HaulPass Fiber: Next-Generation SDN Wireless Transport White Paper

VUBIQ NETWORKS

Making Millimeter Wave Ubiquitous

1 Introduction

Vubiq Networks, Inc. (VNI) has just released its latest E-band point-to-point wireless link product, the HaulPass Fiber. Designed to provide up to 10 Gbps Ethernet full duplex throughput, the new product has the industry's lowest power consumption, smallest footprint, and lowest latency for the 70/80 GHz E- band spectrum.

2 A New Architecture

The HaulPass Fiber departs from traditional microwave or millimeter wave (mmWave) radio link design by decoupling the radio frequency or RF components from the networking components. This design approach can be likened to an "RF Front End" (RFE) that is no longer burdened by the cost, power, and latency of network hardware. In this sense, the RF design, composed of the mmWave radio and modem components, is simplified in both hardware and software. The user traffic/data interface is presented as an Ethernet Layer 2 forwarding engine.

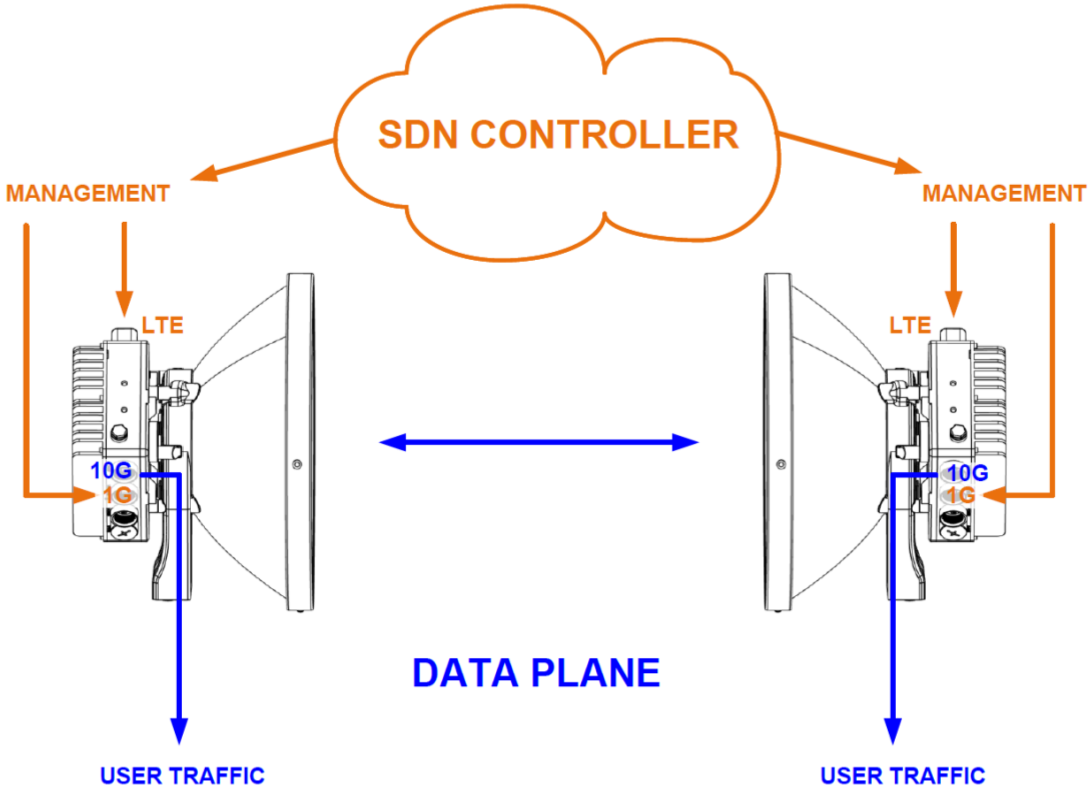

Figure 1. HaulPass Fiber Radio Link with SDN Controller and Traffic Connections

It was recognized that users have already established their specific network designs and do not want the added complexity of more network hardware when enabling wireless transport. Software-defined networking (SDN) is an approach that uses software through application programming interfaces (API) via the network configuration (NETCONF) protocol to communicate with the underlying hardware.

3 Absence of an Ethernet Switch

Specifically, the HaulPass Fiber connects the data port directly to the radio modem. A simple straight-through structure joins the 10 Gbps physical circuit, or 10G PHY, through the modem to the RF PHY without traversing an Ethernet switch. Any configuration and monitoring are provided through the management SFP or LTE ports via SDN NETCONF API interfaces. Since there is no switch in between, the system delay, or latency of the HaulPass Fiber E-band link is the lowest in the industry. The one-way system latency is 6.5 µs[1].

Without the need for an Ethernet switch, the associated management overhead, latency, cost, and power are significantly reduced. And, data security is enhanced since the data plane and the management plane are literally separated, which is not the case with an embedded switch. Hence the security boundary between the data and management planes is hardware enforced. Think of the HaulPass Fiber as a simple in-line extension for fiber, requiring minimal management. The light-touch approach, with the network connection as a Layer 2 forwarding engine, provides transparent protocol compatibility for MPLS, eCPRI, VoIP, video streaming, etc., since the Ethernet traffic is pipelined directly to the radio modem.

Note the simplicity of the HaulPass Fiber hardware design in Figure 2. The data plane is completely separated from the control section. Control, configuration, and management are interfaced via the 1G SFP port or the LTE modem.

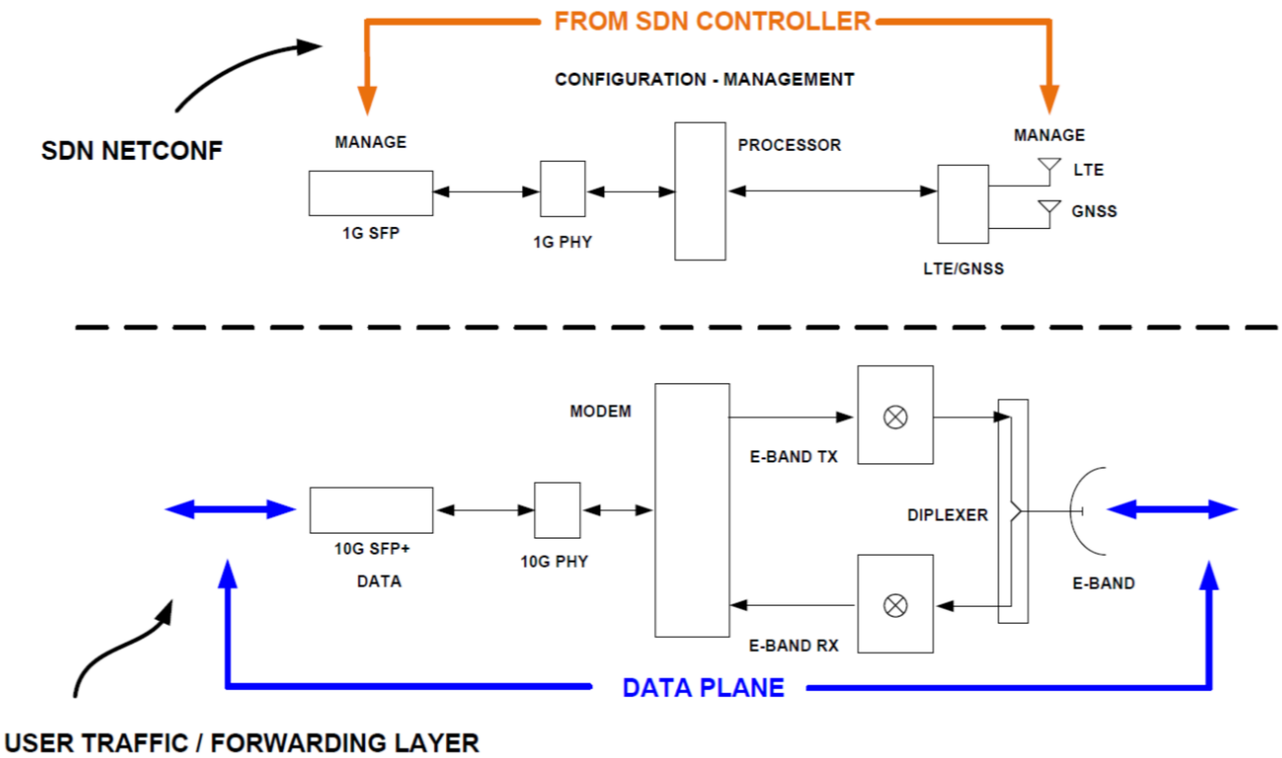

Figure 2. HaulPass Fiber High-Level Diagram

4 SDN Management

The telecommunications industry for both carrier and private networks is rapidly moving to cloud based, SDN management systems. Simply put, network configuration and control are software rather than hardware centric. Virtual networks can be created to separate functionality, control and security levels based on the requirements for a given network partition. Security is also enhanced since the SDN approach offers visibility into the entire network, giving wider view to any network threats , and also due to keeping the data plane and controller completely decoupled.

Traditional networking is depicted in Figure 3. Note the overlap of functions, and importantly, driven by hardware specific parameters. Each piece of network hardware in this model is unique, and requires the creation of special management functions. An example is the SNMP private MIB – private meaning different from product to product. Due to the difficulties in using specific “SET” commands in SNMP for configuration, the IETF came up with the idea of SDN using standardized models for management and configuration, called YANG models[2]. NETCONF is the protocol used which was created much earlier[3]. As the networking community is moving towards all SDN, it is also moving towards open systems, so that hardware interfaces can be standardized. The Open Networking Foundation (ONF)[4] and the IEEE[5] have also created standards for SDN management. As an example, the IETF has defined a standardized YANG data model for microwave and millimeter wave radio links[6]. This allows the manufacturers to create products that can be managed in a standardized manner moving towards open systems design.

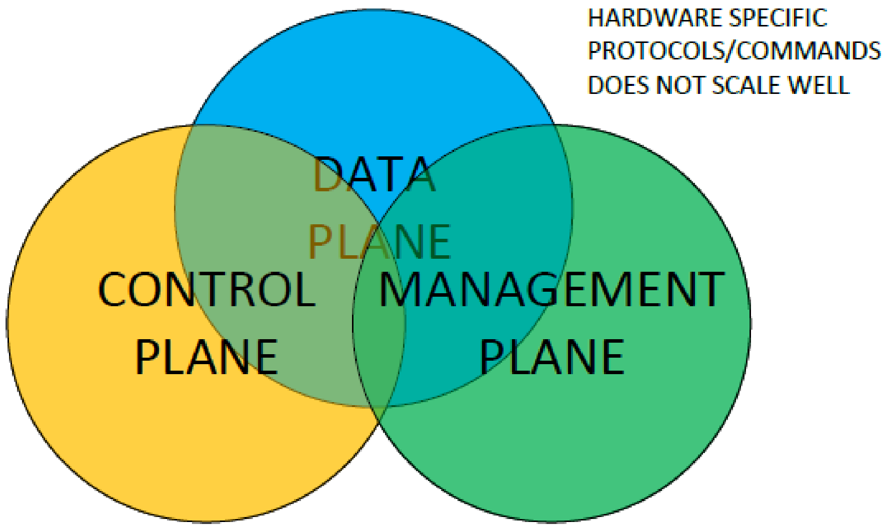

Figure 3. Traditional Networking Architecture

The Software-Defined Network architecture, or SDN, is shown in Figure 4. Typically, the network management Application Layer and the Control Layer are cloud-based, again moving towards a completely software defined environment. Through the use of standardized YANG models or files, diverse hardware interoperability, leading to open systems results. Specifically, YANG is a data management modelling language. Compared with an SNMP MIB, YANG is highly extensible, more hierarchical, and can distinguish between configuration and status.

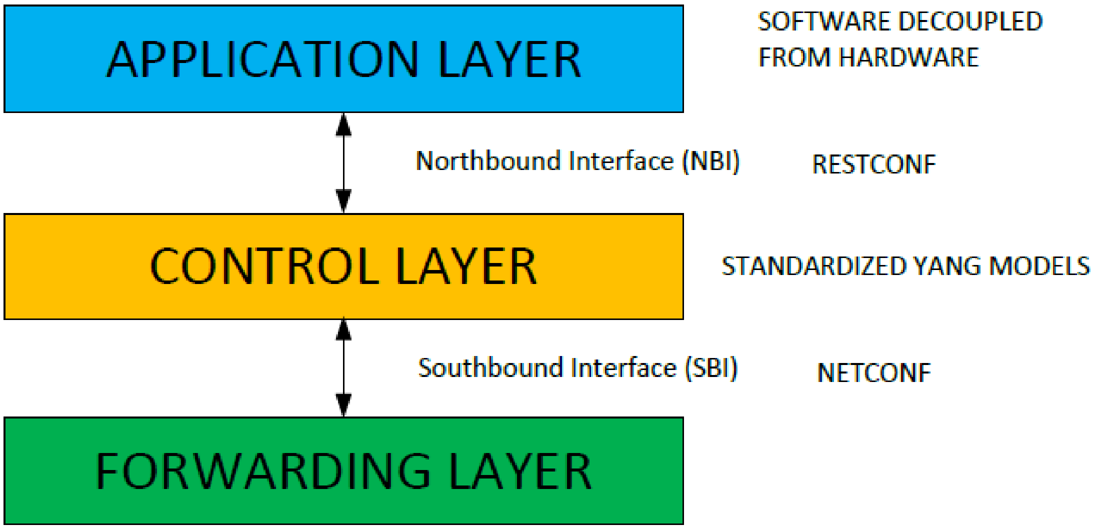

Figure 4. SDN Architecture

Through the creation of customized YANG models, the HaulPass fiber can be easily configured for specific customer and network management requirements, while avoiding any Ethernet switch monitoring or control requirements. The resulting model is simplified.

5 HaulPass Fiber Designed for SDN

As described above, the HaulPass Fiber has been designed to simplify network management, summarized by:

1. The radio and modem (user/data plane), are separate from the management plane
2. The simplicity of this architecture is identified as an *API-driven RF Frontend*
3. Switchless, so that the radio link performance is maximized (low latency, low power)
4. Designed to interface with an SDN, through NETCONF/YANG

To support this design, the software partitioned as shown in Figure 5. The Linux OS provides standardized functions with future proof programmability.

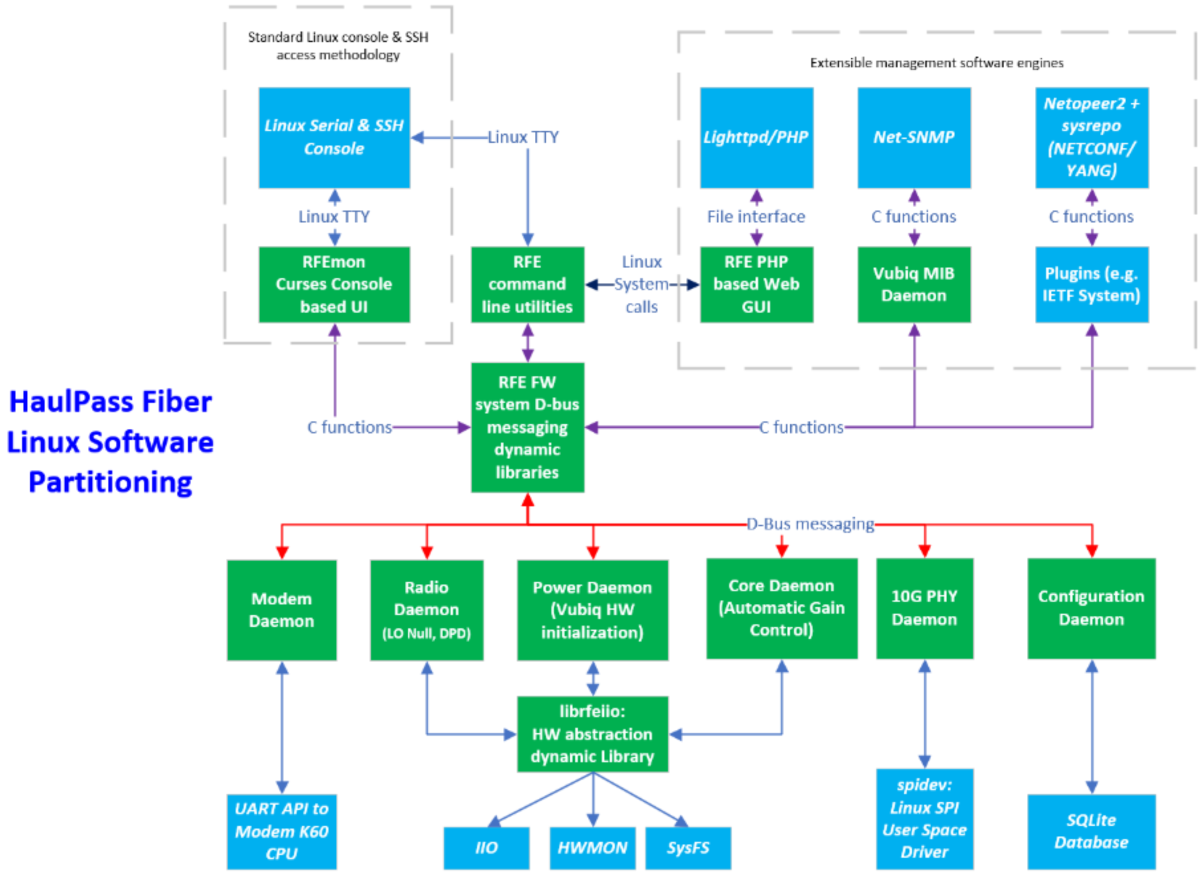

Figure 5. HaulPass Fiber High-Level Software Diagram

The NETCONF interface in the HaulPass Fiber is represented in the diagram at Figure 6. A standard method for implementing the NETCONF server in an embedded device/network element running Linux is to use the Sysrepo[7] engine along with the NETOPEER2 NETCONF server. Note the terminology used in this context: The NETCONF "Client" is actually what is hosted on the SDN controller application, and the "Server" is hosted on the embedded device/network element.

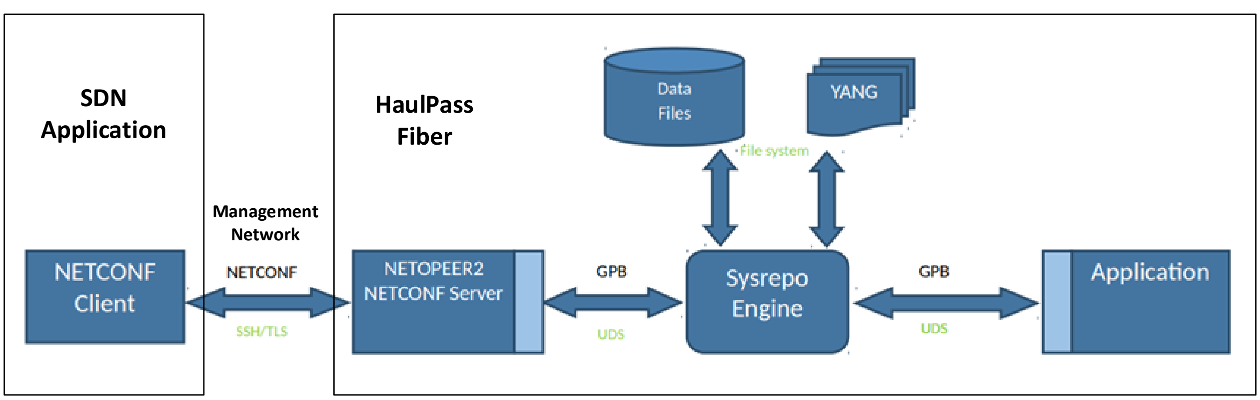

Figure 6. HaulPass Fiber NETCONF Server Interface and Sysrepo Engine

Various attributes can be monitored and configured on the device and is dependent on YANG data model implemented. Using the IETF RFC7317 YANG model for System Management[8], the HaulPass Fiber examples for a Remote Procedure Call (RPC), a Read-Only (RO) function, and a Read-Write (RW) function are shown in Figures 7, 8 and 9.

```
rpc system-restart {
nacm:default-deny-all;
description
"Request that the entire system be restarted immediately.
A server SHOULD send an rpc reply to the client before
restarting the system.";
}
```

Figure 7. HaulPass Fiber Example YANG Model for RPC (System Restart)

```
leaf current-datetime {
      type yang:date-and-time;
      description
            "The current system date and time.";
        }
```

Figure 8. HaulPass Fiber Example YANG Model for RO (Date and Time)

```
+--rw dns-resolver
            +--rw search* inet:domain-name
            +--rw server* [name]
            | +--rw name string
            | +--rw (transport)
            | +--:(udp-and-tcp)
            | +--udp-and-tcp
            | +--rw address inet:ip-address
            | +--rw port? inet:port-number
            +--rw options
                  +--rw timeout? uint8
                  +--rw attempts? uint8
```

Figure 9. HaulPass Fiber Example YANG Model for RW (DNS Resolver)

The diagrams in Figures 7 through 9 show the typical hierarchical structure of the YANG data model, which provides much better control and monitoring capability than earlier simple “SET” and “GET” functions implemented via SNMP.

6 Conclusion

The HaulPass Fiber radio link has been designed to meet the current demands of disaggregated, cloud based SDN management needs. By architecting hardware enforced out-of-band management in a switchless design, the management is simplified, and the performance is maximized.

The key takeaway from this white paper is the HaulPass Fiber has been designed to reduce the complexity of integrating a point-to-point radio link into the user's network. The simplicity of the architecture by partitioning the control and traffic sections allows natural connectivity into an SDN environment. Smaller, better, faster is literally the best description for the next generation design used in the HaulPass Fiber.

Footnotes:

1. RFC2544, frame size 1518B. Over the air propagation latency adds 3.3 μs/km
2. RFC6020 YANG Data Model Language for NETCONF https://datatracker.ietf.org/doc/html/rfc6020
3. RFC4741 NETCONF Configuration Protocol https://datatracker.ietf.org/doc/html/rfc4741
4. TR-532 https://opennetworking.org/wp-content/uploads/2013/05/TR-532-Microwave-Information-Model-V1.pdf
5. IEEE 802.3.2 YANG DATA MODEL DEFINITIONS-2019 https://ieeexplore.ieee.org/document/8737019
6. RFC8561 A YANG Data Model for Microwave Radio Link https://datatracker.ietf.org/doc/rfc8561
7. https://www.sysrepo.org/
8. IETF RFC7317, https://datatracker.ietf.org/doc/html/rfc7317

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