Research on New Network Architecture Through Sd-Wan

Sallauddin Mohmmad, Dadi Ramesh, Syed Nawaz Pasha, Shabana, Kotha Shankar

Abstract:Todaysocietyandmanyorganizationsusetheinternetwhichisinterconnectsthepeoplearoundtheworld.ThisinternetusesthetraditionalWideAreaNetworkarchitecture.ThetraditionalWANrequiresasingleprovidertoaccessmanysiteswhichdoesallowthesitesfordirectaccesstocloudresources,inflexibleandthesearehadunpredictableperformance.ToovercometheseproblemsSD-WANarchitectureintroducedbasedonSDNtechnology.SD-WANhaddynamicmulti-pathselectionandcloudoptimizedfunctionalities.Thesefunctionalitiesareprovidingimprovedperformanceandfaulttolerance.TheimplementationofSD-WANininterautonomoussystemswithCloudComputingallowsvirtualizationonthenetworkarchitecturewithprovisioningandde-provisioningofresourcesondemand,soitisbecomingneweraofservicebyCloudComputingnamedasNetworkasaService(NaaS).RecentlythetelecomservicesstartedtheNaaStotheirsubscriberstoavoidthemoreuseofphysicalnetwork.DuetopresentnetworktrafficdemandsSD-WANneedsdynamicnetworkcontrols,optimalpathselections,Forwarderrorcontrolsandsecuretransmission.InthisarticlewediscussaboutSD-WANdesignissues,transmissioncontrolandpossibleintegratedarchitecture.wealsopresentthefunctionalprocessofRESTfulAPIonSD-WANwithprogramfragments.

KEYWORDSSD-WAN,dynamicmulti-pathselection,NetworkasaService,RESTfulAPI

I. INTRODUCTION

Intoday'sworldtheusageoftheinternetiseverywhere.Theusageofthebasicprotocolsismoreandneednewadvancedprotocolstoimprovetheefficiencyoftheinternet.Todayinternetnotonlyusedfortheacademiccommunitybutitsusabilityisexpandtoconsumerorientedusecases.InordertodeploynewadvancedprotocolsneedstandardizationthroughInternetEngineeringTaskForce(IETF).Thatprocesswasslow.AsaresultofthisresearchersarestronglyrecommendedtodevelopprogrammablenetworktoacceleratetheusageofinternetovertheWorldWideWeb.

Inthiscontext,firstefforttoachieveprogrammablenetworkwasActiveNetworkArchitecture[1].InANAworkingprocedureloadsthecustomizeddesignprogramsintonetworkdevices.Theseprogramsperformcorrespondingfunctionsinthenodeatthetimeofwhenapackettraversedthroughit.Theseprogramsareembeddedanduploadedinthenetworkdevicebythethirdparty.Thirdpartiesaredevelopinganddeploycustomfunctionalityfortherespectivenetworkdevice.TheActiveNetworkscreatenewnetworktrendandtechnologiesinthenetworkarchitecture.Thesearefullynetworkprogrammed.TheActiveNetworksarebrokemanyconventionalprimitives.Thesearewidelyusedanddeployedinthenetworks.TheActiveNetworksareleadustotheSoftwareDefinedNetwork(SDN)[1][2].

Theprogrammablenetworkneedscontroloverthenetworkingprotocolstogaincontrollability.Soweneedtoseparatethecontrolanddataplaneinthenetworkarchitecture.Bythiswecangetmoregeneralizedcontrolprotocols.OpenFLowwasthefirstprominentefforttoaprogrammablenetworkingarchitecturemeansSoftwareDefinedNetwork(SDN)[2].OpenFlowmainlyfocusedonthetwomajorinsights.First,itaimstoanetworkwithgeneralizednetworkdevicesandfunctions.SecondlyittellsaboutnotationswithrespecttoNetworkOperatingSystem.

OpenFlowconsistingofasoftwarewhichisasimplifiedAPIandprogrammingabstractionstodefineapplicationstocontrolandmanagethenetwork.TheAPIsupportsanylanguagestowritenetworkpolicestocontrolthenetworkoperatingsystem.Theseprogramsarestandardizedthenetworktogaincontrollability.OpenFlowisnottheonlyprotocolthatcanbeimplementingtheSDNarchitecture[3].PathComputationElement(PCE)architectureisusedforcentralizedcontroltrafficInthenetworktopology.ThePathComputationElementProtocol(PCEP)isalsousedforsamepurposeinthenetworktopology.

SoftwareDefinedNetworks(SDN)aresimplifiedthewholenetworkarchitecturebysimplifyingfunctionalitiesofnetworkdevices.Thesenetworkdevicesareverysimple,automatedandunintelligentboxesthathavejobofhandlingpacketsbasedtransmissionwithrespecttotherulesofcontrolplane.SDN-enabledforwardingelementstoperformactionaccordingtomatchingpattern,meanswhenanetworkpacketpassingthroughadevicesuchasforwardordropinthatdeviceneedstobematchingwiththepacketheadersaspertheruledefinedbythecontrollogic.BasicallySDNarchitecturehasbeendatacentricsettings.

OntheotherhandWideAreaNetworksweremoreexpensivetothepresentnetworkarchitectureanditalsodifficulttomanagebecausetheyconsistsofhigh performancerouterstohandlehugedata,thisleadstoincreasingcapitalexpenditure(CAPEX)aswellascomplexconfigurationrequiringextensivemanagementeffortsincreasingOPEXandfailureprobability.TosolvealltheseproblemsresearchersaregivingmoreprioritytotheSDNforWideAreaNetwork[4].Thiscanestablishnewnetworkarchitecturewithcentralizedcontrolandloadplanningtodistributeloadmorewisely,adapttovarious.

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Presently,societymorereliesonthenetworktointerconnectwiththepeople,devicesandcontent.Thenetworksarebecomesdailyroutine.Theinternetinterconnectsallthings.Sothenetworksareprovidemorevaluetotheuser.ProgrammablesystemsareprovidingefficientapplicationstocloudtoserveITutilityforaglobalizedandmobileworkforce.ImprovementofMulti-ProtocolLabelSwitching(MPLS)andCarrierEthernet(CE)hadprovideservicestotheWAN.Inthisinterconnectionofnewsiteswereanissue,servicechanges,bandwidthchangesandcloudserviceswerethemajorchallengesfortheWAN.SD-WANwasemergedasoneofthesolutionforaddresstheseissues. TypicalWANnetworkarchitecturehadcomplexity.ByusingtheSD-WANwecanreducethenetworkcomplexityalot.SD-WANnetworkarchitecturehadcentralizedcontrolprograms.Theseprogramsimprovetheapplicationperformance.SD-WANusesdynamicmultipathselection.ThisimprovestheperformanceofnetworkandalsoprovidesredundancyforaWAN.AsinglewebbasedportalprovidesrealtimeanalyticsforeveryconnectedsiteintheSDWAN.Bythiseachsitecandiagnosetheperformanceoftotalnetwork.InthisarticlewediscussaboutSD-WANdesignissues,transmissioncontrolandpossibleintegratedarchitecture.wealsopresentthefunctionalprocessofRESTfulAPIonSD-WANwithprogramfragments.Section2tellaboutthesurveyaboutthetopicincludingtechnicalissues.section3tellaboutrealtimeimplementationusingRESTfulAPIinterfaceinthenetwork.Section4describethebasicSD-WANarchitecturewithassociationCloud.Section5discussthefewchallengesovertheSD-WAN.

II. RELATEDWORK

InseparationofnetworkdevicesandcontroloperationstheOpenFlowprotocolplayedtheimportantroleandcreatedtheprogrammablecontrollingonnetwork[3].OpenFlowinsistedthetwomajorthinginSDN.First,itcreatedthegeneralizationfunctioningfornetworkdevicesbyasimplepacketbasedmatch-actionpattern.Secondly,OpenFlowcreatedthenecessityofNetworkOperatingSystem.InthisnetworkrevolutiondifferentkindofAPIarecontrollingthenetworkspartswiththesupportofNOS. APIisataskbasedsimplifiedprogrammingabstractionwhichcanhandlethespecificnetworkoperationornetworkphysicalpart.SuchkindofAPIcanabletodevelopbyanyprogrammingplatform. Asdiscussedearlier,OpenFlowalsoaapplicationbasedprotocol. OpenFlowcreatethecommunicationbetweenthecontrolanddataplanes.FromthedataplaneOpenFlowobtainthetopologicalstructuresdynamicallywiththesupportofPCEandforwardpacketflowobtainPCEP.AswellsomeothersupportingprotocolsforOpenFlowareNETCONF,RESTCONF,andOVSDB.IntheSDNthemajorfunctionalityimplementedasasoftware-basedvirtualnetworkfunction(VNF)whichmayrunonavirtualCustomerPremisesEquipment(CPE)attheclientpremisesoranyothertypeofgeneralizedcomputeplatform,e.g.,serverinadatacentre,whichmayalsobemanagedbythebyacloudserviceprovider[4][5].InpresentdaysthenetworkalsobecomingintovirtualizationbecauseofSDNintegratedCloudtechnology.CloudcomputingintroducedthenewservicesasNetworkasaService.

2.1.NetworkasaService

CloudComputingsupportingforvirtualizationonthenetworkarchitecturesandcontrollingsystemsothatitisbecomingnewareaofresearchinthepresentdays.thatservicenamedasNetworkasaService(NaaS).Withrespecttothatthenewcustomerofcloudcantakerentalnetworkitselfwithoutestablishingthephysicalnetwork.Theusercanabletoaccessthenetworkasaservicewhereeverhesit.Itjustreducetheeffortsofserviceholder.InsimilarmannerthevirtualizednetworkcontrolisavailablefromthecontrolplanewhichcanmanagethevirtualizednetworkTopology.theimplementationofsuchnetworkisneedwithOpenFlowbaseddevices.Presentlyitisspreadinginallkindofnetworksystemslikedatacentrenetwork,mobilecommunicationnetworksandsatellitenetworksetc.EvenIfthistechnologyimplement50%ofnetworkthenitwillreducetheuseofnetworkphysicalarchitectures,networkinvestments,datatransmissionproblems,reducetheuseofmorebandwidth,packettracingsandproblemofphysicaldamagingofdata.

RecentlythetelecomservicesstartedtheNaaStotheirsubscriberstoavoidthemoreuseofphysicalnetworkandtheyintegratedinWANalso.GoogleimplementedtheSDNontheirdatacentrenetworks.Toreducetheuseofdumbpipesnowaday'stelecomoperatorsstartedtheNaaSserviceusingcloud.BasicallythisNaaSservicesareimplementedinthecloudusingWANconnectivitywhichisbasedonSDN.typicallyNaaSservicesarelikedatacentrenetwork,telecominternetservicesandBandwidthonDemand.Datacentres(DCs)networkprovisioningandde-provisioningappliedintheglobalnetworksystem.ConsequentlywhichcomesundertheWideAreaSoftwareDefinedNetworking(WA-SDN).GoogleandAWSareestablishedtheirdatacentresinallcornersoftheworld.ThevirtualizationofdatanodeusingthecloudcanbedonebyIaaS.Buttobringtheirdatacentresnetworkintothevirtualizationisachallengingfactor.CloudtechnologyshouldappliedineveryedgeofnetworkwhichmayalsoinWAN.TheimplementationofSDNininterautonomoussystemsiscalledasSoftware DefinedWideAreaNetwork(SD-WAN).

2.2.ManagedSD-WANService

SD-WANconsequentlybecomepopularintheeraSoftwareDefined NetworkwhichisappliedonWANconnection,thistechnologyintegrationusedtoconnectedtheenterprisenetworksincludingtheirbranchesanddataservers.generallytheWANnetworkreachtoswitchbytakinginmanyhopstorach.WANcontainsoneormoreautonomoussystems.thecommunicationandtransmissionlatencyarehigherthanthenormalnetwork.Sothatwiththe singlecontrolsystemwecan'tcontrolnetworkoptimally.WhichleadstoestablishmulticontrolsysteminSDN.VerypopularSD-WANbasednetworkisGoogle’sB4networkwhichisalargestimplementedSDNbasednetworkwithmultiplenumberofSDNcontroller[6].

2.3.SD-WANtrafficpathcontrol

SDWANhasbeenbroadlyfollowed,mostlybecauseofSDWANvendorswhooffernumerousandproprietarypathandnicemanagecapabilities.LeadingSDWANcompanieslikeVelocloud, Viptela,VersaNetworks,Cisco,Juniper,Riverbed,SilverpeakandCitrix,serveorganizationcustomersbothbyusingpromotingSDWANanswersdirectlytothemorwiththeaidofpresentingtheequaltotelcosinordertoprovidecontrolledSDservicestoorganisationcustomers.courseandhighqualitymanipulatefeaturessuppliedbymeansofeverySD-WANdealerareslightlyoneofakindfromsuppliertoseller(much likemobileVideoOptimizationcarriershadtheirownoptimizationmethodssomeyearsinthepast).SD-WANcontrollerisresponsiblefordeliveringpoliciestoeachSD-WANCPEandisavailableinmanydifferentconfigurations[1][6].

2.3.1.PathselectionbyapplicationandDynamicPathControl(DPC)

Thefirststepisselectingthepathsfortheapplicationforexamplethepathsfor MPLSpathforVoIP,videoconferencingandERP,butInternetforothers.AnMPLScommunity,eventhoughextraordinarilyhighlypricedcomparedtobroadbandinternet,doesprovidehighgreatcarrier.however,broadbandnetservicedoesnotincludeSLAlikeMPSVPNdoes,sothere'snoassureregardinglatencyorpacketloss.So,yougetwhatyouget,anditoftenforhomeusers.forthisreason,therewerereasonableconcernsamongstorganizationsapproximatelyhandingoverespeciallyessentialutilitytrafficlikeVoIP,videoconferencing,ERP,andsoon.MPLSandinternetarepacketnetworks.Packetnetworksaregenerallyatthedangerofgoingthroughcongestion.therefore,whatSDWANanswerwantmostisacoursecontrolsolutionthatallowsforeverysoftwaretodynamicallytransfertheirpathsinactualtime,inresponsetocommunitysituations,asopposedtostickingtoatleastonespecificnetwork.DPCensureseachSD-WANCPEmonitorsthequalityofmultipletunnels(i.e.,latency,packetloss,jitter,throughput)inrealtime.If“low-loss”policyisappliedandDPCisenabled,aVoIPapplicationguaranteesthatVoIPpacketsaredeliveredthroughthebestpossiblepaththatalltimebydynamicallyswitchingbetweenMPLSandInternetpathsdependingonthepacketlossconditionsinthenetwork(Note:Itisdifferentfromloadbalancingbetweentwopaths).

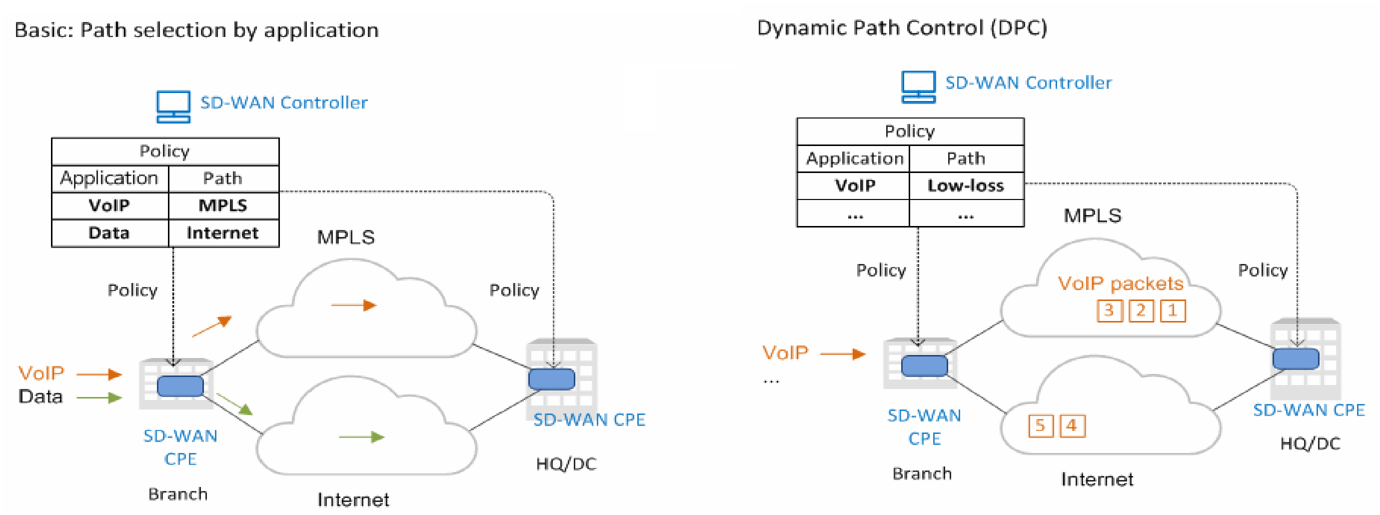

Figure 1. Path selection and Dynamic Path Control in SD-WAN

2.3.2.TunnelBondingandFEC(ForwardErrorControl)

ForapplicationssuchasDataRelation,Backup,andFileTransfer,theperformanceoftheseapplicationsdependsontheavailablebandwidth.Timeisoptimalwhenonepathisutilizedratherthanallavailablepaths"TunnelBonding"performsper-packetloadbalancinganddistributethepacketsbelongingtooneflowtodifferentWANpathsandhenceachievingmaximumthroughput.ThebasicconceptofthetechnologyisquitesimilartoMulti-PathTCP(MPTCP),thathasbeenadoptedincommercialnetworksinSouthKorea.Thedrawbackofthissolutionisthatthepacketsarenotintheoriginalorderassentbythesender.Toaddressthisissue,SilverPeakintroducedPacketOrderCorrection(POC),are-sequencingprocessperformedbySD-WANCPEonthereceivingend.InInternetnetworks,packetlossisnotguaranteed.SopacketssomehowlostonthewaywhichtriggerTCPretransmissionandsignificantlylowersTCPthroughput.AsasolutiontothisSilverPeakcameupwithwastoinsertFECpacketstosomewhereamongthepacketsbeingtransmitted[7].Asseeninthefigurebelow,theFECpacketmaybesentthroughMPLSseparately,orthroughtheInternetwithotherpackets.

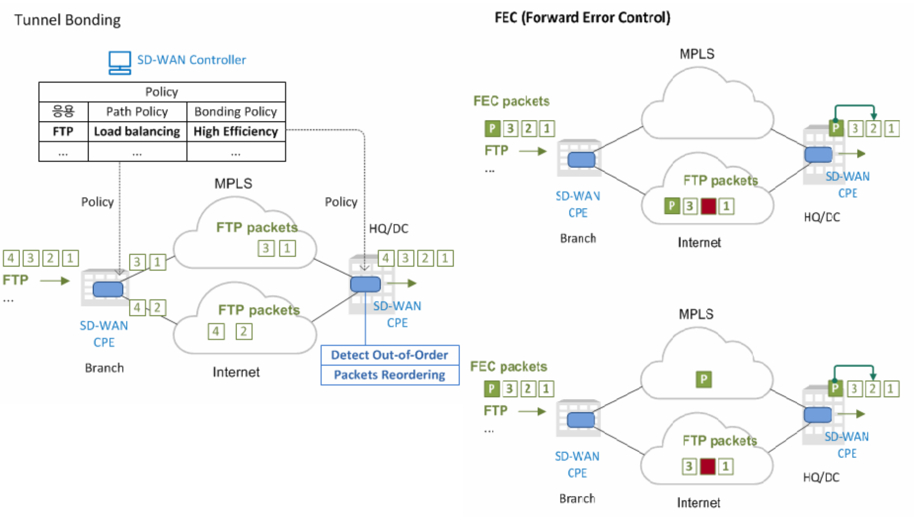

Figure2.TunnelBondingandForwardErrorControlinSD-WAN

III. APPLICATIONINTERFACE

InSDN,thedataplaneandthecontrolplanecaninteractwithina closedcontrolloopInitiallythecontrolplanereceiveseventsfrom dataplaneandthenitcomputessomenetworkoperationsbasedon theevents.Thedataplanethenexecutestherequiredoperationswhichcanchangethenetworkstates.Anetworkisacomplexstructurewhosefunction,resourceandbehaviourvariesdynamically.TheNBIofthenetworkhastoadoptaccordingtotheevolvingnetworkstructureandtheapplicationparadigmshifts.AsaresultRESTfulNBIhasbeendesignedtomanagedistributedresourcessuchas datanetworking.ThebenefitofRESTAPIisitprovidesdifferentfunctionsatthesametime.ARESTAPIiscapableofachievingsuchflexibilitythroughthemechanismofhypertext-drivennavigationofconnectedresources,whichisalsodescribed as"hypertextastheengineofapplicationstate"in[8].TheSDNcontrollercomeswithalogically-centralizednetworkabstractionforapplicationstomanagethenetworkinanefficientandflexiblemanner.Figure2illustratestheinternalarchitectureofatypicalSDNcontrollerbasedonthemodel ofOpenFlow.AtthebottomistheOpenFlow-basednetworkabstraction.Thecontrollermaintainsaglobaltopologyofthenetworkwhichwillconfigurethe APItomanagetheflowtablesintheunderlyingOpenFlowdevices.Basedonthisconfig urationAPI,built-inapplicationscanbeabletoimplementhigh-levelnetworkabstractions,suchasvirtualnetworks,thatprovide anefficientwaytomanagemoderndatanetworks,especiallyforthelargescaledatanetworksindatacentresandcloudcomputingplatforms.

TheOpenFlowconfigurationAPIrequiresapplicationstodeviseflowentriesacrossvariousOpenFlowdevices(e.g.switches/routers).Someofthedeclarativeconfigurationlanguages,suchasFlow-basedManagementLanguage(FML),Procera,andFrenetic,are proposedtoexposenetworkprogrammabilitybyexpressingthesemanticsofnetworkpoliciesdeclaratively,andthepolicylayer,whichisgenerallybuiltontopofexistingcontrollers,suchasNOX, willcompilethehigh-levelpoliciesintotheflowconstraintstobeenforcedbythecontroller.AlthoughtheseAPIsareeffectiveinsomeapplications,theyarenotasreliableasRESTfulservices.

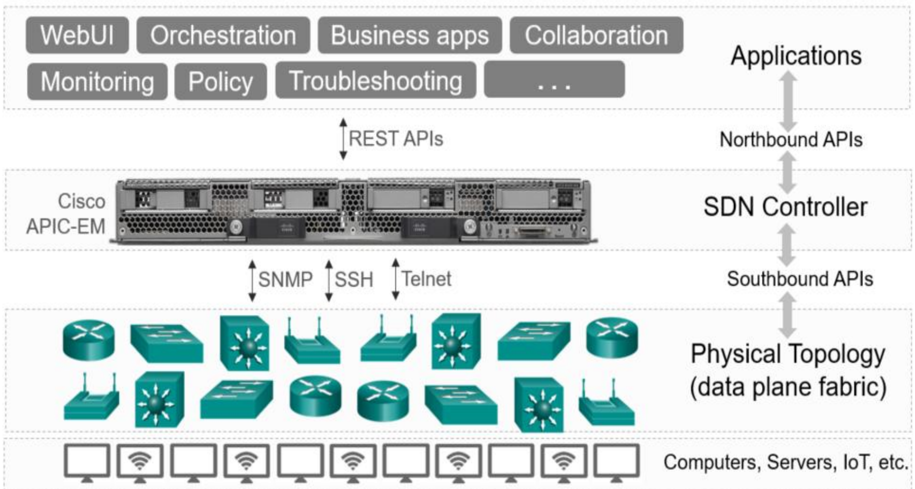

Figure 3. SDN based application interface for SD-WAN

TheRESTinterfacemakesuseofHTTPGET,PUT,POST,and DELETEoperationsagainstadefinedsetofURLsrepresentingGOresources.ThetransfertaskrequiresausertoissuesaPOSTtohttps://transfer.api.globusonline.org/v0.10/transferwithadocumentdescribingthetransferrequest,including,forexample,source anddestinationendpointsandfilepathsandoptionsandtoaccessthestatusofatask,theuserissuesaGETrequesttohttps://transfer.api.globusonline.org/v0.10/task/<task_id>;thesystemthenreturnsadocumentwiththestatusinformation.TheRESTinterfaceis versioned,soGOcanevolveitsRESTinterfacewithoutbreaking existingclients.DocumentsthatarepassedtoandfromHTTPrequestsareformattedusingJavaScriptObjectNotation(JSON)and ExtensibleMark-upLanguage(XML).SupportedsecuritymechanismsincludeHTTPSmutualauthenticationwithanX.509clientcertificateand(forWebbrowsers)HTTPSserverauthenticationwithcookie-basedclientauthentication.TheWebinterfaceareincorporatedontheRESTinterfaceusingstandardAsynchronousJavaScript(AJAX)andXMLtechniques.AGOWebpagecontainsstandardHTML,CSS,andJavaScript,interactingwiththeRESTinterfacethroughstandard-sessioncookiebasedclientauthentication.TheWebGUIsupportsbrowsingremotefilesystems,aswellassubmitting,monitoring, andcancellingtransferrequests.

IntheSD-WANtocommunicatetheclienttoserveroranyproxyserverrequestandresponsescreatedmostprobablybytheRESTfulAPI.WhichisaninterfacebetweenApplicationsanSDNcontrollerintheNorthbound.TheRESTfulrequestelementconsistingofmethod, URL,authentication,customerheadersandrequestbodyintheprogramfragment.ThemethodsarelikeGET,POST,PUTandDELETEandtheAuthenticationprovidedbybasicHTTP,OAuthand CustomfinallytherequestbodycancreatedbyJSONorXML.AuthenticationofaRESTfulrequestisprocessedbyfourways:

*None:*TheAPIresourceispublicandanybodycanplacetherequest.

*BasicHTTP:*Theusernameandpasswordareforwardedtotheserverinanencryptedformat

*Token:*AsecretkeywhichiscreatedandprovidedfromtheWeb APIdeveloperportal.

*OpenAuthorization(OAuth):*AnopenstandardforretrievinganaccesstokenfromanIdentityProvider.Thetokenisthenpassed witheachAPIcall.

Foryourpurposes,youwillusetokenauthentication.Toaddatokentoyour RESTfulrequest,simplyaddkey=your_api_key,asshowninbelowfigure.

Figure4.RESTfulAPIrequestparametersforrequestaddressinSD-WANnetwork.

3.1.CreateVariablesforAPIRequest

RESTfulrequestinputURLisacombinationoffollowingvariables:

main_api-themainURLthatyouareaccessing

orig-theparametertospecifyyourpointoforigin

dest-theparametertospecifyyourdestination

key-theMapQuestAPIkeyyouretrievedfromthedeveloperwebsite.

main_api="https://www.mapquestapi.com/directions/v2/route?"
orig="Washington"
dest="Baltimaore"
key="your_api_key"

Createavariableurltostoretheresponsefromourrequest.

url=main_api+urllib.parse.urlencode({"key:key","from":orig,"to":dest})

Aftercreatedtheseprogramfragmentswecanmakearequestbycreatingthejson_datavariable,Thevariablemakesuseofthegetmethodoftherequestsmoduleandspecifies JSONastherequestedformat.Theprintstatementisusedtotestthattherequestwassuccessful.

json_data=requests.get(url).json()
print(json_data)

Requestshasbuilts-inJSON,whichyoucanusetogetresponseinJSONformatagain.

importrequests
importjson
req=requests.get('https://xyz.com/timeline.json')
req.json()

Rewritetheoriganddesttobewithinawhileloopinwhichitrequestsuserinputforthestartinglocationanddestination.Thewhileloopallowstheusertocontinuetomakerequestsfordifferentdirections.Besurealltheremainingcodeisindentedwithinthewhileloop.

whiletrue:
orig=input("Stringlocation:")
dest=input("Destination:")
url=main_api+urllib.parse.urlencode({"key":key,"from":orig,"to":dest})
print("URL:"+(url))
json_data=requests.get(url).json()
json_status=json_data["info"]["statuscode"]
ifjson_status==0:
print("APIStatus:"+str(json_status)+"=Asuccessfulroutecall.\n")

JavaScriptObjectNotation(JSON)isaformatofscriptinglanguageforstoringandexchangingtextbetweenaserverandaclient.InpresentdaysJSONisbecomeverypopularformatthatwebbased servicesanddifferentAPIsareusingbecauseofitcaneasytoparse withmostmodernprogramminglanguagesincludingPython.

InJSONisobjectnotationhereobjectsareindicatedbycurlybraces,assembledinPythondictionaries.JSONarraysareheldinsquarebracketswhichareinPythonlists.Tosimplifythediscussion, wewillrefertotheJSONstructuresusingthefamiliarPythonterms.Keepinmindhowever,thatJSONdataisusuallyconvertedtoPythondatastructuresbeforeitisusedbyPythonprograms.

```
{
    message: "success",
  - request: {
        altitude: 100,
        datetime: 1539354878,
        latitude: 30.26715,
        longitude: -97.74306,
        passes: 5
    },
  - response: [
      - {
            duration: 254,
            risetime: 1539357421
        },
      - {
            duration: 638,
            risetime: 1539362981
        },
      - {
            duration: 537,
            risetime: 1539368837
        },
      - {
            duration: 108,
            risetime: 1539374926
        },
      - {
            duration: 450,
            risetime: 1539386568
        }
    ]
}
```


Figure4.JSONResponseDatainSD-WAN

IV. SD-WANARCHITECTUREANDSERVICECOMPONENTS

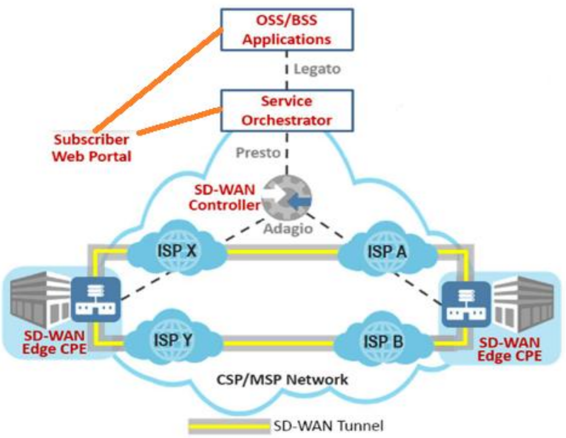

Figure5.SD-WANbasicArchitecture

TheSD-WANarchitectureusetheservicecomponentstomanagetheservicesinthenetwork.Thissectionwilldescribewhereeachoftheseservicecomponents.

·SD-WANEdge
·SD-WANController
·ServiceOrchestrator
·SD-WANGateway
·SubscriberWebPortal

TheSD-WANServiceComponentstounderstandtheirplacementinthearchitecture.ThedifferentSD-WANservicecomponentsinacomprehensivenetworkdiagram.Tosimplifythediscussion,thispaperwillfocusonasingleproviderdomainandthusnotcovertheinterfaceswhichareusedforthecommunicationofinter-providerservicefunctions[9][5].

4.1.SD-WANEdge

TheSD-WANEdgecreatestheTunnelsforthevarioustypeswiredorwirelessunderlaynetworkslikeBroadbandInternet(DSL,CableandPON),Wi-FiandLTEwirelessnetworks,andIP(Internet)andMPLScorenetworks.ThisSD-WANEdgeprovidestheservicedemarcationsameashoetheEthernetNIDprovidestheservicedemarcationforaCarrierEthernetservice.ThefunctionalityoftheSD-WANEdgeistocheckingapplication-basedQoSandsecuritypolicyenforcement,applicationforwardingoveroneormoreWANconnections,andQoSperformancemeasurementsovereachWANtodetermineWANpathselection[10][11].TheSD-WANEdgeoperatetheWANoptimizationfunctionssuchaspacketbuffering/reordering,datade-duplication,datacompression,andforwarderrorcorrection.SinceSD-WANEdgesoftenconnecttopublicInternetWANs,theywouldinclude,ataminimum,someNATandfirewallcapabilities.

TheSD-WANEdgeoperationsmaybeprovidedbyaphysicalCPEdeviceresidentontheclientpremisesandmanagedbytheCSPorMSP.SD-WANEdgefunctionalitymayalsobeimplementedasasoftware-basedvirtualnetworkfunction(VNF)whichmayrunonavirtualCPEattheclientpremisesoranyothertypeofgeneralizedcomputeplatform,e.g.,serverinadatacenter,whichmayalsobemanagedbytheCSPorMSPorbyacloudserviceprovider.TheMSPorCSPoperatesandmaintainstheSD-WANEdgeaspartofanSD-WANmanagedservice.

4.2.SD-WANGateway

TheSD-WANGatewayinterconnectsthevariousclientssiteviaSD-WANVPNnetworks.SD-WANdeliveritsservicestoconnectedsitesintwoways.OnewayisthroughtheSD-WANEdgeconnectwiththesitespresentintheVPNnetwork[12].AnotherwayisSD-WANgatewayoperatestheconnectedsitesmeansinitiatetheservicesandterminatingtheservices.SD-WANservicefunctionalitiessuchasapplication-basedtrafficforwardingovermultipleWANsorQoSandSecuritypolicymanagementwillnotbeavailableattheMPLSVPNsitesbecausetheydonothaveSD-WANEdgeswhichperformthesefunctions[13].

4.3.SD-WANController

TheSD-WANControllermanagesbothphysicalandvirtualdevicesforall SD-WANEdgesandSDWANGatewaysassociatedwiththecontroller.ThefunctionalityofSD-WANcontrollerisnotonlyConfigurationandactivationofIPaddressbutalsoitmaintainsconnectionstoallSD-WANedgesandgatewaystoidentifytheoperationalstateofSD-WANedgesacrossthenetworkandretrieve

betterQoSperformanceforeachSD-WANedge[6][14].TheMSPorCSPoperatesandmaintainstheSD-WANControlleraspartandSD-WANmanagedservice.

4.4.ServiceOrchestrator

ThefunctionalityofServiceOrchestratorisprovidingtheservicemanagementtotheSD-WANservicelifecycleincludingfulfilmentofservice,performanceofSD-WAN,controlofarchitecture,assuranceforservices,usage,securityandpolicy[15].ThisoperatesandmaintainstheServiceOrchestratorwithanSD-WANmanagedservice.TheServiceOrchestratoralsocanperformservicemodificationrequestsfromaSubscriberPortal.

4.5.SubscriberWebPortal

WhentheSD-WANserviceisactivated,theSubscriberWebPortalconnectwiththeServiceOrchestratorformodifyingSD-WANservicesuchassettingupdifferentQoS,securityorbusinesspoliciesbasedonauser'srole,e.g.,'view-only'capabilityorabilitytomodifytheSD-WANservice[7][16].TheServiceOrchestratoralsoperformsservicemodificationrequestsfromtheSubscriberPortal.

V. CHALENGESTOIMPLEMENTSD-WAN& RESULTS

IndesigningofWideAreaNetworksvariouschallengesforthedesignersespeciallyfortheSDNSystems.ThismayoccursduetolinkfailureandcomplexconnectivityinnetworkarchitectureWANnetworkarchitecturemainlyfocusonlinkproblems,complexityofnetworksmorethanthedatacentriccontrol.Datacentersarededicatedcontrolnetworkswithhighdegreeofparallellinksthesearedeployedinasafeandcontrolledenvironment.SDWANhadbeenuseddistributedcontrolplane[17].ThemainchallengesofSDWANisupdatingthenetworkconfigurationinanetworkswitchinconsistentmanner,distributingtheSDNcontrollerstateandwheretobeplacedthecontrollerinstances.

5.1.DistributingSDNControllerState

InmostoftheSDNdeploymentsfollowsacontrolprogramtodefinetheoverallnetworkoperatingsystemwithcontrolanddataplanetogether.SDNcontrollerrepresentasinglecheckpoint,itisalsoasinglepointoffailure[1][17].Toovercomescaleoutperformanceandfaulttolerancedistributed SDNcontrollershadbeenproposed[7][11][16].SDNcontrollermainlyhashighthroughputrequirements.SDNcontrollersinstancesdistributedinthenetworknaturallyalsorequiredistributingthecontrollerstate.Thestatesaregenerallymatchactionrules,topologyinformationandstatistics.ONOS(OpenNetworkOperatingSystem)isControllerarchitecture.ONOSprovidestwomainfunctionalities:firstlyglobalabstractviewofthesharingnetwork.Secondly,extensivecapabilitiesforbothperformanceandfaulttolerance.ONOSoperateseachswitchasthecontrollerthatprogramsforwardingplane.Theswitchesdistributedamongtallcontrollerinstances.

5.2.PlacingControllerInstances

IndeploymentofWideAreaNetwork(WAN)placingmultiplecontrollerscanleadsgreaterlatencyandfaulttolerance.Indeploymentofcontrollersvariousquestionsmaybearisehowmanycontrollerstodeployandwheretoplacethem.Theresearcherswerereducedtheplacementproblembasedonthedesiredmetric(1)whenusesaverage-caselatencytheproblemreducedtominimumk-medianproblem.(2)whenworstcaselatencyitreducestothek-centreproblem.(3)whennodesnotexceedsaspecificlatencyitreducestoNP-hardandboundtonextcontroller.

5.3.UpdatingSDNSwitchesinaConsistentManner

InSDWANnetworkarchitectureforwardingswitchesareusedforenablingdynamicandcustomizeddataplaneconfigurations.Eachswitchpresentinthedataplanemustbeupdated.Updatingofdataplaneinalargenetworkmaycausesevereinconsistencies.Mainreasonfortheseproblemsisinfeasibilitytoupdateentirenetworksystemautomaticallytomainfullnetworkoperation.Theresultswitchesaregenerallyupdatedandconfiguredinstepbystepprocedure.Inconsistencyinnetworkmayleadstointerruptedconnectivity,forwardingloops,oraccessingcontrolviolations.Intermediateupdatestatesarecausingviolationinthebandwidth.Inordertoavoidthisproblemmostofthem,relyonplanninganexactupdateorder.

VI. CONCLUSIONS

WecanconcludetheSoftwaredefinedWideAreaNetworkingoverviewalongwithitsarchitecture.PresentdaySDWANbecominghighlydemandingnetworkarchitecturebecauseofitsperformance,reliability,andimprovisedwideareanetworkissues.InparticularWANweremoreexpensiveandneedshighperformancehardware.SDWANarchitectureoptimizestheWANnetworkandprovidesbetterscalabilityandfaulttolerance.SDWANtechnologiesanddeploymentssustainsforlongertimeandcreatemoreimpactonthefutureoperationofWANS.SD-WANimplementationwithCloudComputingisachallengingtask.FromthispaperweexplainedaboutarchitecturalissuesintheSD-WAN.Inthefeaturewecontinueourresearchwithoptimalpathtracingbycontrolplaneandsecurityissuesinthe SD-WAN.

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