarts or industry leaders. Software and hardware abstraction layers, open APIs and management interfaces, enable seamless integration without compromising the compelling cost benefits of white box, general hardware.

Conclusion

Network disaggregation offers pervasive benefits to network operators who are seeking to exploit the open networking revolution, and the compelling advantages it yields. Far more than White Box hardware, disaggregated platforms are a tool for network transformation in an era dominated by the Cloud. They achieve significantly higher agility, and TCO reduction, while future-proofing the network as well.

Well-established hardware and software components have evolved over the years, and have crossed the chasm to yield fully-qualified, and supported platforms that have been deployed around the globe.

Network disaggregation is the future of networking, available today.

For more information:

Contact IP Infusion at www.ipinfusion.com.

ABOUT IP INFUSION

IP Infusion, a leader in disaggregated networking solutions, delivers enterprise and carrier-grade software solutions allowing network operators to reduce network costs, increase flexibility, and to deploy new features and services quickly. IP Infusion is headquartered in Santa Clara, Calif., and is a wholly owned and independently operated subsidiary of ACCESS CO., LTD. Additional information can be found at <http://www.ipinfusion.com>

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