Converged Access Switch (CAS) Requirements and Use Cases

Revision 1.0

Author: Mike Meche

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Revision History

Revision	Date	Author	Description
1.0	7/10/19	Mike Meche	Initial Draft

Contents

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Scope

AT&T has documented technical requirements and use cases for two network devices:1) Fronthaul Gateway (FHG) and 2) Converged Access Switch (CAS) to provide multi-service wireline and wireless service aggregation and transport. The FHG performs a conversion of CPRI to Ethernet using Radio over Ethernet (RoE, IEEE 1914.3) standards, as well as, CPRI/eCPRI interworking, commonly known as Low-PHY offloading, using the O-RAN open fronthaul interface. The CAS is a next generation access aggregation switch based on new Time Sensitive Networking Specification (TSN, IEEE 802.1CM) while acting as an Edge Grand Master (GM) with Primary Reference Time Clock (PRTC). This document specifically addresses the CAS proposal. The details of the FHG are provided in a separate specification. This document provides requirements and use cases as a guideline for a detailed manufacturing specification to be developed.

Overview

To maximize RAN resources, many carriers are re-architecting portions of their networks into a CRAN (Centralized-RAN) architecture by co-locating baseband units (BBU) in centralized locations (CRAN HUB). The CRAN architecture applies Data Centre Network technologies to allow a low cost, high reliability, low latency, high bandwidth flexible interconnected baseband "Pool" (BBU Pooling). BBU pooling allows for efficient joint processing or CoMP (Coordinated Multi-Point) communications between BBUs and higher utilization of BBU resources which provides CapEx and OpEx savings.

The CAS, deployed at CRAN hub locations, provides RAN vendor agnostic fronthaul transport aggregation on an Open White Box Platform meeting the low latency requirements for fronthaul traffic and enabling BBU Pooling. The CAS will terminate 100G Ethernet transport interfaces over point to point dark fibers from remote FHG devices and switch eCPRI, and RoE (IEEE 1914.3, converted CPRI traffic) to the vDU or subtended FHG devices as appropriate.

The CAS, deployed at a CRAN hub site, will act as Edge Grand Master with Primary Reference Time Clock (PRTC), distributing phase and time accuracy via PTP (ITU-T G.8275.1), in accordance with ORAN Config 3, to both RUs and BBU/DU pools. CAS must operate with new high accuracy fronthaul synchronization and timing requirements (IEEE STD 802.1CM-2018 Category A, ITU-T G.8273.2 T-BC, Class C) to ensure error free operation of new 5G and cooperative radio techniques.

System Overview

This document describes the technical specifications of the CAS. It is an open hardware solution with disaggregated software solution offering the following key features:

- The CAS is a mountable 2RU fixed configuration fronthaul aggregation point deployed within the CRAN hub supporting 40x100G interfaces
- CAS is designed to support IEEE STD 802.1CM-2018 Category A and ITU-T G.8273.2 Class C time/sync requirements for Edge Grand Master / Telecom Boundary Clock
- Support a timing circuitry block supporting a variety of timing Inputs {TOD, 1PPS, 10Mhz} and Timing Outputs to {1PPS} to adapt to the evolving timing requirements and implementations in the 5G technology evolution.

Standards Compliance

The CAS is required to comply with the following principal industry standards and implementation guidelines in Table 1 – Standards Compliance.

Standards Specification	Notes
IEEE STD 802.1CM-2018 Time Sensitive Networking for Fronthaul, Profile A (support strict priority queuing) for Class 1 & 2 (CPRI and eCPRI) traffic	
eCPRI specification v1.2, Common Public Radio Interface: eCPRI Interface Specification	
ITU-T G.8262.1 – Timing characteristics of enhanced synchronous Ethernet equipment slave clock	
ITU-T G.8273.2 Telecom Boundary Clock Class C	See Note 1
ITU-T G.8275.2 – Precision time protocol telecom profile for time/phase synchronization with partial timing support from the network	
Ethernet Service OAM (IEEE 802.1Q/ag, ITU-T Y.1731, MEF17/30.1/35.1)	See Note 2

Table 1 – Standards Compliance

Note 1: Because of the criticality of accurately synchronized clocks in delivering error free fronthaul transport of radio channel information, it is necessary to comply with all clauses and subclauses in Sections 7.1 – 7.4 of the ITU-T G.8273.2 standards, covering not only time error noise generation and holdover performance, but also noise tolerance, noise transfer and transient response. Utilizing state-of-the-art devices that support 1ns (Nanosecond) timestamping accuracy and automatic compensation of the time error created by the 25GbE RS-FEC are necessary to meet these requirements.

Note 2: The implementation guideline is to build this functionality with a hardware assisted design in order to provide carrier grade OAM support and avoid restrictions on PDU rates. It is necessary, for example to generate 3.33ms Continuity Check Message (CCM) PDUs for fast failure detection and to process SLM and DM in hardware to accurately measure frame loss ratio, frame delay and frame delay variation.

Network Deployment Architectures

5G mobile network evolution is driving network operators to deploy massive new capacity with 5G NR radios at new and existing LTE radio sites and is enabling network efficiencies by supporting BBU/DU/vDU centralization and virtualization at CRAN Hub sites.

The network architecture for the deployment of the CAS at a CRAN hub is a disaggregated model consisting of CAS and distribution layers of FHGs. Figure 1 – CAS Network Architecture show these multiple layers. The CAS must support IEEE STD 802.1CM-2018 Category A and ITU-T G.8273.2 Class C. The FHG at the tower sites, Pico sites and in the distribution layer at the HUB site are described in more details in the Physical Design section of this document.

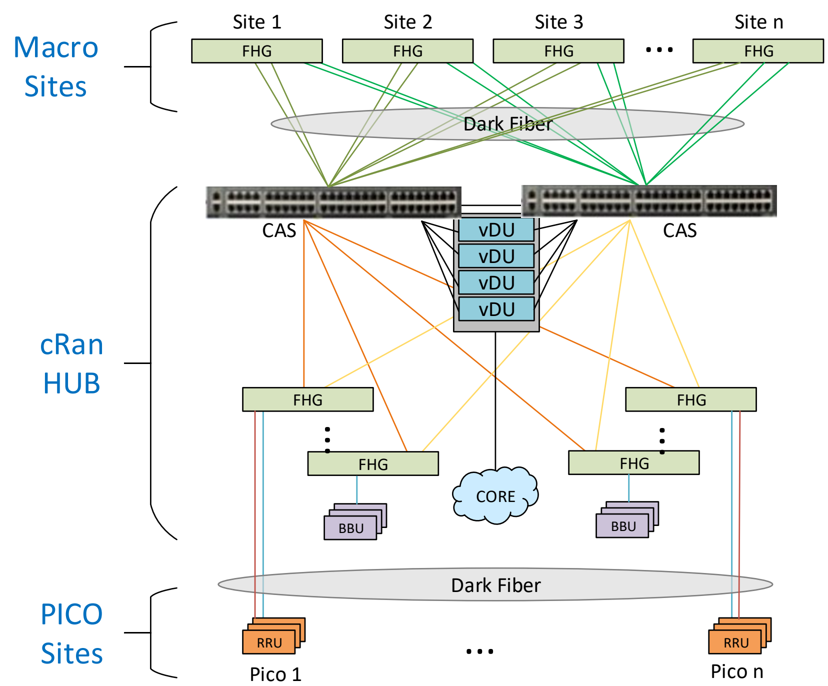

Figure 1 – CAS Network Architecture

To successfully scale the deployment of the FHG in a mobile network, the CAS deployed in a CRAN hub site must aggregate interfaces from hundreds of remote towers. The scaling of the CAS devices with respect to the number of aggregated remote interfaces is not detailed as part of this document. The CAS will switch eCPRI traffic directly to the 5G BBU / vDU pool. However, the RoE (IEEE 1914.3) traffic received by the CAS will be switched to an FHG at the distribution layer.

Multiple 100GE interfaces may be required to transport the traffic from the remote tower terminating into the CAS. The interfaces may individual Ethernet connections over dark fiber(s) or may be multiple lambdas carried over a WDM solution in fiber scarce scenarios.

The CAS maybe deployed such that two (2) CAS are connected per each remote Macro site to provide resiliency and traffic load balancing. Additionally, a pair of CASs maybe directly connected to aid in the case network degradation / recovery.

End to End Network Latency

The mobility network must meet strict end to end latency requirements to ensure the quality of services. For the context of this document, end to end latency is from the egress of the RRU to the BBU and back to the RRU. The processing performed by the BBU is not included in the round-trip time (RTT). The maximum fiber distance between the RRU and BBU is 10km. The round trip (RRT) must not exceed 125 micro seconds.

As described in the Network Architecture section of this document, there could be up to three (3) FHG / aggregation devices between the RRU and the BBU/vDU. The delay budget of 125 micro seconds must include the processing of each of the FHG/aggregation devices between the RRU and BBU. However, Low PHY processing within an FHG is an exception and should not be included in this processing time. This delay budget requirement applies to both CPRI and eCPRI traffic.

Taking into account the (3) devices in the traffic flow path, as well as the time to transmit over the 10km fiber path, each device (FHG and CAS) must be capable of processing each message in less than four (4) micro seconds.

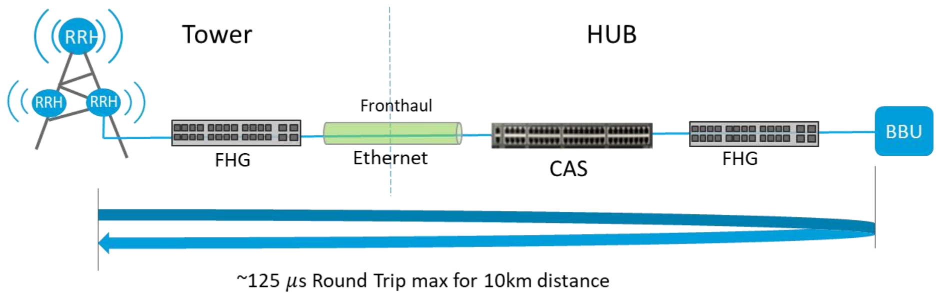

Figure 2– End to End Latency

Use Cases

Use Case: Ethernet Aggregation and Switching

The CAS device, located at the CRAN Hub, serves as aggregation point terminating 100G Ethernet interfaces from remote tower site locations. The CAS must also be able to switch / route L2/L3 Ethernet traffic in support of transport fronthaul traffic as well as Ethernet traffic from offering of Business Ethernet services (ie: connecting an NTE) as well as management type interfaces for tower support and control. The Ethernet traffic will be composed of a mix of eCPRI, RoE (IEEE 1914.3) and Ethernet traffic.

For RoE (IEEE 1914.3) traffic, the average expected packet size is ~600-700 bytes per packet. The eCPRI packet sizes may range from very small packets (<100 bytes) for control messages to a larger packet size of ~1700 bytes for user and management. The CAS must also be able to switch jumbo Ethernet packets (9K) to support the offering of Business Ethernet services.

Use case: Timing and Synch

The CAS must support the distribution of timing and synchronization as an Edge Grand Master. The CAS will include PRTC within the device. The CAS must have the ability to support Telecom Boundary Clock (T-BC) Class C as per ITU-T G.8273.2.

Functional Requirements

Within this section the functional CAS requirements are described.

Timing / Synch

CAS deployed at a CRAN Hub location must support synchronization as an Edge Grand Master and thus will be the timing source for the FHG, RRUs, BBUs and vDU. The CAS must include PRTC within the device. Additionally, The CAS will have an input for an external GPS antenna and support of ITU-T G.8275.1 telecom profile for Fronthaul. Backup phase and time accuracy synchronization are required as specified in ITU-T G.8275.2 with APTS G.8273.4 (Assisted Partial Timing Support). The CAS must support IWF (interworking functionality) between ITU-T G.8275.2 to G.8275.1, called IWF P-F and defined in ITU-T G.8271.2 Appendix I and ITU-T G.8275.1 Appendix III in the event of GPS outage. Backup PTP synchronization will come from a core GM located in a MTSO. FHG and CAS must have the ability to provide Telecom Boundary Clock (T-BC) Class C as per ITU-T G.8273.2. Synchronous Ethernet must be supported as per ITU-T G.8262.1. The CAS Device must support at least a Stratum 3 Internal Oscillator.

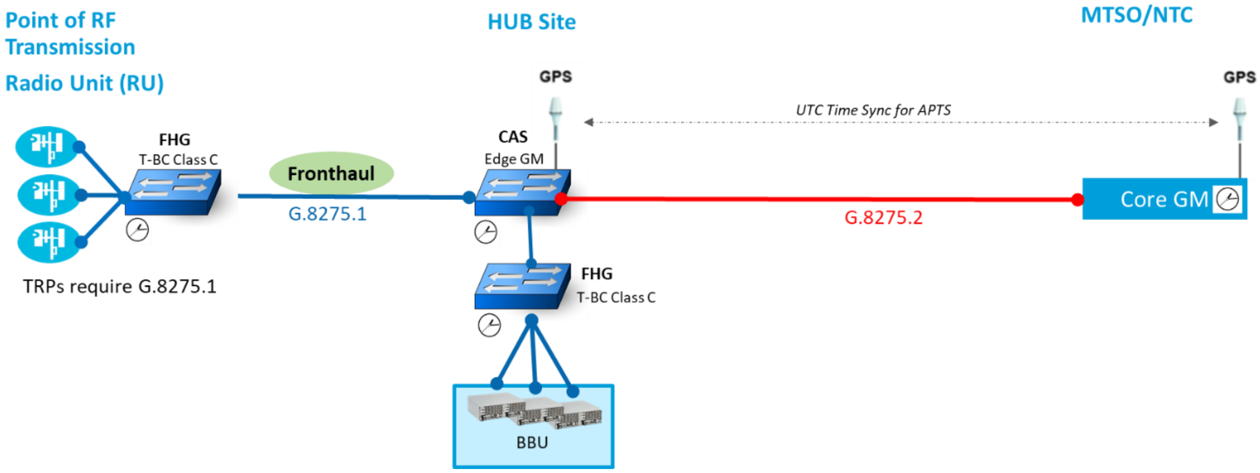

Figure 3– CAS Timing

TSN Forwarding (IEEE STD 802.1CM-2018)

The 802.1 Standards group has defined the TSN (Time Sensitive Networking) to enhance switched Ethernet for time critical applications such as fronthaul traffic. For the CAS, IEEE STD 802.1CM-2018 Time Sensitive Networking for Fronthaul, Profile A (support strict priority queuing) for Class 1 & 2 (CPRI and eCPRI) traffic is required. Frame Pre-emption (802.1Qbu) is not required. The NNI interfaces to the CAS are strictly 100G, given this link speed, the benefit of Frame Pre-emption is negligible and therefore not a requirement.

The forwarding of the TSN switching block is based on the VLAN Bridge specification in IEEE STD 802.1Q, that defines the forwarding of Ethernet packets supporting various networking topologies, which can be provided by Virtual LANs (VLAN) supported by one or more VLAN-IDs (VID) in a fronthaul network. These VLANs can implement the required point-to-point, point-to-multipoint, multipoint-to-point, or multipoint-to-multipoint connections between the source and the destination. The support of at least six different VLAN-IDs is required; including the default PVID (which is untagged, by default, e.g., to carry non-fronthaul traffic). The Ethernet frames that are supported are RoE, eCPRI and other packets that are transported over the Ethernet infrastructure.

The TSN forwarder must support the following functionality in addition to those for VLAN-aware Bridges:

- Support of the use of at least six VIDs, one of which is the default PVID, configured to be untagged on all Ports.
- Support a minimum of two traffic classes on all Ports, of which both traffic classes support the strict priority queuing algorithm for transmission selection
- Optional support for Frame preemption depending on NNI link rate

The maximum carried payload the fronthaul traffic in a frame is 1700 bytes, and the maximum frame size including headers, tags, etc., is 2000 bytes.

Priority for the user IQ data must be configured as high priority traffic class in order to decrease the effects of other traffic. Preferably, the highest priority traffic class is only used for IQ data.

Transport Operations, Alarm and Management – OAM

The OAM functional block is responsible for the operation, maintenance and management of the Ethernet

Network connection maintenance and network connection control, including the line and client interfaces.

For the Ethernet layer of eCPRI, Ethernet OAM is required. Ethernet OAM is a common name for the IEEE 802.1Q and ITU-T Recommendation G.8013/Y.1731. The IEEE 802.1Q Ethernet CFM (Connectivity Fault Management) defines three protocols, Continuity Check Protocol (CC), Link Trace (LT) and Loop-back (LB). ITU-T defines the same functions and tools in Y.1731 by the Ethernet continuity check (ETH-CC), Ethernet remote defect indication (ETH-RDI), Ethernet link trace (ETH-LT) and Ethernet loopback (ETH-LB), and also adds more OAM functions like Ethernet alarm indication signal (ETH-AIS), Ethernet loss measurement (ETH-LM) or synthetic loss measurement (ETH-SLM), and Ethernet delay measurement (ETH-DM).

The OAM hardware engine enables an inline mode of performance monitoring for the FHG Ethernet interfaces and the processing of the OAM protocol data units (PDUs) on the forwarding OAM ASIC. This mode of operation has no impact on the CPU performance, and when increasing the number of performance monitoring sessions and achieve a maximum scaling for service OAM performance monitoring sessions a consistent ultra fast timely behaviour is expected. The consistent behaviour is a very important aspect in ability to detect transport network failures and initiate in a dissolute matter the resiliency action.

Service layer OAM must also be provided in compliance to MEF17/30.1/35.1

DWDM for Network connection

Ethernet over Dark Fiber is the preferred transport mechanism between tower and CRAN hub locations when fiber is in abundance. However, for situations where fiber from the tower site is scarce, a DWDM solution must be deployed. A supported combination of passive / active DWDM devices may be used to enhance network bandwidth over existing fibers as an alternative to deploying additional fibers. DWDM uses multiple wavelengths (lambdas) over dark fiber to provide additional network bandwidth as compared to using a single color of light for transmissions.

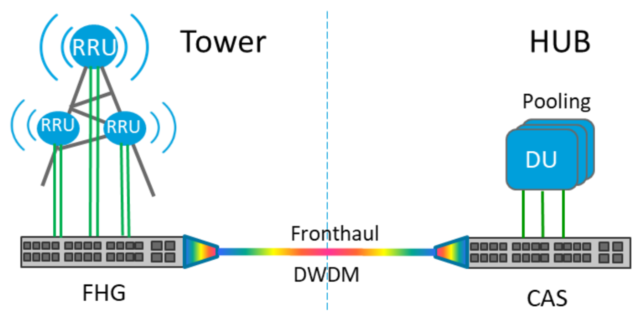

Figure 4– CAS w/DWDM

Management and Automation

The CAS must support a standard NETCONF controller interface (API), CLI, SNMP, and (S)FTP for device management, network element configuration and alarm management. This Controller interface must provide FCAPS management functions (fault, configuration, accounting, performance, and security). The CAS devices are required to leverage Zero Touch Provisioning (ZTP) capability for automating the configuration of the device(s). The CAS devices should incorporate a mechanism to notify the Domain Resource Controller with an event about client port activation and configured signal type. The notification will include all information enabling the Resource Controller to automate the service configuration

Device Management failures should not impact the operations of the devices. Any pending provisioning requests should be queued until the Controller recovers. Software upgrades to the CAS must be performed in automated fashion. The configuration and state of the CAS prior to upgrade must be preserved / restored following the upgrade.

L2/L3 Requirements

The CAS must support a combination of L2 and some L3 capabilities. From a layer 2 functional point of view, as indicated and documented in the Section “TSN Forwarding”, Virtual Local Area Networks (VLAN) will be used to differentiate the traffic (data and management independently) within a network. The CAS should have the capability of adding an inner and an outer tag to identify traffic. Tagged and Untagged traffic on the same interface must be supported. The VLAN tag value is determined by Type II ESP agreement. If more than one VLAN tag is contained in the packet, they are carried transparently with no impact on packet forwarding. VLAN-based service binds all traffic coming out of a CAS port with a specified VLAN tag to a given destination and FHG port. The CAS will support VLAN tag push, pop, swap for both VLAN tags. There should be no restriction on use of tag values 1 - 4095 for VLAN tags. The CAS must support at least 4K routes.

From the L3 functionality point of view the CAS must provide support for the following routing and signaling protocols:

- IP/L3 features
  - Static routes -> uses manually-configured routing entries, rather than routing information from a dynamic routing protocol. Typically, the network operator or administrator configures the static routes entries manually into the routing table. Static routes remain fixed and do not change if in the event of a network reconfiguration, or failure.
  - OSPFv2/v3 Open Shortest Path First (OSPF) is a routing protocol for Internet Protocol (IP) networks. It uses a link state routing algorithm and falls into the group of interior routing protocols, operating within a single autonomous system (AS). Must support both OSPF Version 2 in RFC 2328 (1998) for IPv4 and the updates for IPv6 are specified as OSPF Version 3 in RFC 5340 (2008).
  - Border Gateway Protocol (BGP) is a standardized exterior gateway protocol designed to exchange routing and reachability information among autonomous systems (AS) on the Internet. The protocol is often classified as a path vector protocol but is sometimes also classed as a distance-vector routing protocol.
    - BGP v4/v6
      - Support for iBGP and eBGP peers - BGP supports two types of exchanges of routing information: exchanges among different ASs and exchanges within a single AS. When used among ASs, BGP is called external BGP (EBGP) and BGP sessions perform inter-AS routing. When used within an AS, BGP is called internal BGP (IBGP) and BGP sessions perform intra-AS routing.
    - MP-BGP - Multiprotocol BGP (MP-BGP) is an extension to BGP that enables BGP to carry routing information for multiple network layers and address families. MP-BGP can carry the unicast routes used for multicast routing separately from the routes used for unicast IP forwarding. Support for IPv6, L3VPNv4/v6 should be supported
  - MPLS Routing. Multi-Protocol Label Switching (MPLS) for forwarding speed of the routers, and support for large scale IP networks.
    - Static configuration must be supported
    - Dynamic configuration based on RSVP, RSVP-TE and LDP should be supported
  - Link Aggregation Group – LAG must be supported
    - LAG member up to 4 members must be supported
    - ECMP must be supported over the LAG
  - Multicast may be supported.

The CAS must similar or equivalent features as the following:

- BFD (Bidirectional Forwarding Detection) to quickly detect failures and prevent traffic blackholing)

- Dampening (ie: Interface dampening where an interface should not be allowed to flap in quick succession. As well as Event dampening where syslogs/traps must be throttled and perhaps aggregated)
- Broadcast storm protection at port level (minimum)
- Strong authentication support (GTAC/AAA)
- Port Mirroring
- Unidirectional Link Detection Protocol (UDLD)

Quality of Service Requirements – QoS

In mobile networks, transport and switching network resources are shared among multiple services (e.g. Internet, voice, video, e-mail, and file sharing, and network control traffic), each of which has different QoS requirements in terms of required data rates, acceptable packet loss rates, and packet delay. Particularly, the traffic flows in the fronthaul require very tight latency bounds and ultra-low packet loss.

QoS provides the operator the means to differentiate or classify different traffic flows based on various fields in the received packet header, to differentiate traffic and then apply different forwarding behaviors to that different traffic, such that real-time services can be prioritized over non-real-time services.

Hierarchical Quality of service (HQoS) is the ability to apply traffic schedulers and shapers to a hierarchy of scheduler nodes. Each level of the scheduler hierarchy can be used to shape traffic based on different criteria such as application, user, VLAN, and physical port. The CAS must support 3 schedulers levels of HQoS.

The CAS should support the ability to configure the following QoS behaviors:

- Prioritizing traffic over other traffic based on Layer2 or Layer3 protocol fields or a combination of these fields; such as the source or destination address, priority fields, or a source or destination port number.
- Classifying ingress or egress traffic in any number of simple and combined manners – separate Multicast Queues must be supported
- Controlling the configured ingress or egress interfaces bandwidth.
- Reading and re-writing packet header fields based on the configured QoS forwarding behavior.
- Congestion control dealing with traffic overload situations when there is more data traffic in the network than can be sent with reasonable packet delays, no lost packets, sending the highest priority traffic first based on scheduler queuing priorities. The CAS solution must support shaping support on all levels of scheduler, and three drop precedence colors per queue
- Controlling packet loss based on random early detection (RED) algorithms, must support Drop profiles – per CoS and per port, and strict priority, Weighted Round Robin, and Weighted RR, Weighted deficit Round Robin.

Optics / Transceiver

The CAS must support full duplex GE (Gigabit Ethernet) ports. Support for bi-direction (BiDi) optics must be provided to reduce the needs for physical fibers. The CAS must also provide support for DWDM self-tuning and colored optics so that a DWDM solution can be deployed between the FHG and the CAS Network connections (NNI). The CAS must support compatible 3rd party optics.

Host CPU

The Host Module will use standard 4Core x86 General CPU, with 16GB DRAM, and 128GB SSD. Examples of CPU options may include but are not limited to Intel Rangeley, D-1500, NXP multi-core communications processors family such as T1040

BMC

The BMC is associated with CPLD logic and allows for managing the FHG. The BMC may be instantiated with a separate physical device, or a software component available with high reliability from the host module. When the BMC is provided on the host module, then the design must include a simplified, low-cost module to host the BMC software in those cases where a more functional CPU is not desired, and the CPU module would normally be omitted from a build. The BMC must provide management for the following:

1)System, ASIC / FPGA, and Host CPU module power management
2) Temperature monitoring
3) Voltage monitoring
4) Fan control
5) Reset control
6) Programming FPGA/CPLD/and other various flash/BIOS
7) Read the Rx loss and other signals from the SFP and QSFP ports
8) Host CPU Module boot up status
9) System Identifier, including ability to set user-defined identifier, as well as control of locator lamp.
10) Serial number / unique identifier
11) Board revision ID
12) I2C interfaces to Host CPU, USB, temperature sensors, and voltage controllers.

The BMC functionality could be provided in a software solution running on the host CPU as opposed to a specific CPU dedicated for BMC processing. This variant must be both functionally equivalent and preforms the same as the dedicated hardware solution.

MACsec Support

The MACsec capability (IEEE.802.1AE MAC Security standard) should support DOT1Q in the Clear in order to operate over different Ethernet Provider service offerings. The MACSec must support at least 40Gpbs of traffic. Due to this limitation, the MACsec should process only the control messaging.

Physical Design Requirement

The CAS must be mountable in a 19" EIA cabinet (supporting both 2 and 4 post mounting). All cabling must be front accessible and adhere to AT&T bend radius standards as specified in ATT-TP76300, section J part 2.10. Air flow must be front to back. The height should not exceed 2 RU and the Depth must not exceed 30 inches. These Units must be stackable without any airgap.

The CAS must support 40x 100GE Ports with a switching bandwidth of 4.8Tbps. Any of the 40x 100E ports can be used for accessing traffic coming from a client interface or connecting to a line side core network interface. **Error! Reference source not found.** provides a summary of the required interface ports.

Physical Ports	Type	NW Interface	Rate
40	QFP28	UNI/NNI	100Gbps

Table 2 – CAS Interface Ports

An Industrial temperature range (-40C to + 65C ambient) meeting AT&T TP76200 (Issue 20) / TP76450 (version 17) for Level 3 requirements for sealed GR-3108 OSP Class 2 cabinets is required. These document and general information about AT&T's environmental equipment standards can be found at https://ebiznet.sbc.com/sbcnebs/.

Timing Ports

The CAS must support the physical ports to support the 1588 Timing / Synch requirements as described in Table 3 – CAS Timing Ports.

Port Description	Port Type	Input/output	Notes
1pps/ToD	RJ45	Input /output	
10MHz	SMB	input	
1PPS	SMB	Output (test port)	Optional
GNSS	SMB	Input	GPS input for Edge Grand Master

Table 3 – CAS Timing Ports

Management Interfaces

Refer to (Table 4 – CAS Management Interfaces) for a list of Management ports required with the CAS device. Only one Serial input can be active for the Console. Micro USB will have higher priority than RJ45 and USB serial by default.

The RJ-45 OOB Ethernet management port needs to be operational even when all the interfaces on the system are in the shutdown mode. As such it needs to be designed using the standby power rail. It also needs to provide simultaneous connectivity to the X86 CPU and the BMC.

Type	Quantity	Purpose
Micro USB RS232I	1	Console
RJ45 – craft terminal 10M/100M/1G	1	Console
RJ45 RS232 terminal	1	Console
RJ-45 10M/100M/1G	2	Ethernet OOB
SFP/SFP+ 1/10G	6	Fiber Management interfaces
In-band Management virtual interface	n/a	IP in band management

Table 4 – CAS Management Interfaces

Grounding Ports

The CAS devices must have a dedicated “ground” interface which the personnel handling the CAS Unit must connect to prior to safely contact the device.

Host CPU

Intel x86 Broadwell-DE CPU with associated storage and memory.

Service and Transport OAM

To ensure scalable deterministic carrier grade transport and service OAM, the CAS must provide

- Ethernet Service OAM (IEEE 802.1Q/ag, ITU-T Y.1731, MEF 17, MEF 30.1, MEF 35.1) - The implementation guideline is to build this functionality with a hardware assisted design in order to provide carrier grade OAM and avoid restrictions on PDU rates. It is necessary, for example to generate 3.33ms CCM PDUs for fast failure detection and to process SLM and DM in hardware to accurately measure frame loss ratio, frame delay and frame delay variation.

Power Requirements

The total system power consumption of the CAS must not exceed 1300 watts. All system components chosen for this build must be energy efficient to keep the energy consumption low. The total estimated system power consumption must be specified in watts. This is based upon worst case power assumptions for traffic, optics used, and environmental conditions.

- ATIS TEER (ATIS-0600015.2009) should be measured and provided (Preferred)
- SPECpower_ssj2008 can be substituted for ATIS TEER (Acceptable)
- US EPA Energy Star Certification is favored.
- Power terminations must be clearly labeled and fully protected with a non-metallic, non-flammable cover.
- ATT-TP-76208 lists additional power requirements for under and over voltage, grounding, and current characteristics.

Dual power inlet

The CAS must support dual power inlet connections to provide power resiliency. Please use the below as a general guideline for the dual power inlet connections:

- The system must support AC or DC power input.
- The system must support DC input between -57 and -40VDC or support AC input between 100 & 240 VAC.
- Power inlet physical connectors must have a mechanism that prevents accidental dislodging of the cord.
- DC PSMs have additional physical connection requirements listed in AT&T TP 76450, section 2.4.

Fan Module

The CAS Device must support a hot swappable Fan Modules. Please use the below as a general guideline for the FAN selection:

- The FAN Module must meet the power requirements of the design, 50W WATT or less
- The FAN must be available with F2B airflow.

The FAN must have a mechanism that prevents accidental dislodging.

LED Operations Recommendations

Refer to AT&T Hardware Common Systems Requirements for recommendations on system and interface LED colors and operations.

The indicator lamps (LEDs) must convey the information described in Table 5 – CAS LED Definitions. The number, colors, and flash behaviors are desired but not mandatory.

LED Name	Description	State
PSU	LED to indicate status of Power Supply	Green - Normal Amber - Fault Off – No Power
System	LED to indicate system diagnostic test results	Green – Normal Amber – Fault detected RED - “major” or “critical” failure
FAN	LED to indicate the status of the system fans	Green – All fans operational Amber – One or more fan fault RED - “major” or “critical” failure

LOC	LED to indicate Location of switch in Data Center	Blue Flashing – Set by management to locate switch Off – Function not active
SFP/QSFP28	LED built into SFP/SFP+ SFP28/QSFP28 cage to indicate port status	On Green/Flashing – Port up (Flashing indicates activity) On Amber – Port up with no active CAS/FHG Off – No Link/Port down
OOB	LED to indicate link status of 10/100/1000 management port	On Green/Flashing - port has link Off – No link

Table 5 – CAS LED Definitions

Design Overview

As an aggregation point in the fronthaul domain, the CAS device is required to be a high capacity switching device that also must meet the low latency and timing synchronization requirements to support fronthaul traffic. The Broadcom Jericho 2C (BCM88800) is designed to meet these requirements including support for Boundary Clock Class C (ITU-T G.8273.2 Telecom Boundary Clock (T-BC) Class C). Figure 5**–** CAS with Jericho2C shows an overview of the CAS device with a single Jericho 2C ASIC. As show above (Table 2 – CAS Interface Ports) the CAS must support 40x 100GE interface port. As depicted in the Network overview (Figure **1** – CAS Network Architecture) the CAS will aggregate 100GE direct fiber connections from remote sites and with switch eCPRI traffic to the vDU Pool and RoE traffic to subtended FHG devices. The CAS must be able to switch messages from any I/O port out through any I/O port.

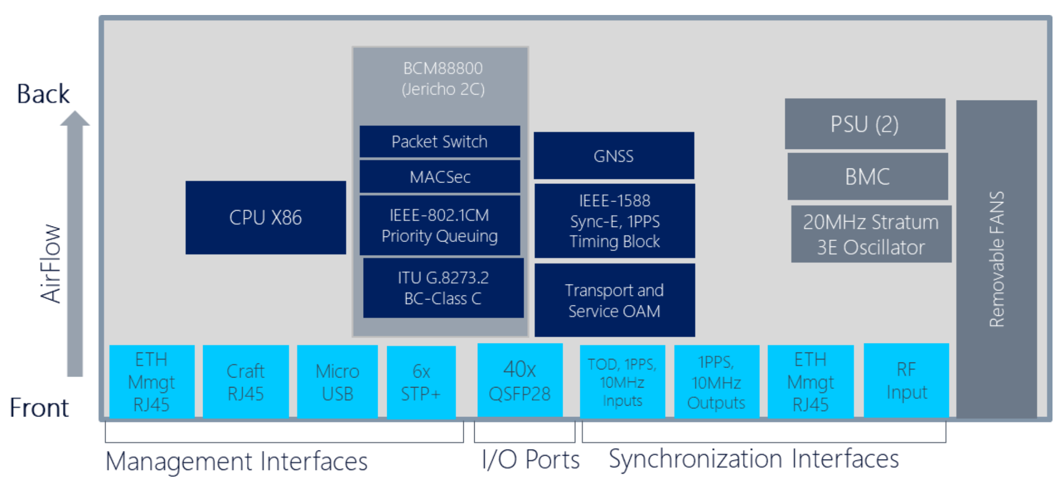

Figure 5**–** CAS with Jericho2C

Software Support

The FHG supports a base software package composed of the following components:

Network OS (NOS)

The CAS is an open hardware platform that must support any supplier's NOS. Equipment should be available with Open Network Linux, and AT&T expects to develop open source support for this platform over time.

BMC support

Open BMC with Redfish implementation is the target platform. Commercial BMC with IPMI 2.0 is acceptable.

ONIE (Open Network Install Environment)

To allow installation and boot of ONL. ONIE version 2014.08 or greater will be supported

Open Network Linux

See http://opennetlinux.org/ for latest supported version

Specification Requirements

AT&T has established specifications for servers and NFVI communications equipment that are intended to be used in Central Offices. These specs revisit classical NEBs requirements – particularly in the face of new resiliency and availability architectures. Servers and switches that are not a single point of failure for their services (e.g. follow a typical cloud resiliency model) follow ATT-TP-76207. Telco devices that do have or comprise single points of failure for their services including this specification follow ATT-TP-76208.

This specifications is subject to follow ATT-TP-76208 which is available at this URL:
https://ebiznet.sbc.com/sbcnebs/Documents/ATT-TP-76208_vOLT%20Equipment%20Standards.pdf

These requirements are partially repeated here. Specifications that require testing must be confirmed by an accredited agency recognized by the National Cooperation for Laboratory Accreditation or ISO/IEC Guide 25 or ISO/IEC 17025. Note: These specifications are limitations placed on any design. The actual performance of FHG and CAS must meet or exceed these specifications.

Environmental

- Light weight is favored
- Humidity 5% to 85% non-condensing (operational and storage)
- Vibration – IEC 68-2-36, IEC 68-2-6
- Shock – IEC 68-2-29 • Acoustic Noise Level – Under 78dB in 26-degree C
- Altitude: -200ft (-60 meters) to 6000ft (1830 meters).

Safety

Fire Spread: Field conditions for telco deployment may require deployment in existing Carrier Communications Spaces that utilize Fire Code Exemptions and do not have automatic fire suppression. NFVI equipment, like the FHG deployed in these locations must meet enhanced fire spread requirements:

Generally, the equipment must meet ATIS-0600319.2014 *Equipment Assemblies – Fire Propagation Risk Assessment Criteria* (see note below).

Note: Equipment may conform to this requirement by way of inherent design features that include all three items below:

1. Height of 2 RU or less

2. Metallic 5-sided enclosure with a metallic or non-metallic front cover or faceplate
3. Non-metallic materials shall comply with ATIS-0600307 4.1

For equipment that does not meet the fire spread requirements of ATIS-0600319.2014 by way of inherent design features noted above, the manufacturer must attest that the equipment has successfully passed the burn test as referenced in the ATIS document.

- UL/ Canada
- CB (Issued by TUV/RH)
- China CCC

Electromagnetic Compatibility

- GR-1089-CORE
- FCC Title 47, Part 15, Subpart B Class A

ROHS

Restriction of Hazardous Substances (6/6)

Compliance with Environmental procedure 020499-00 primarily focused on Restriction of Hazardous Substances (ROHS Directive 2002/95/EC) and Waste and Electrical and Electronic Equipment (WEEE Directive 2002/96/EC)