PCCW Global®

ICAO CRV program - MID region

PCCW Global

1st March, 2018

HKT Here To Serve

a PCCW - HKT Group member

Agenda

1. Company Introduction
2. Why and What is CRV?
3. Network Architecture, Applications & Security
4. CRV Packages
5. How to proceed
6. Investment Summary

PCCW Global®

1. Company Introduction

HKT Here To Serve

a PCCW - HKT Group member

Our Parent Company: HKT

- PCCW Global is an international operating division of HKT, Hong Kong's premier telecommunications service provider, majority-owned by PCCW Limited.

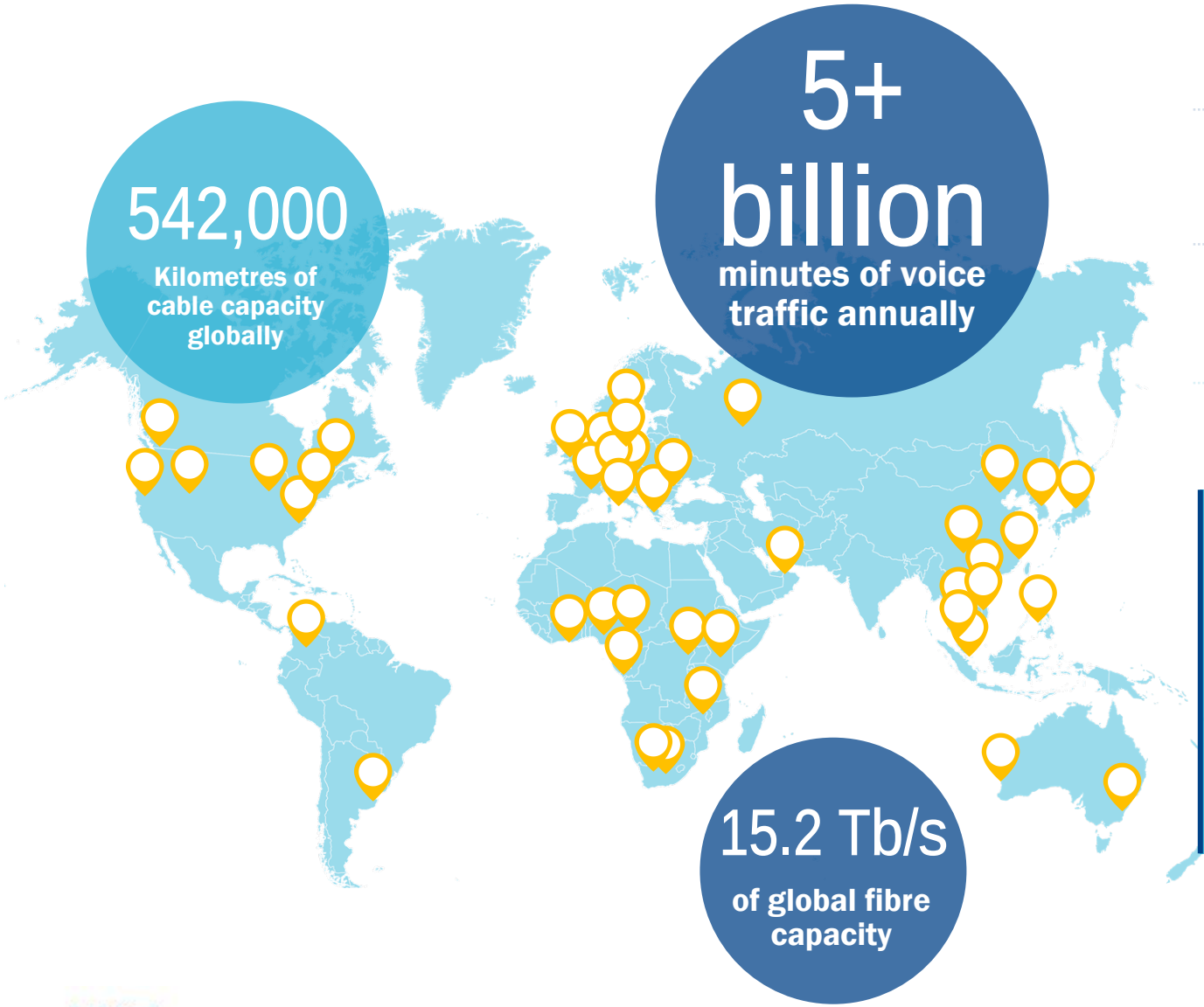
- In 2014, HKT acquired CSL, Hong Kong's first mobile operator. Launched in 1983, CSL is at the forefront of delivering world-class network built above GSMA standards.

- PCCW Global is able to take local innovations in media, broadcasting, smart city solutions and reach out to global audience.

*Source: Gartner 2014

HKT

- Headquartered in Hong Kong
- Founded in 1925
- 2017 Revenue: US$4.3 billion
- Employees: 18,900
- Number 1 Provider to consumers and enterprises
- Local quadruple-play services:
  - Fixed
  - Broadband
  - Mobile
  - Pay TV
- Listed on the Hong Kong Stock Exchange in 2011
- China Unicom is the 2nd largest shareholder of HKT



55 Locations Worldwide

TOP 10

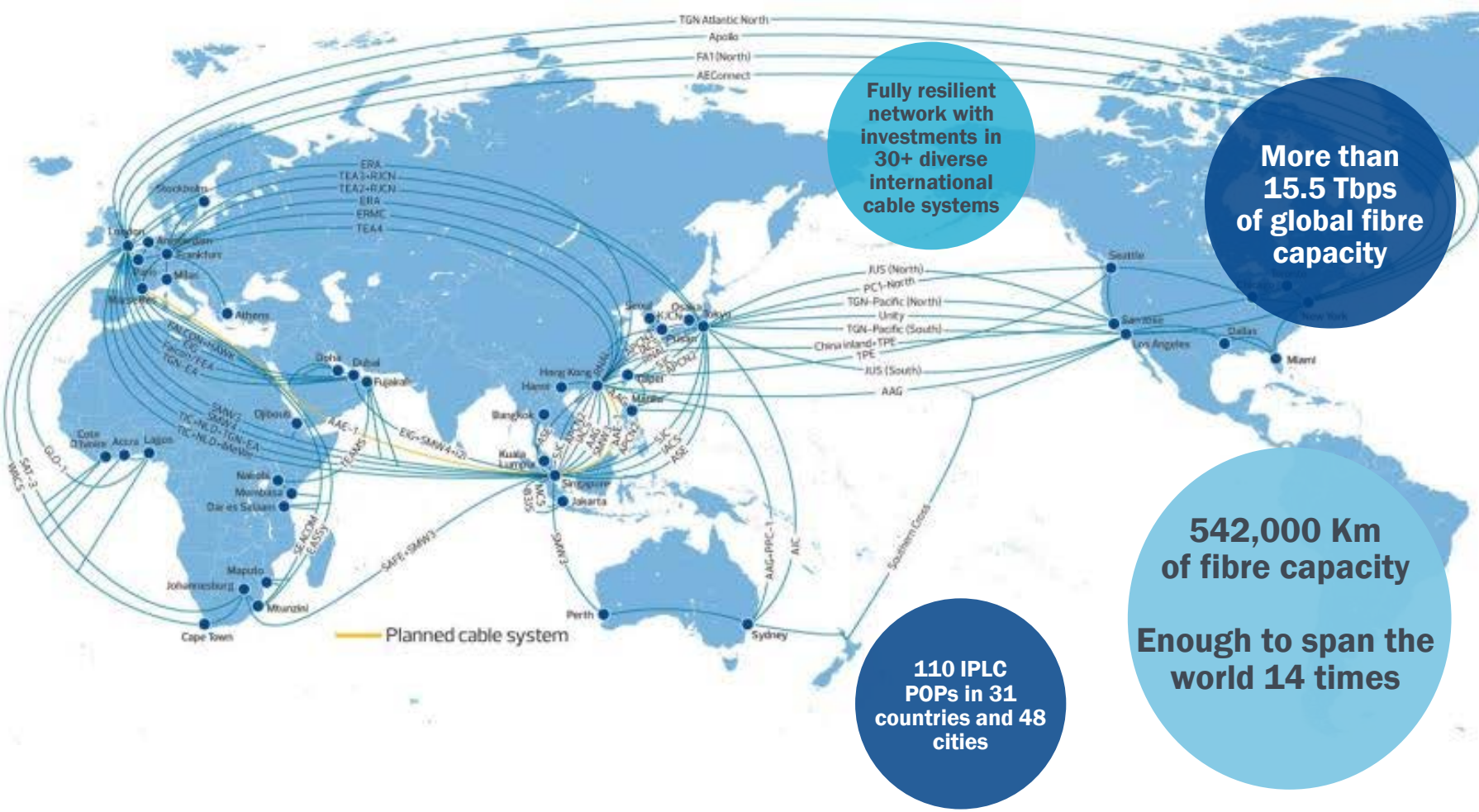
in IP Transit services globally

Network presence in over 3,000 cities and 150 countries

We Serve...

Fixed & Mobile Network Operators	Cloud and Application Providers	Internet Content Providers	Internet Service Providers	Enterprises / NGOs / Governments	Media & Broadcast Companies

Global Connectivity – Fibre Network



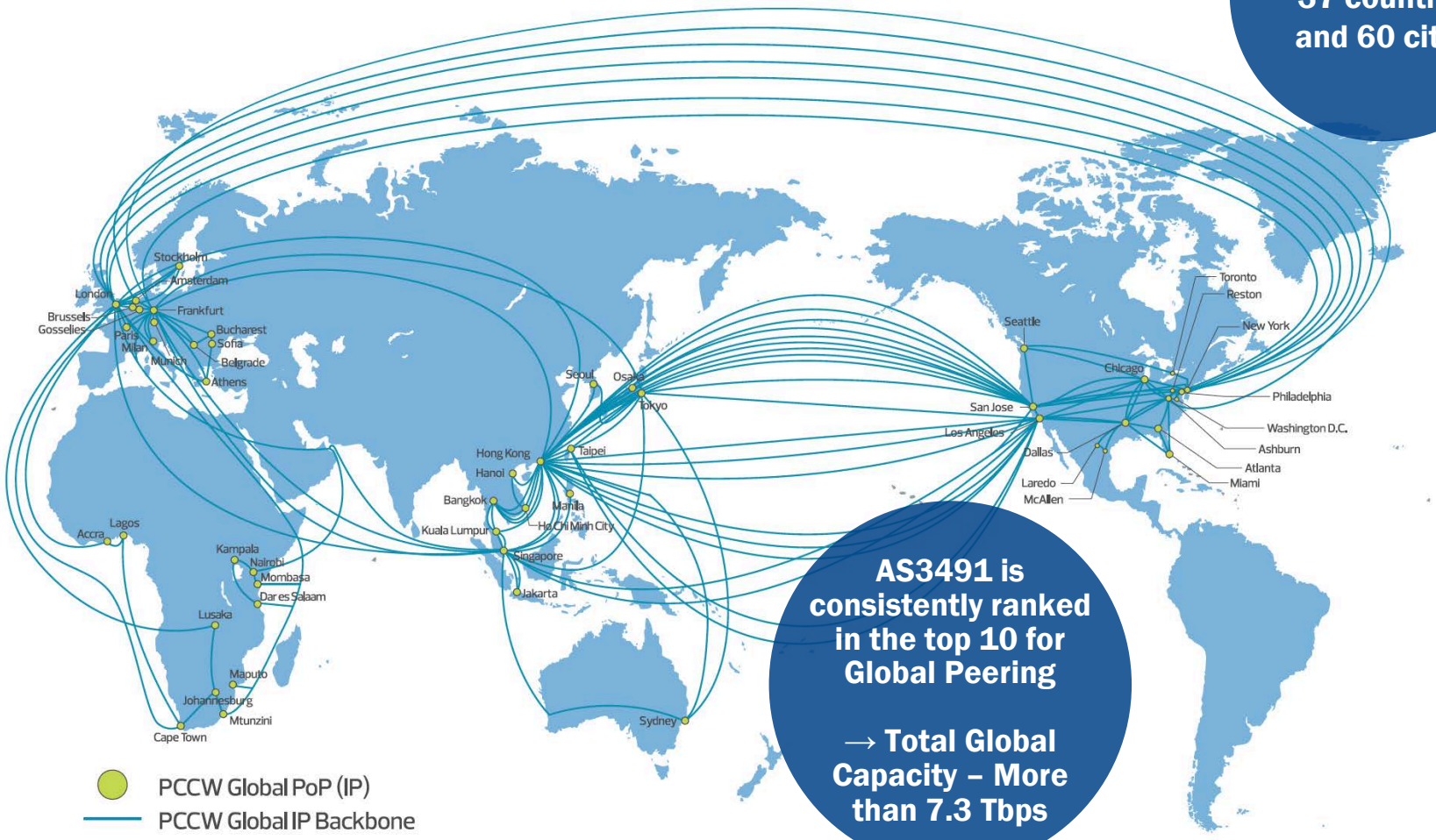
Investments in the Future

The Asia Africa Europe-1 (AAE-1) cable system will provide greater capacity and connectivity between Asia and Africa and support the growth of the Asia-Africa trade corridor.

PCCW Global continues to invest in the future of its infrastructure, ensuring customers have access to the best technologies and most reliable networks.

Our IP Backbone

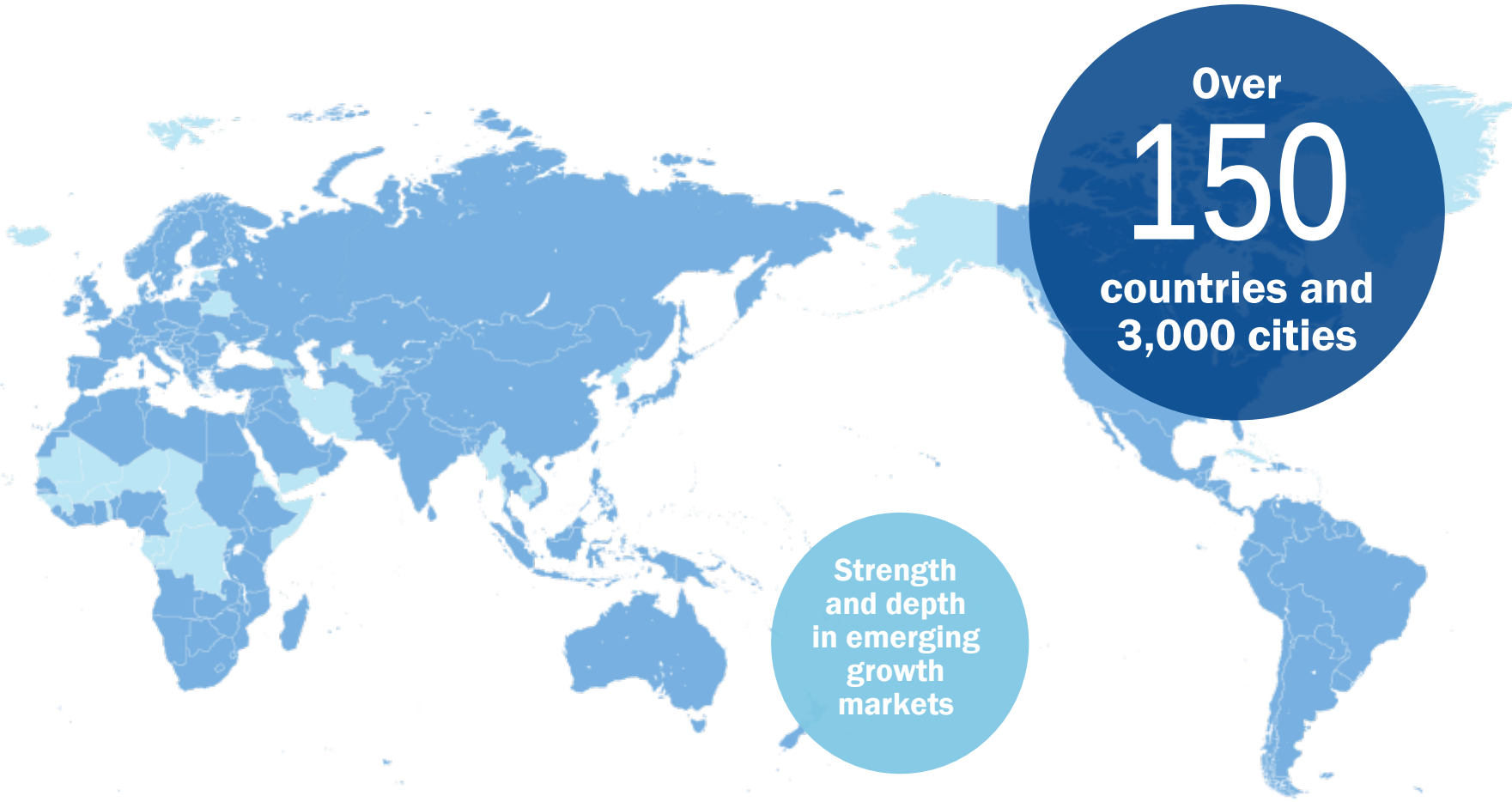
98 IP POPs in 37 countries and 60 cities



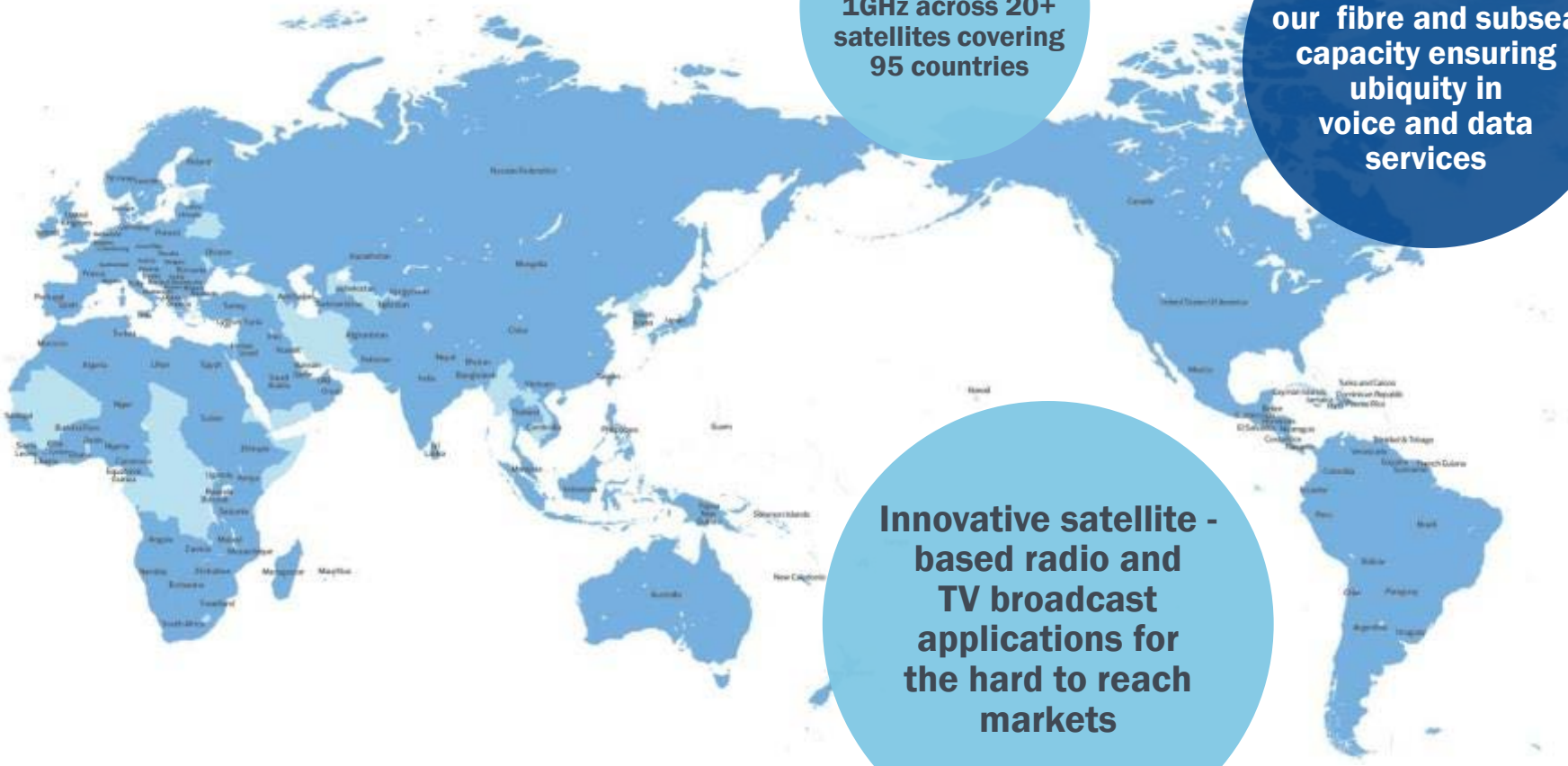
AS3491 is consistently ranked in the top 10 for Global Peering

→ Total Global Capacity – More than 7.3 Tbps

Global Connectivity – MPLS Coverage



Satellite Connectivity

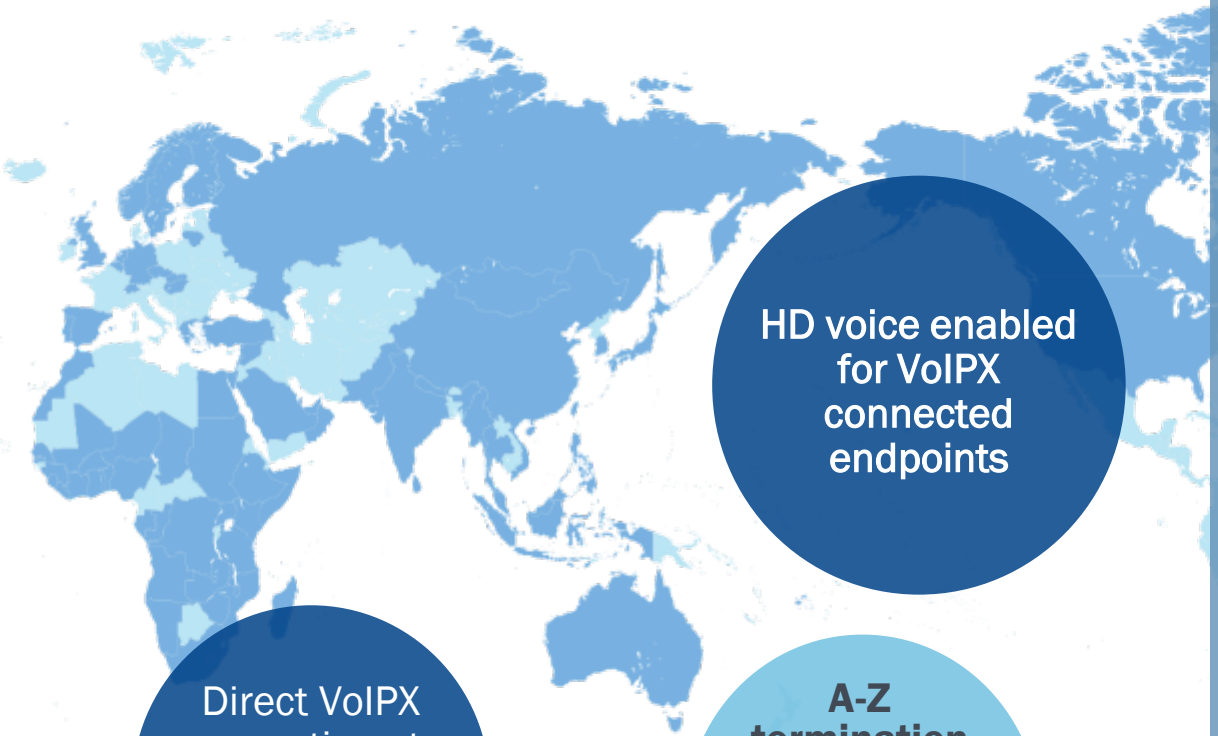


Extensive global satellite network - 1GHz across 20+ satellites covering 95 countries

Provides resilience to our fibre and subsea capacity ensuring ubiquity in voice and data services

Innovative satellite - based radio and TV broadcast applications for the hard to reach markets

Direct Voice Coverage



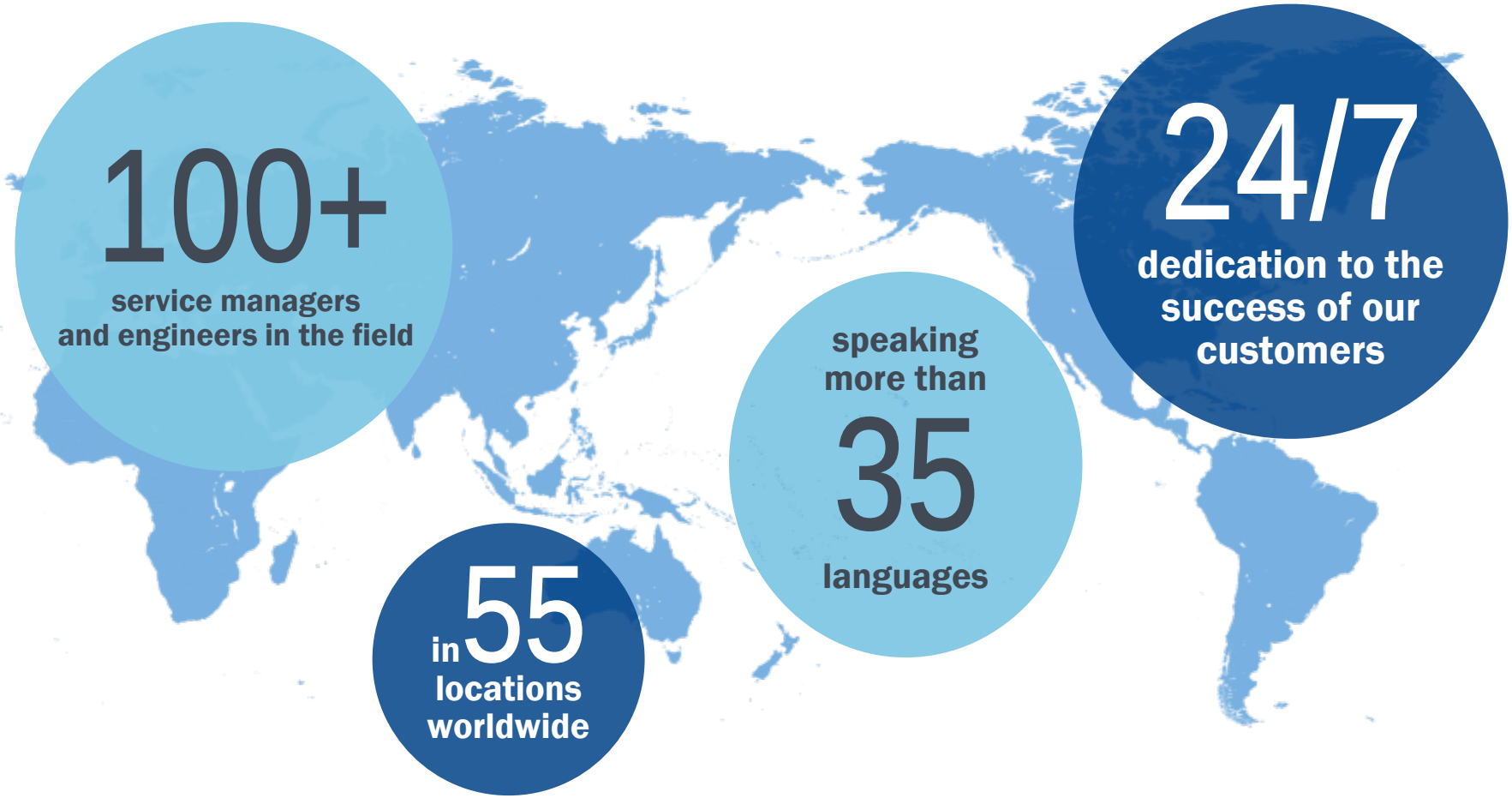
HD voice enabled for VoIPX connected endpoints

Direct VoIPX connections to **70+** Mobile operators & carriers

A-Z termination with 300+ direct connected carriers

- **Direct connections with over 300 major international carries and service providers**
- **Extensive reach into emerging markets of Asia, Africa and Middle East**
- **Direct VoIPX connections to 70+ carriers and mobile operators VoIPX indirects through IPX partners**
- **Routing prioritization for different type of services**
- **Interworking SIP/SIP-I/ITU C7/ ANSI SS7/ ETSI & ANSI PRI**
- **Different classes of services for various market segment requirements, Platinum Plus and Premium services over directs or partners directs with CLI guarantee, Standard service for price sensitive operators**
- **VoLTE READY!**

Our Global Team



Sales Region — Americas

- Serving leading carriers, content providers and Fortune 500 enterprises
- Connecting Latin America globally via strong partners
- Excellence in Project Management -Best North American Project 2015

Sales Region — Europe

gtb GLOBAL TELECOMS BUSINESS innovation awards WINNER IN 2015

- Connecting 20+ European countries to Middle East, Asia and the Americas via diverse and resilient cable routes
- Hybrid connectivity to connect Europe and Africa to meet increasing demand
- Excellence in Innovation – Awarded twice for the Best Service Innovation Award

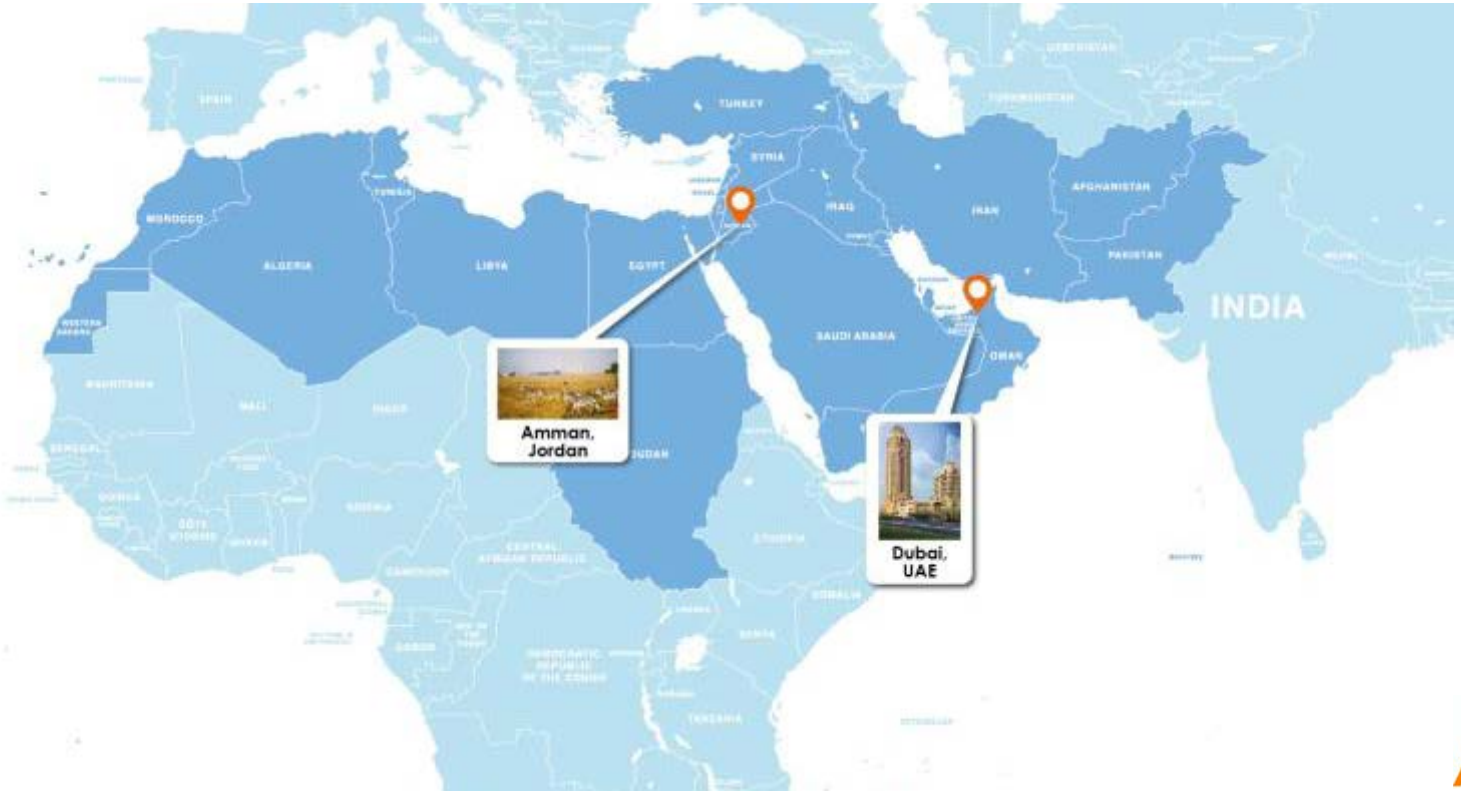
Sales Region — Africa

AfricaCom AWARDS

FROST & SULLIVAN
2015 BEST PRACTICES AWARD
SUB-SAHARAN AFRICAN CONNECTIVITY SOLUTIONS CUSTOMER VALUE LEADERSHIP AWARD

- Experts on the ground since 1991
- Fibre to 40 African countries, including 14 land-locked countries
- Diverse capacity on all cables: West (WACS , SAT3, GLO-1, Main One), East (SEACOM, TEAMS, EASSy)

Sales Region — MENA



The Telecoms World Awards Middle East

- Strategic alliance agreements and strong relationships with regional leading carriers
- Widespread coverage across the region with diverse connections from Gulf Region to Asia and Europe
- Awarded with Best International Wholesale Carrier Telecoms World Middle East consecutively from 2011 to 2016

Sales Region — SSAO

TELECOM Review
telecomreview.com

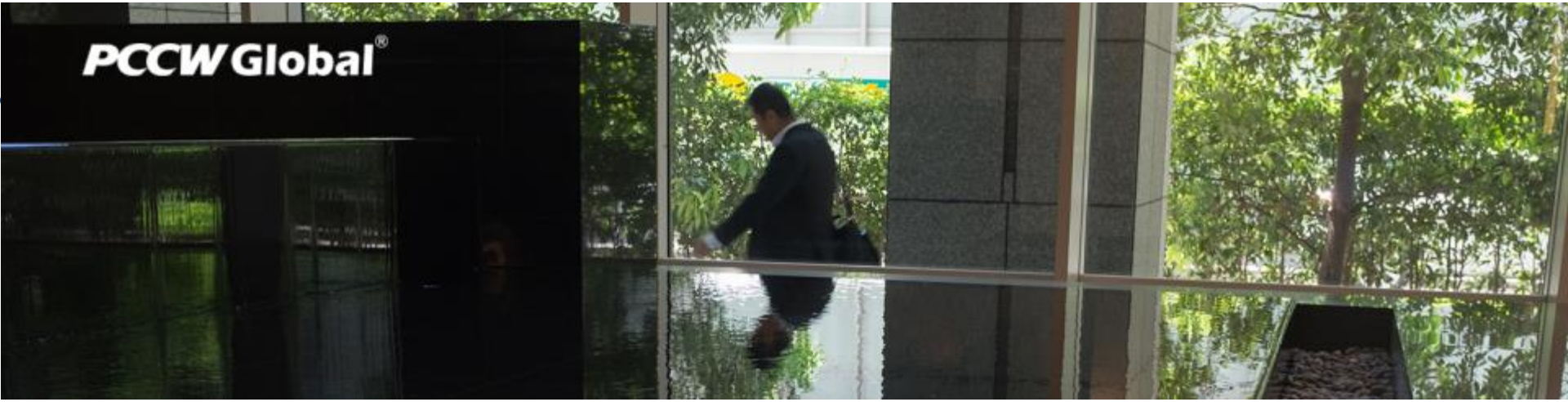
MEF ETHERNET EXCELLENCE AWARDS 2014
Wholesale Service Provider of the Year APAC

- Best Asian Wholesale Operator 2015, 2016 – Telecom Review Awards
- Wholesale Service Provider of the Year – APAC 2014 – MEF

Sales Region — Asia & CIS

MEF ETHERNET EXCELLENCE AWARDS 2014
Wholesale Service Provider of the Year APAC

- Headquartered in Hong Kong, one of the global leading markets in the ICT sector
- Premier provider of international solutions to MNCs and service providers throughout Asia Pacific.
- We interconnect over 24 cities in China with managed cross border solutions



Our Solutions

Our Core & Value Added Services have been designed to give customers new capabilities, reach, efficiency and flexibility.

Value Added Services

Core Services

Cloud
Flexible cloud-based IT and communications applications

Mobility Solutions
Connectivity and solutions for MNOs across technologies and global markets

Global UCaaS Solutions
A single integrated platform delivered from the cloud for global UCaaS

Media Solutions
Superfast delivery of content around the world

Managed Network
Solutions to monitor, optimise networks and free up IT resources

Network Security
Expertise, intelligence and infrastructure to secure assets from cyber attacks

Global Development Services
Leverage the extensive knowledge and experience of HKT and the PCCW Group to support global customers

Voice Service

Data Service

Global Fibre and Satellite Network

Awards & Recognition

World Communications Awards:

- The Users' Choice Award 2016
- Innovation Award: Operator – Global View 2016
- Innovation Award – Threat Management 2015

Telecom Review Excellence Awards:

- Best Asian Wholesale Operator 2015-2016
- Best African Wholesale Operator 2015

AfricaCom Awards:

- Best Network Improvement Award 2016
- Best Cost Efficiency Solution for Africa 2015

MEF Excellence Awards:

- Wholesale Service Provider of the Year - Global 2015-2016

Global Carrier Awards:

- Best Unified Communications Award 2016

Carriers World Awards:

- Technology Innovation Award 2016

Africa Carrier Awards:

- Best West African Wholesale Carrier 2016

Global Telecoms Business Award:

- Customer Service Innovation Award 2016
- Business Service Innovation Award 2015 – Global Network Threat Identification for Enterprises

Frost & Sullivan:

- Customer Value Leadership Award – 2015 Sub-Saharan African (SSA) Connectivity Solutions

Global Carrier Awards:

- Best North American Project 2015
- Best Voice Service Innovation: Emerging Market 2015

Telecoms World Awards Middle East:

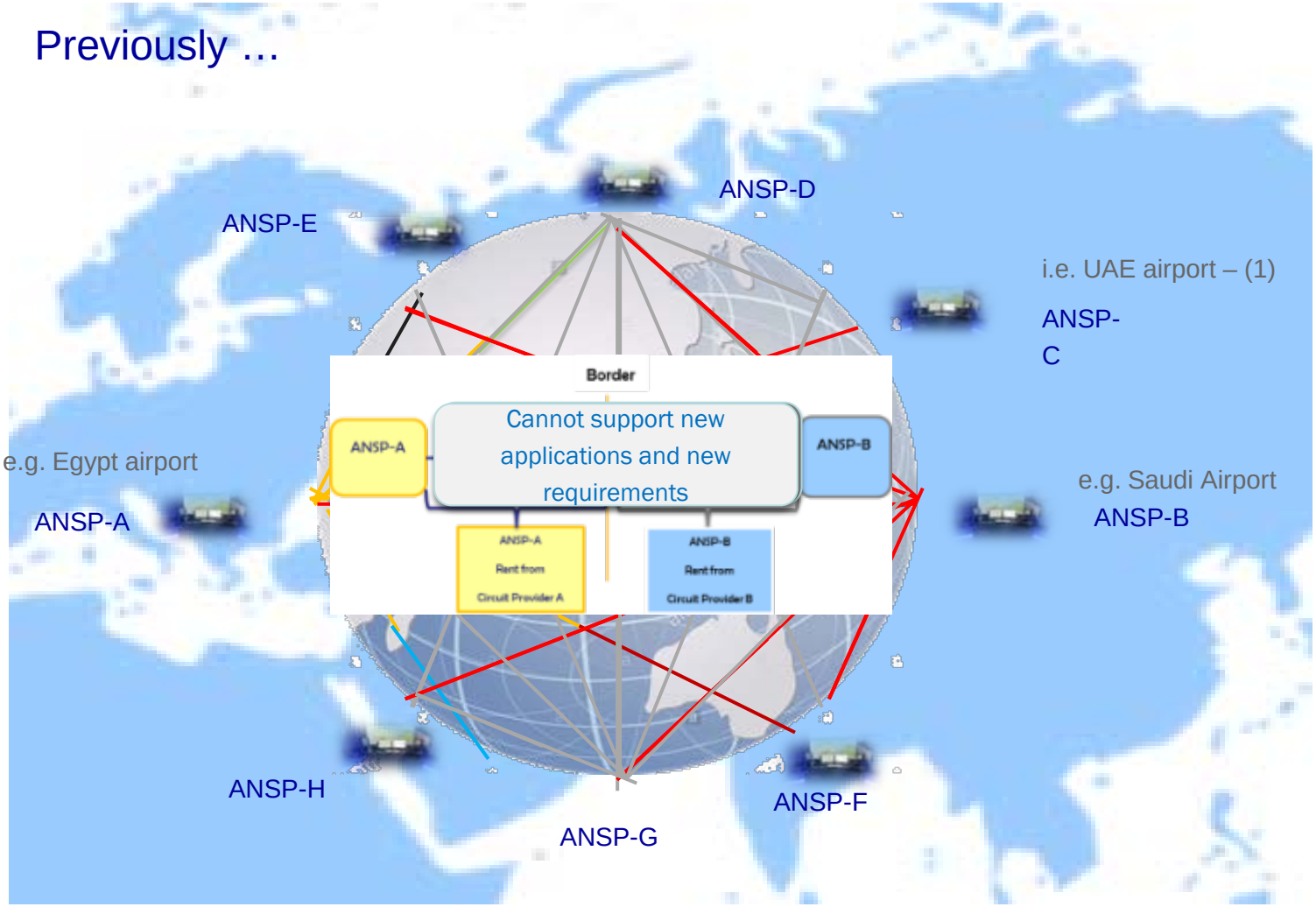
- Best International Wholesale Carrier 2011- 2016

Infocom – Greece:

- 2015 Business Growth

2. Why and What is CRV ?

Previously …


ANSP-D
ANSP-E
i.e. UAE airport – (1)
ANSP-C
e.g. Egypt airport
ANSP-A
e.g. Saudi Airport
ANSP-B
ANSP-H
ANSP-F
ANSP-G
Border
ANSP-A
Cannot support new applications and new requirements
ANSP-B
ANSP-A Rent from Circuit Provider A
ANSP-B Rent from Circuit Provider B

Harmonized and homogeneous level of network performance and services

- Solving current aeronautical communication deficiencies
- Solving current limitations (obsolescence, lack of standardization, poor escalation processes)

Cost efficient

- Reduced procurement time and effort
- Value for money increases over years

Aeronautical Fixed Service (AFS) in the APAC region

- Sharing of surveillance data
- AFTN/AMHS
- Potential for additional connectivity beyond the initial AFTN-like routing network, including both regional and inter-regional connectivity;

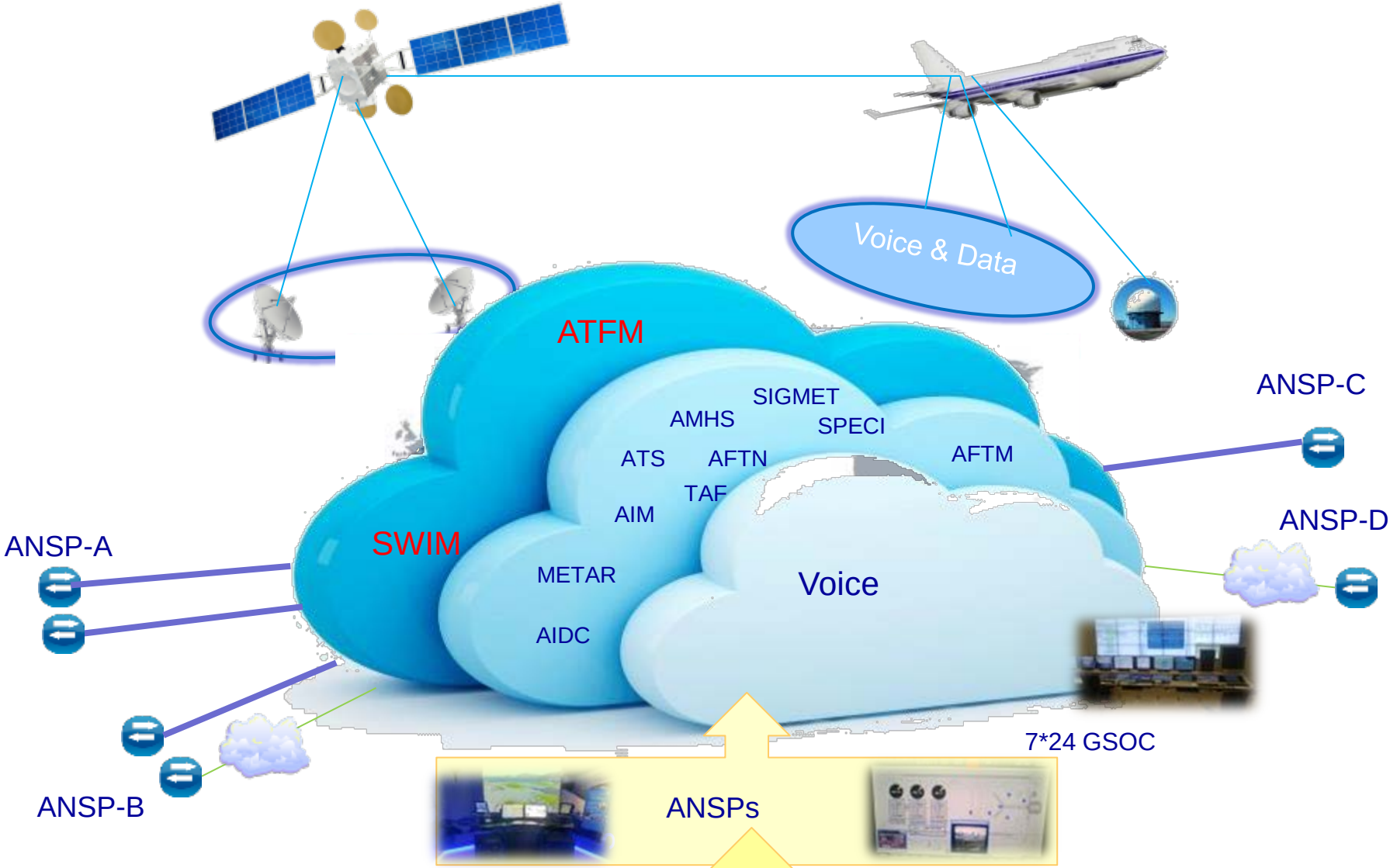
Why CRV (cont.)

Prerequisite of the Global Air Navigation Plan

- Flight and Flow information
- Network operations
- Aeronautical Information Management
- Voice communications (VoIP)
- SWIM

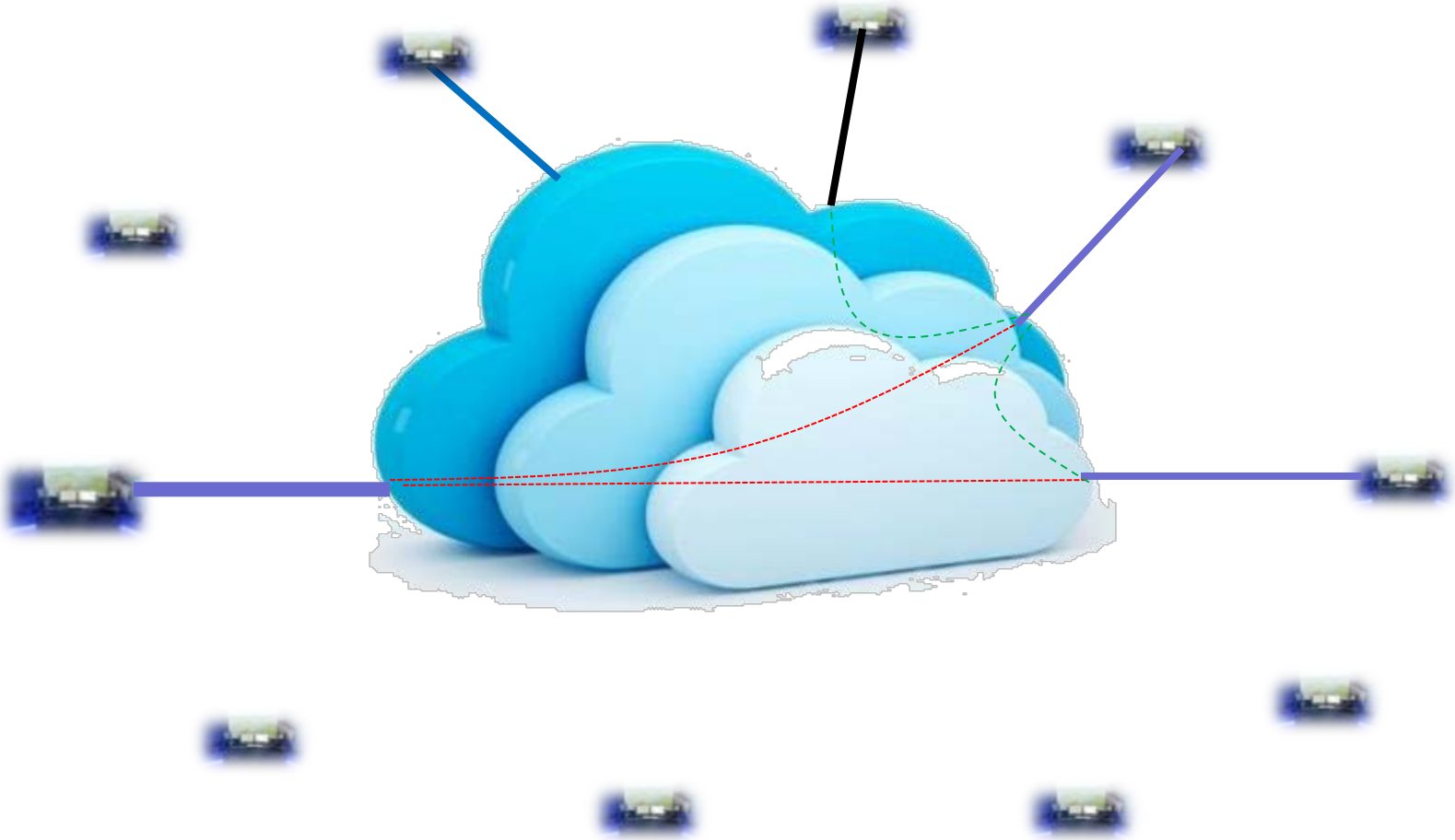
Common helpdesk, common escalation process for network service issues

CRV: the future of Asia Pacific's aeronautical communications infrastructure



Potential : military, airport, ATM industry and airlines

CRV – Meshed ready by our network configuration



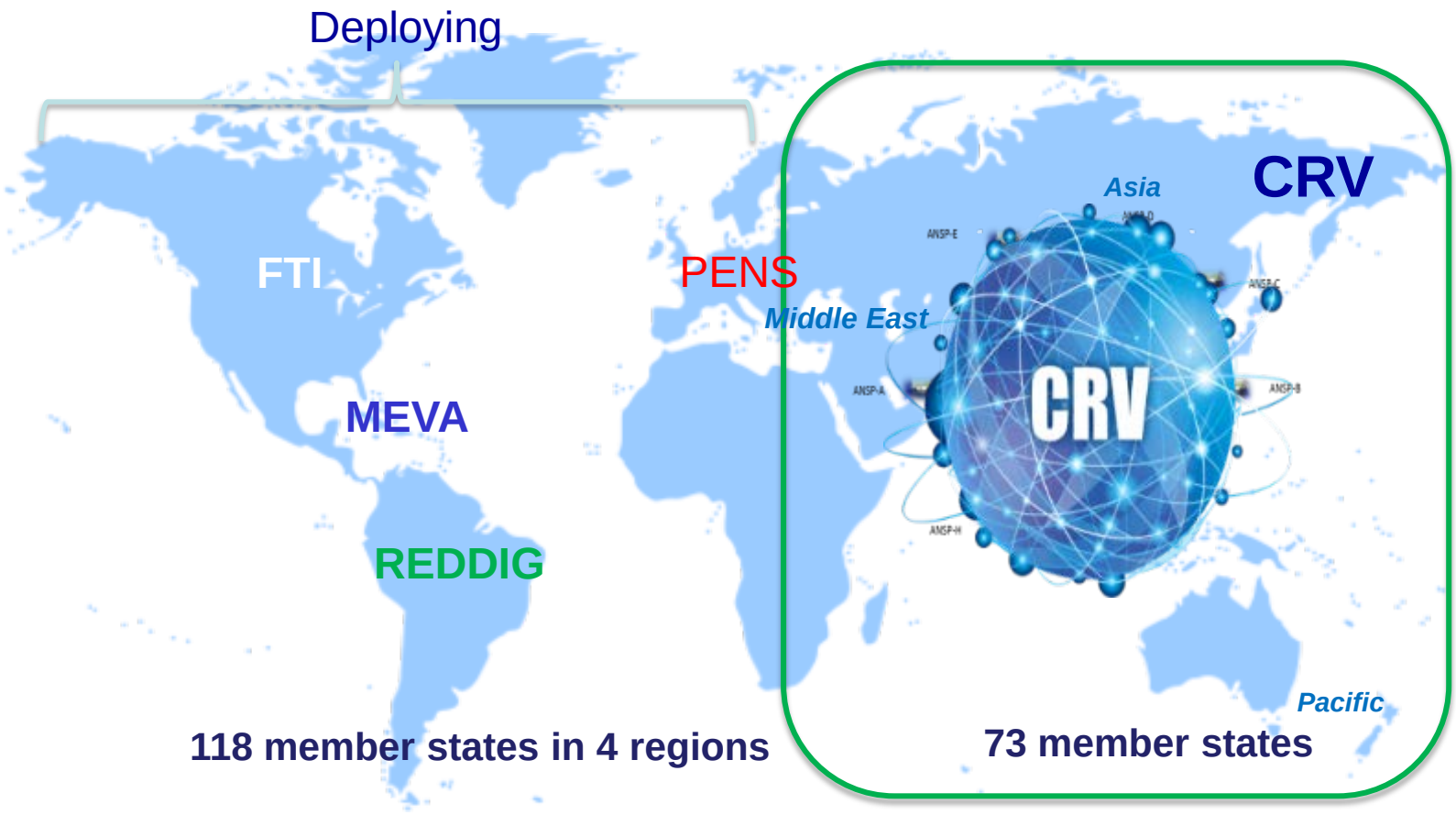
No need to install multiple Bilateral IPL
Our Platform can add on just by configuration

Started from Mid 2015

Tender invitation 2015

Ranked 1st in 1st 2017

From Now on... - Common Regional Virtual (CRV) Network – Powered by PCCW Global



CRV ~ Common regional Virtual private network

July 2017

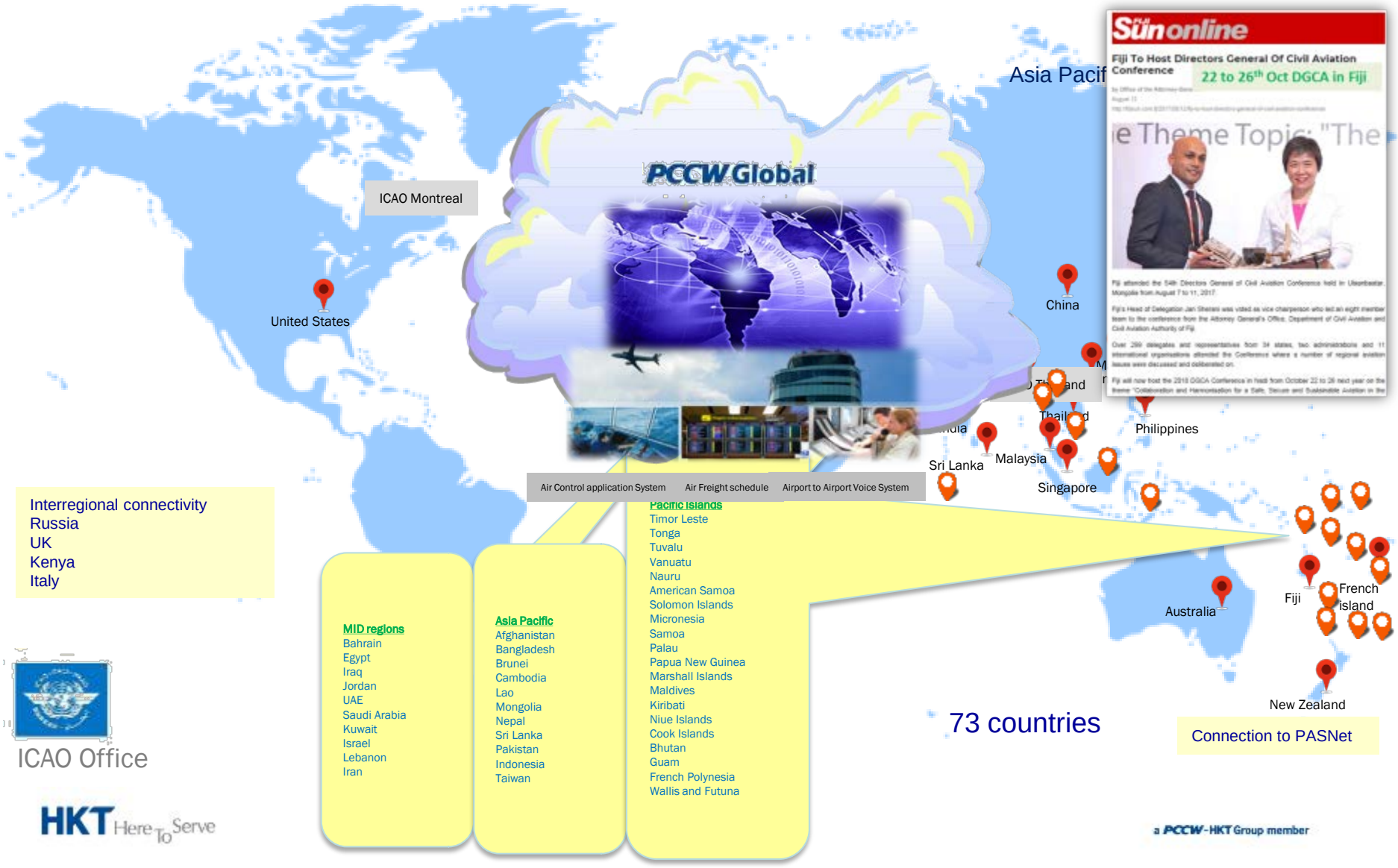

54th Conference of
Directors General of Civil Aviation Asia and

Operational Readiness Ceremony on 14th Dec 2017

Signing Ceremony – Bangkok 18th Dec 2017

PCCW Global

CRV Program diagram



Interregional connectivity
Russia
UK
Kenya
Italy

MID regions
Bahrain
Egypt
Iraq
Jordan
UAE
Saudi Arabia
Kuwait
Israel
Lebanon
Iran

Asia Pacific
Afghanistan
Bangladesh
Brunei
Cambodia
Lao
Mongolia
Nepal
Sri Lanka
Pakistan
Indonesia
Taiwan

Pacific Islands
Timor Leste
Tonga
Tuvalu
Vanuatu
Nauru
American Samoa
Solomon Islands
Micronesia
Samoa
Palau
Papua New Guinea
Marshall Islands
Maldives
Kiribati
Niue Islands
Cook Islands
Bhutan
Guam
French Polynesia
Wallis and Futuna

73 countries

Connection to PASNet

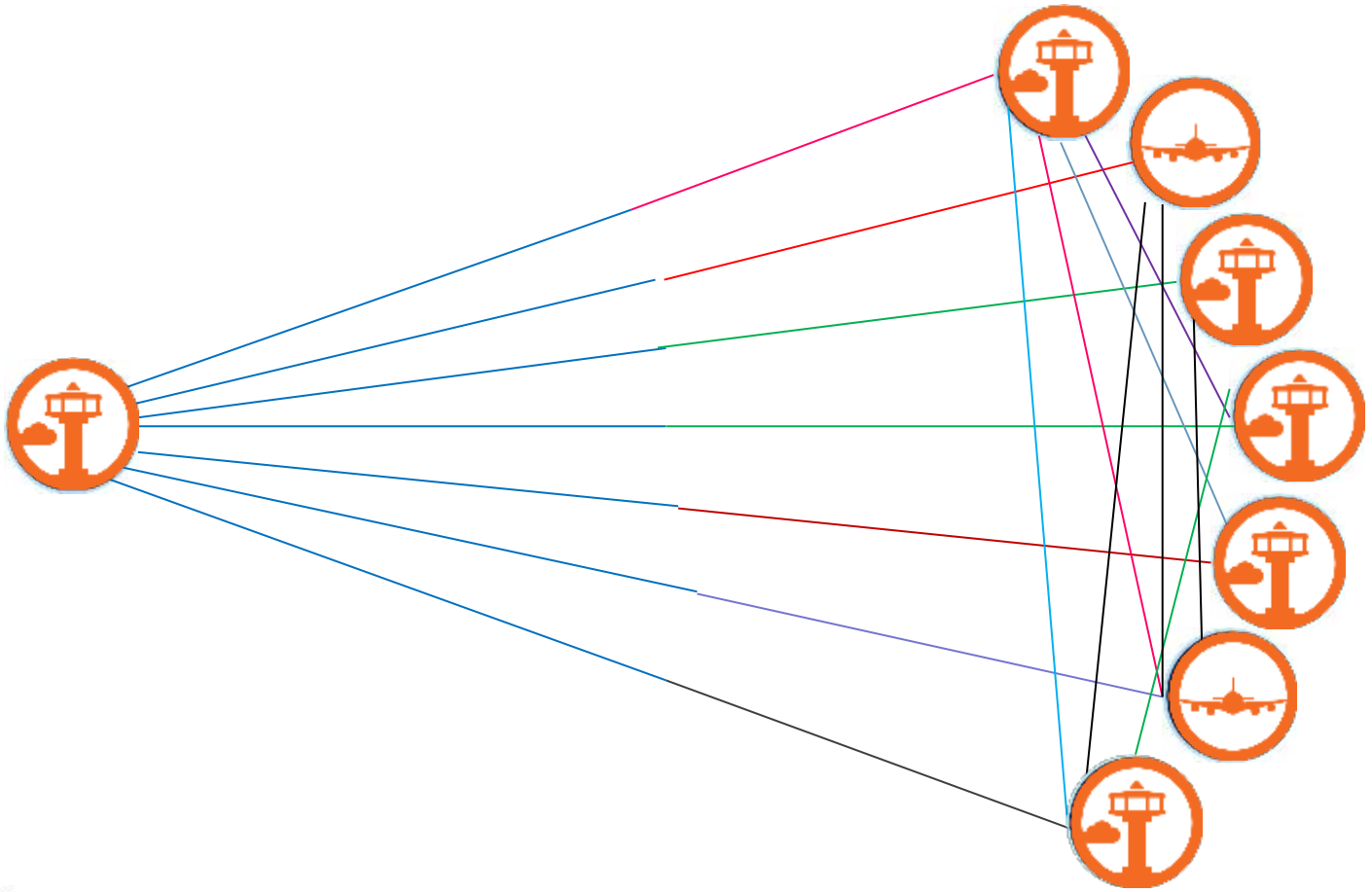
ICAO Office

HKT Here To Serve

a PCCW-HKT Group member

CRV video introduction

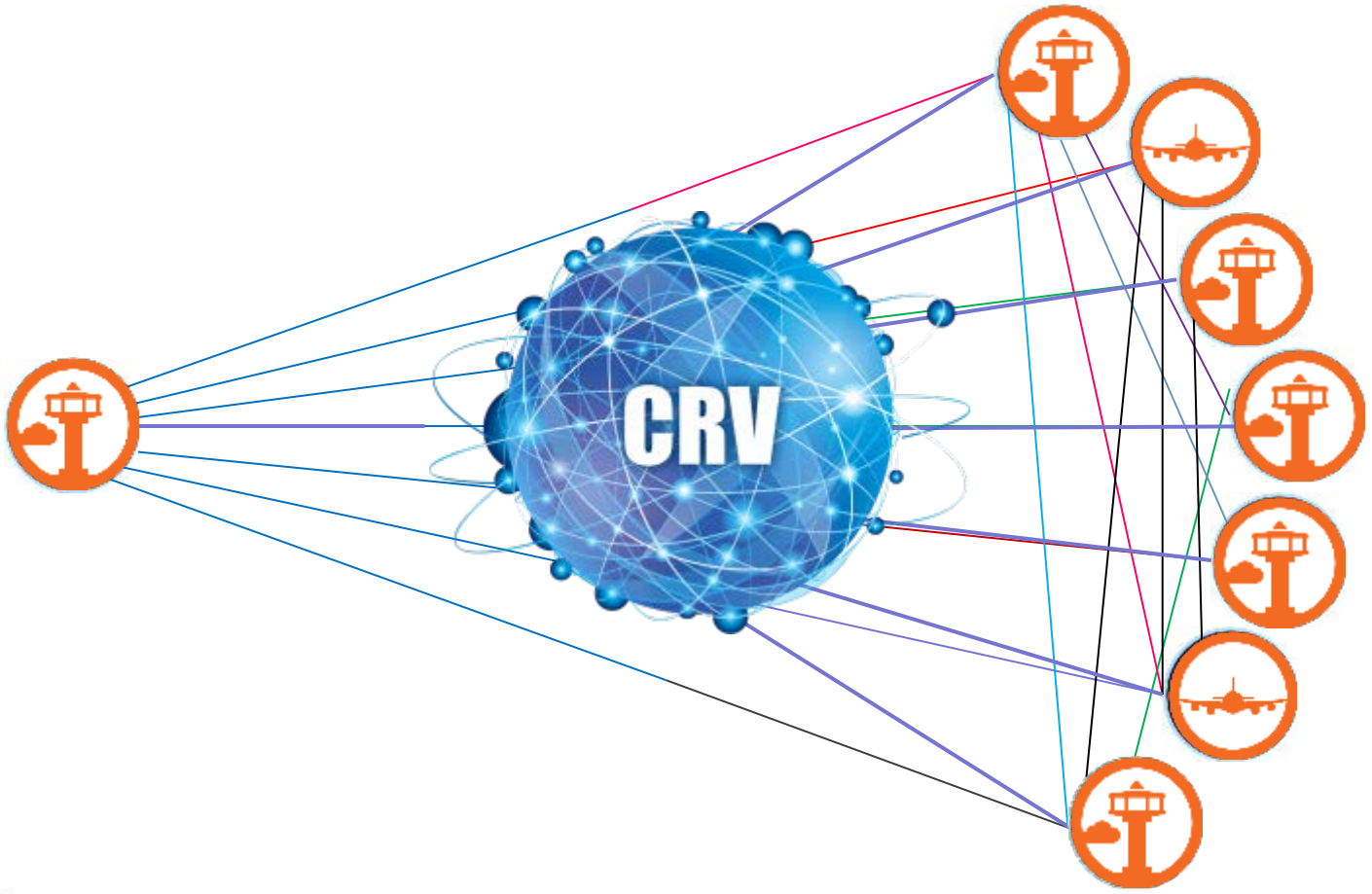
Current Network Situation and why ICAO need CRV



Characteristics and benefits

Simple

- IP based network - single network carries multiple aviation operation traffic
- One Stop Shop - ordering, provisioning, troubleshooting



Secure

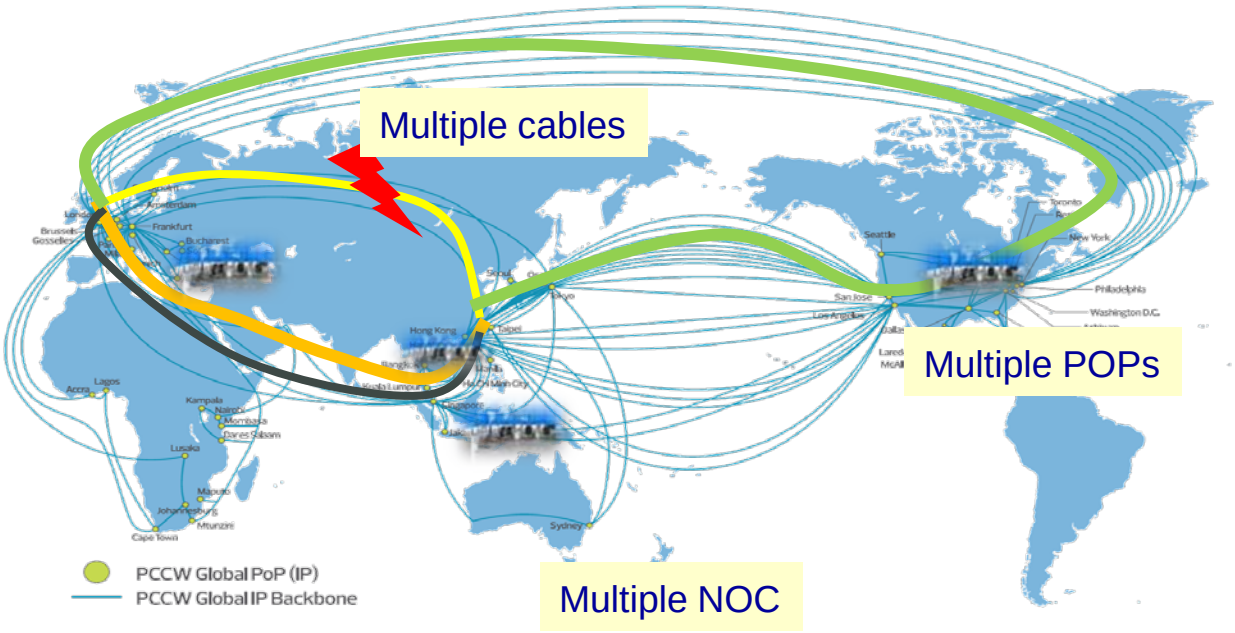
- Closed private network – unreachable & invisible from Internet
- ISO 27001: Information Security Management

Private

Public

Safe

- Resilient network consists of multiple nodes and trunks riding on diverse cable systems
- Contingency plan to maintain high availability



Fully managed

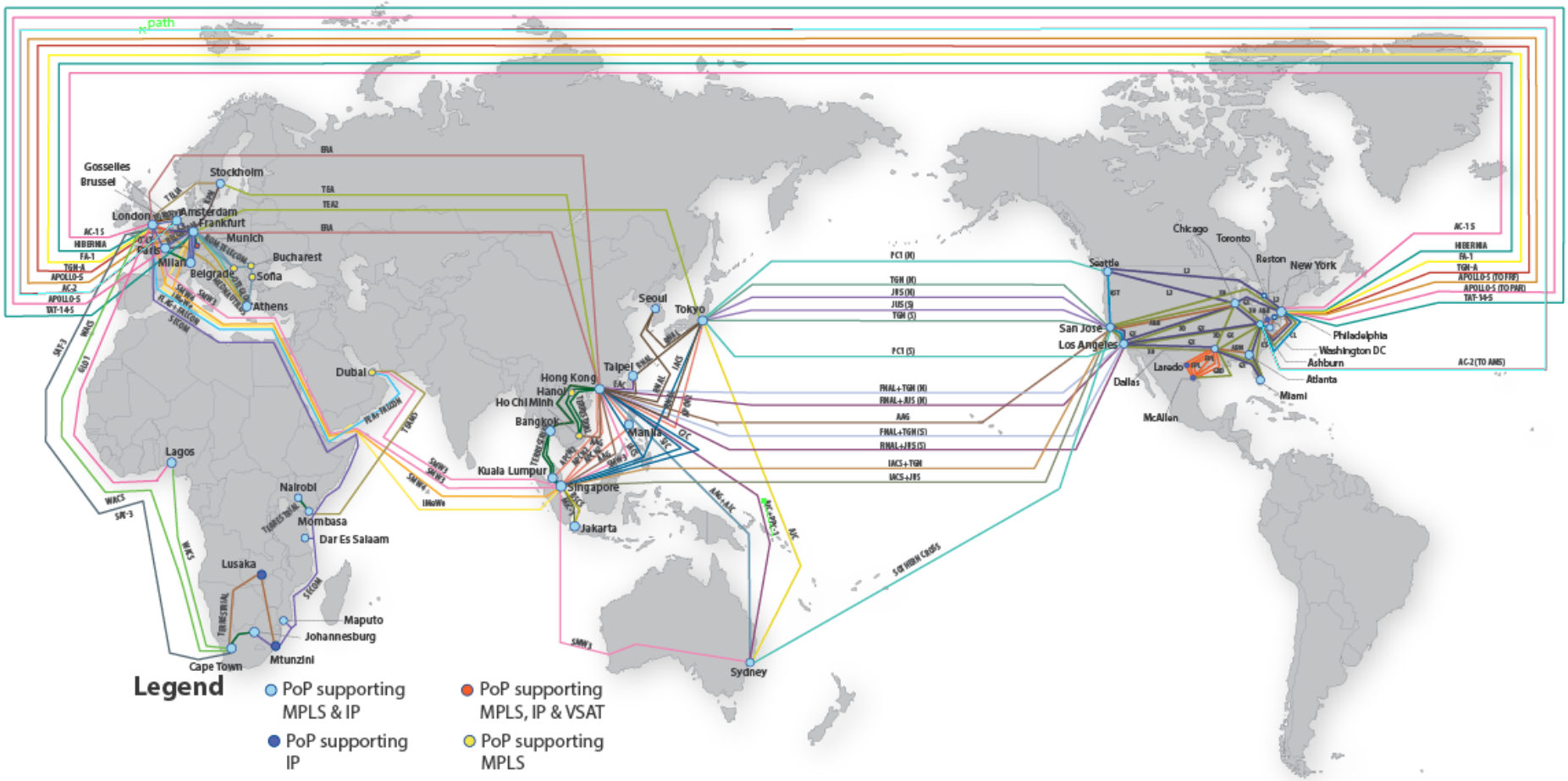
- Central administration of CRV network performance.
- State users have full Visibility and measurable of it's network health.

CRV, the network of tomorrow

3. CRV Network Architecture, Application & Security

PCCW Global®

PCCW Global MPLS Network



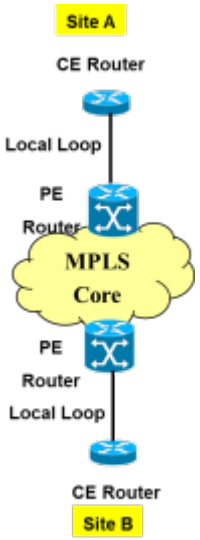
Resilient MPLS core across multiple cable systems

What is MPLS VPN?

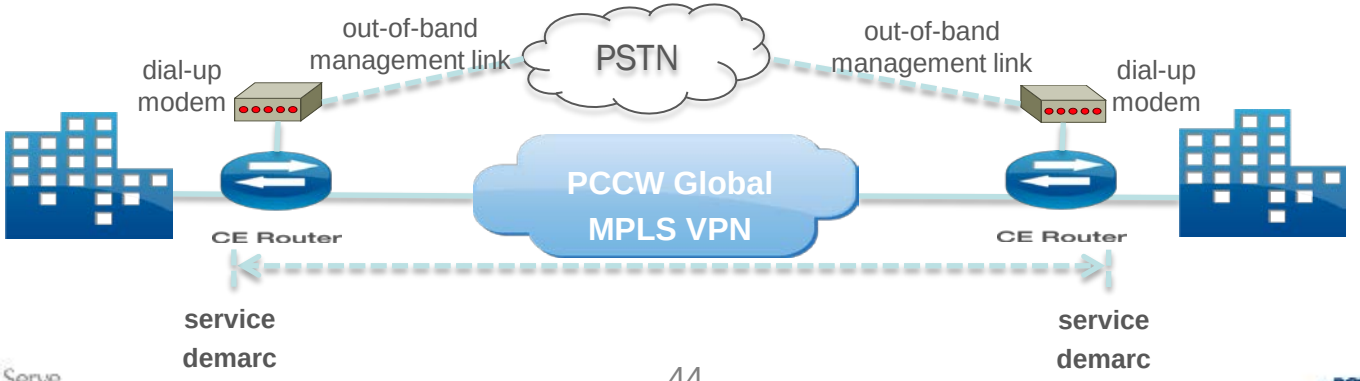
- Provides customers private connections among different locations over IP backbone
- Support multiple services over a single network interface

MPLS Service Components

- MPLS PE router port
- CE router (installed in customer site)
- Local loop between PE port and CE router



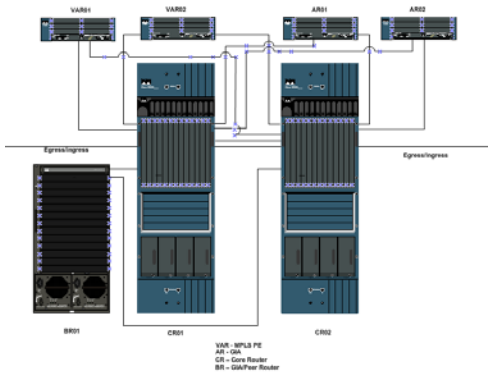
MPLS Management



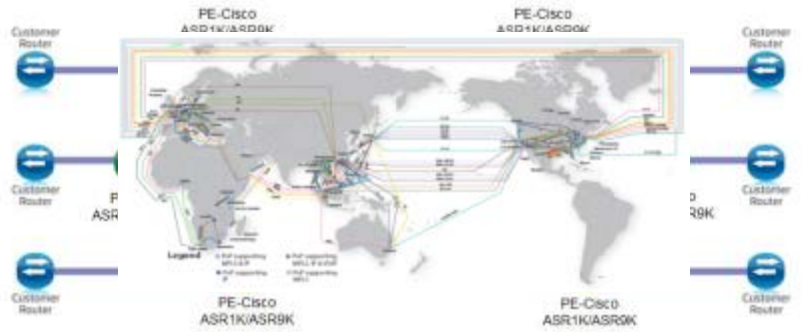
Fully Resilient MPLS Network

Robust network design

- **Equipment diversity**
  - Each MPLS PoP has at least two PE routers (dual power sources)



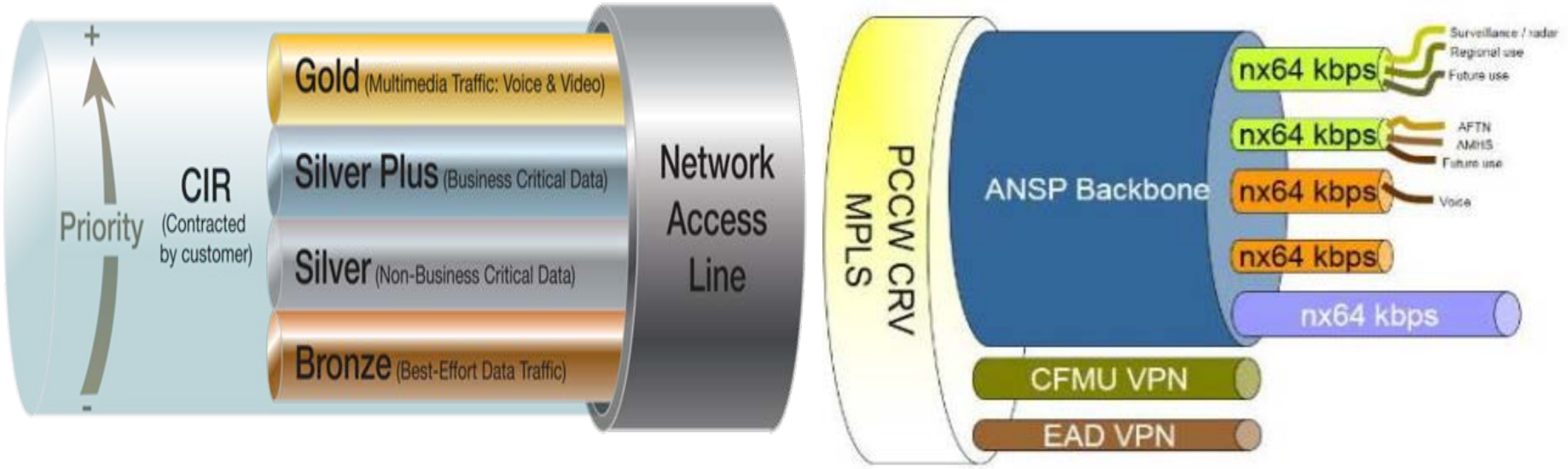
- **PoP diversity**
  - In key countries more than one PoP are set up
  - For key countries with ICI partners, multiple ICI links are built



- **Cable diversity**
  - Multiple Cable systems are either fully protected by itself or with diversity from each PoP

Region	Cable Systems
Trans-Pacific	AAG, China Inland+TPE, JUS-N, JUS-S, PC1-N, PC1-S, Southern Cross, TGN-N, TGN-S, Unity
Intra-Asia	AAG, ASE, AJC, APCN, APCN2, BSCS, C2C, CSCN, EAC, IACS, Matrix, MIC-1, RNAL, SJC, SMW3, SMW4, Singapore / Malaysia / Bangkok Terrestrial, Bangkok to HK Terrestrial + AAG
Trans-Atlantic	AC1-N, AC1-S, APOLLO, FA1, Hibernia, TGN-A
Asia-Europe	ERA, Falcon, FEA, iMeWe, SMW3, SWM4, TEA2
Intra-US	Diversified OC-48 and 10G circuits from: AT&T, Century Link, Coresite, Equinix, FPL, Level 3, Lightower, TeliaSonera, XO, Wilcon, Zayo Bandwidth (AboveNet)
Intra-Europe	Diversified OC-48 and 10G circuits from: BICS, Brutele, Colt, DTAG, Interoute, KPN, Level3, Neo Telecoms, T-Systems, TeliaSonera, WaveNet, Zayo UK
Africa-Europe	SEACOM, WACS, SAT-3, TEAMS, GLO1

Our Network to Map your applications

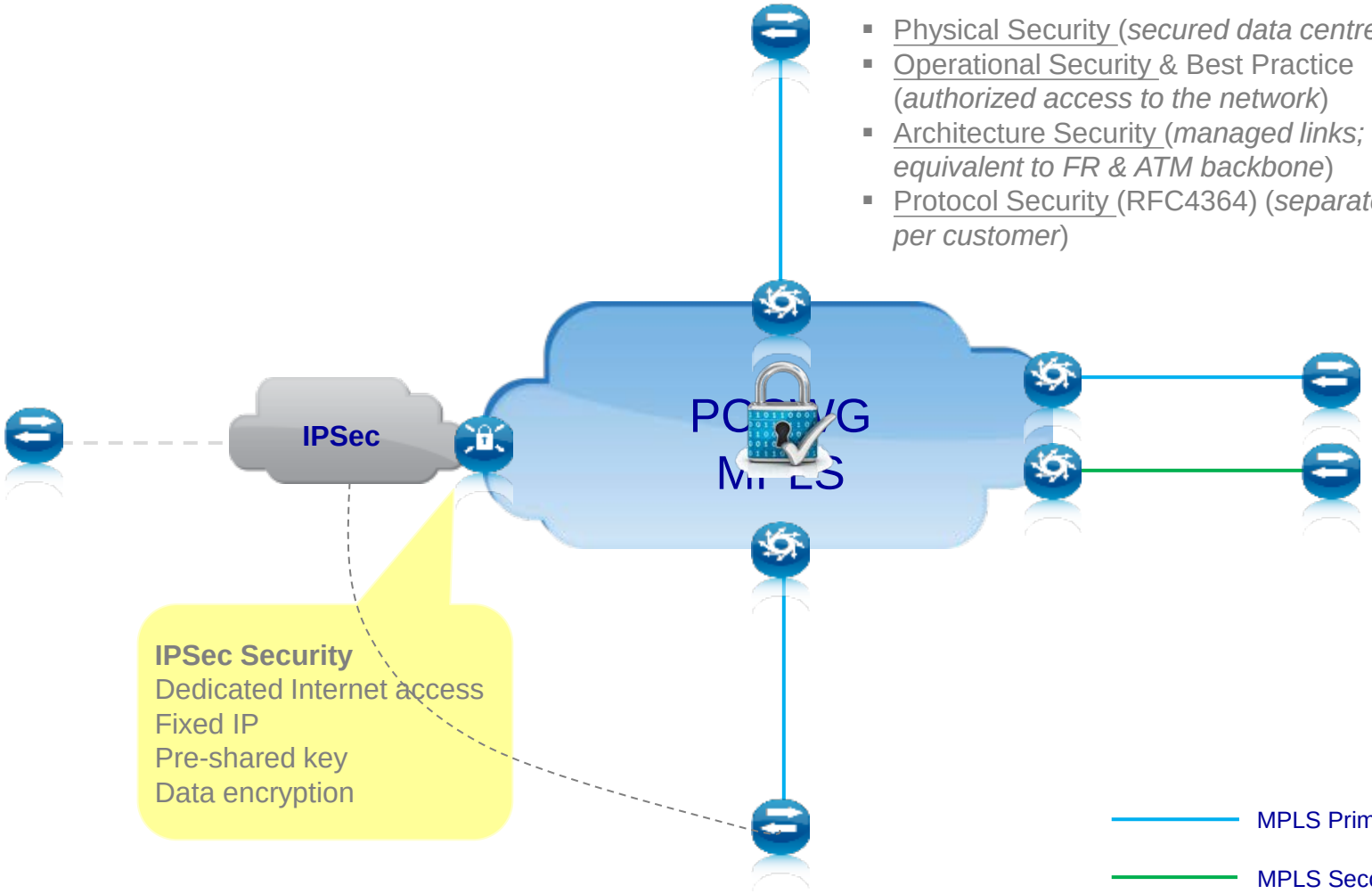


The differentiation functions are performed at the ingress to the PCCW Global network is mapped

- Low latency Queue (LLQ)
- Class-based Weight-Fair-Queuing (CBWFQ)

MPLS Security

- Physical Security (*secured data centre*)
- Operational Security & Best Practice (*authorized access to the network*)
- Architecture Security (*managed links; equivalent to FR & ATM backbone*)
- Protocol Security (RFC4364) (*separated VRF per customer*)

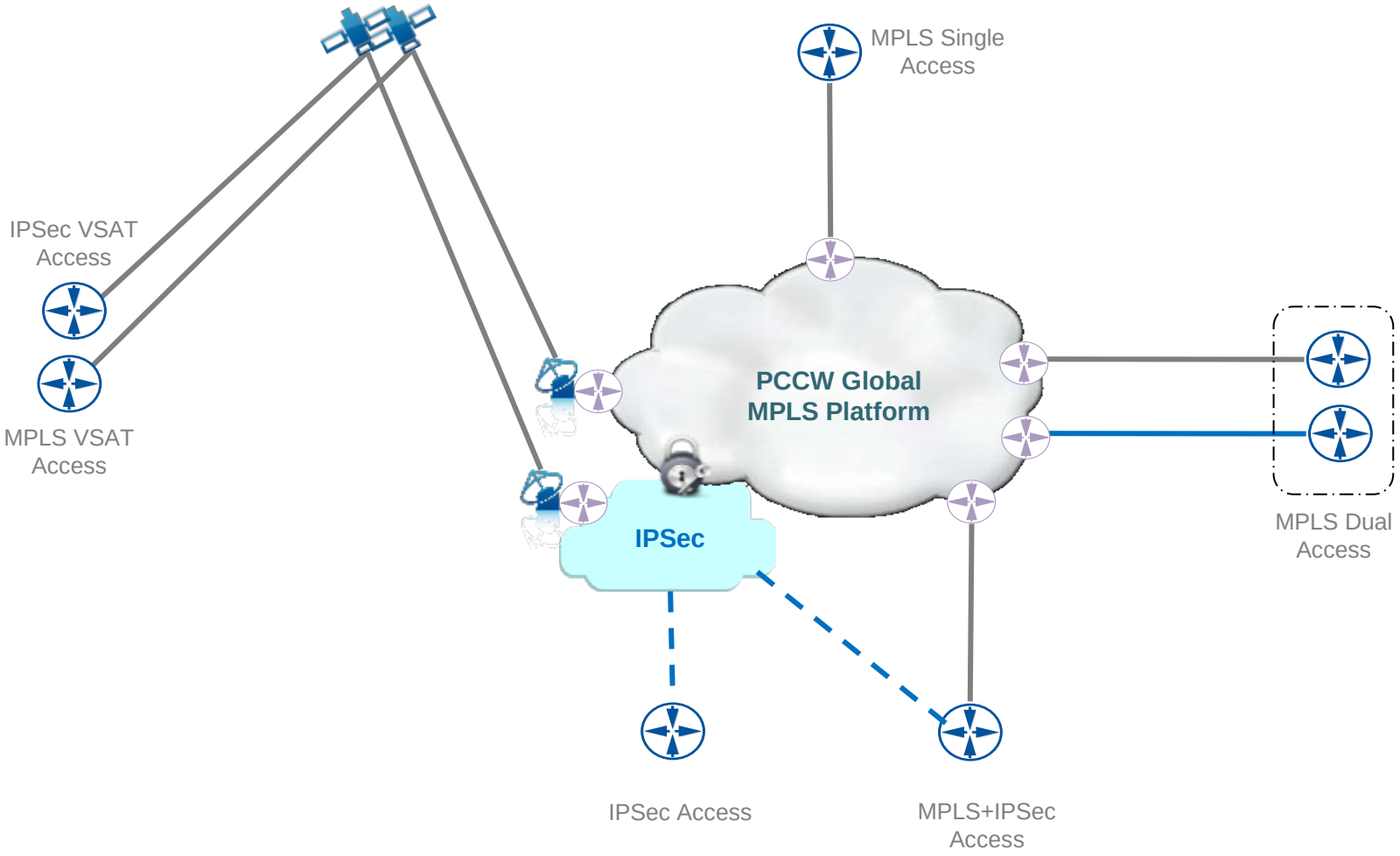


HKT Here To Serve

PCCWG PE Router | PCCWG IPSec G/W | CE Router (NID)

CRV Network Design Overview

High Level MPLS Network Diagram



CE Router (NID)
PoP/ICI
IPSec Gateway
Satellite
Primary Link
Secondary Link
Dedicated Internet Link (customer owned)

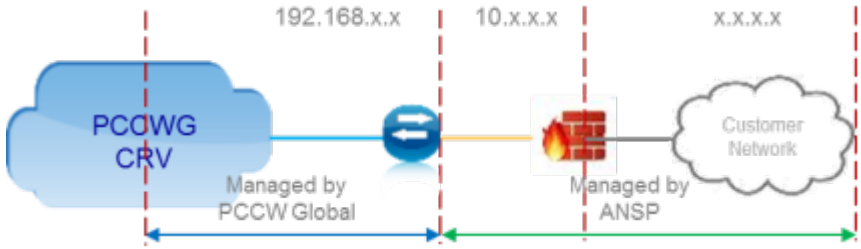
Network Design for CRV

- Fully meshed MPLS IPVPN Network as the core network for connecting CRV users
- CRV users will connect to PCCW Global MPLS platform via terrestrial line or VSAT link subject to feasibility study
- CRV network support multiple Class of Services to optimize network performance on different type of applications such as, voice, AFTN, AHMS, etc.
- End-to-End management includes Managed Router Service (NID) and Pro-active Network monitoring at round-the-clock basis
- Comprehensive online Web based reporting tool is available for network performance review and future planning purpose

Network Design for CRV (cont'd)

- PCCW GLOBAL will manage and allocate IPv4 addresses in the range of 192.168.x.x for the purpose of addressing each connection between the CE & PE routers, and network monitoring services (e.g. loop back interfaces, WAN interfaces, tunnel interfaces, etc.)
- CRV users shall use the IP address scheme (10.x.x.x) as defined in the "Common regional VPN (CRV) Implementation Plan v0.4" and be no overlapping of IP addresses among the sites

- Each CRV user may have its own security policy and requirement to segregate the network while maintaining the interconnection with other users

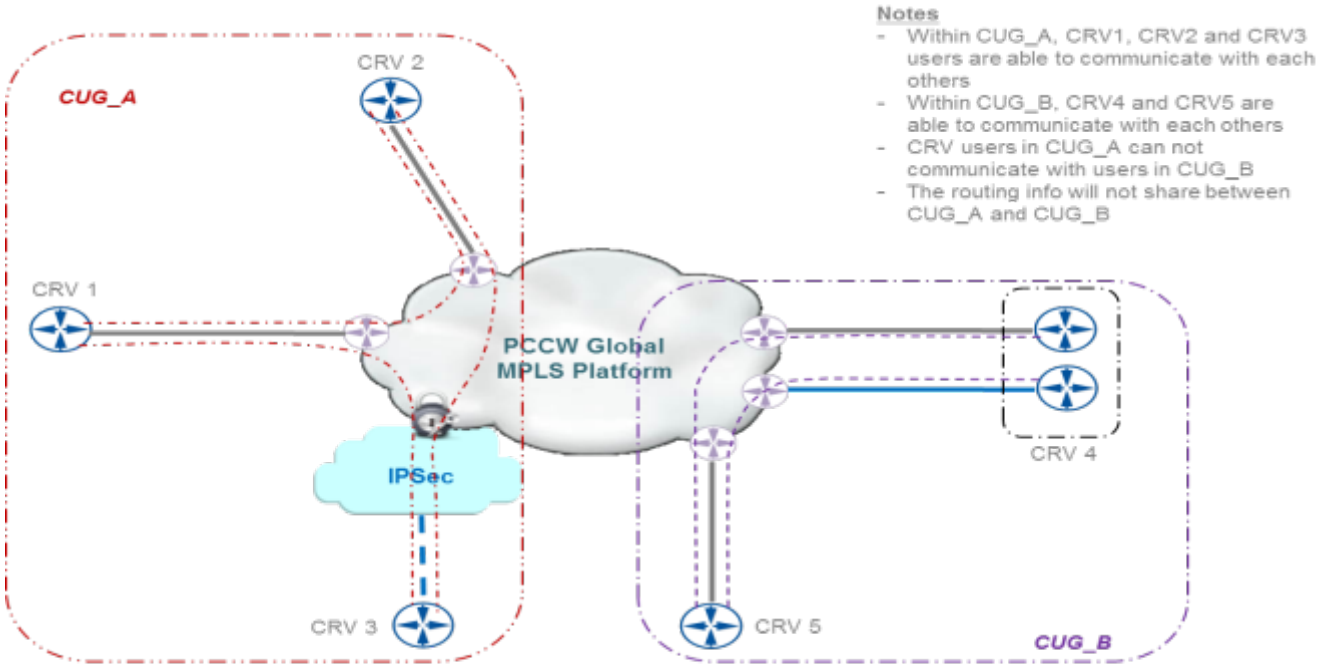


Network Design for CRV (cont'd)

- Cisco router is proposed at the customer site as the CE router (NID) connecting customer LAN and analogue voice (if required) to the CRV network. The CE router will be managed by PCCWG and will become the service demarcation point
  - ACL will be applied allowing only registered LAN IP address (e.g. 10.x.x.x/19) to be redistributed
  - The CE router (NID) can support FXS, FXO, E&M and T1/E1 voice ports. Customer needs to specify the total number of analogue voice ports, port type and dial plan in the requirement for each site when submitting the request. PCCWG will review and confirm the solution accordingly
  - Define specific subnet for voice traffic

Network Design for CRV (cont'd)

- A closed user group among agreed States within the MPLS VPN will be built to enhance security and confidentiality
  - GRE tunnels will be built between CE Routers (NIDs)
  - Only agreed States can communicate with each other
  - The customer LAN routing information is only visible to the agreed States



Network Design for CRV (cont'd)

- Routing Protocol
  - CE and Customer's LAN
    - For the CE-LAN connection, the IP routing protocols that PCCWG supports are:
      - Static
      - OSPF
      - BGP (subject to approval on case by case basis)

- Quality of Service Markings
  - The QoS markings are listed below (refer to bid document 2.6.4 Annex C – Quality of Service Plan):

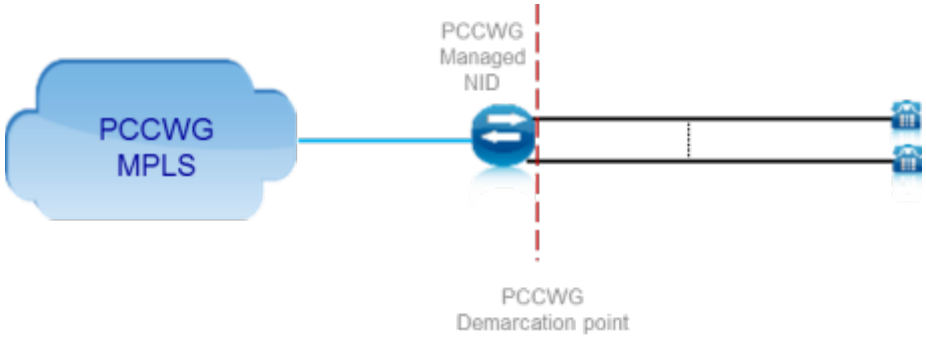
Service class name	DSCP Name
Border Gateway Protocol (BGP)	CS6
Voice	EF
Voice Signaling	EF
ADS-B	CS4
AFTN, ATN.	AF21
All traffic not otherwise defined.	DF (CS0)

Network Design for CRV (cont'd)

- Voice communication Design

  - Customer VoIP On-net calls between states will be riding on the MPLS based IPVPN network. The VoIP packets including signalling will be classified as EF Class

  - If it is analogue voice, customer can make use of PCCW Global managed NID to convert the analogue voice to VoIP or customer can do the conversion via their owned voice gateway
    - The CE router (NID) can also provide limited number of analogue voice ports for voice connections



Network Design for CRV (cont'd)

- CRV users can send VoIP traffic from their media gateway directly to CRV network. CRV users can establish H.323 or SIP from their media gateway to the destination PCCWG NID or other users' media gateway across CRV network

  - PCCW Global NID supports H.323 by default. If SIP is required, please inform PCCW Global in design stage for enabling SIP in the NID which may incur extra charges.

- It is expected that call admission control (CAC) is implemented at customer media gateway to restrict the number of concurrent VoIP calls to CRV network. If the number of calls exceed the subscribed capacity, the voice call will be failure

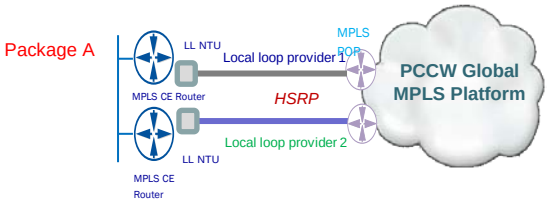
- Proposed numbering plan is in compliance with ICAO 9804. CRV users have to provide CC & OO assignment before implementation

  - An 8 digit numbering plan consisting of the following:
    - 1-3 digits will be for the Country Code/Area Identifier (AA) – E.164
    - 4-2 digits will be for the ANSP Centre code (CC) – ANSP provided
    - 3 digits for the operator position (OO) – ANSP provided

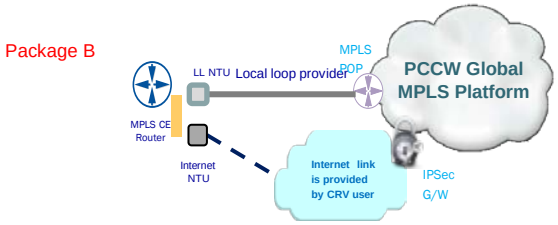
4. CRV Packages

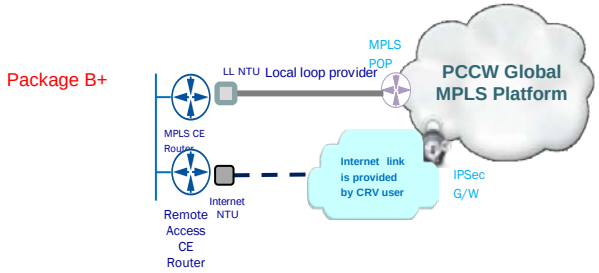
PCCW Global CRV Service Packages

4 major packages plus 2 variations are proposed as below:



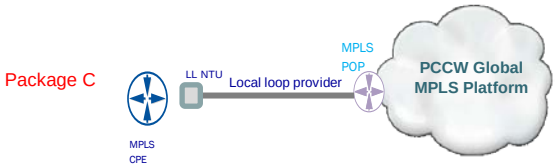
Package A – dual links and dual CE routers (NIDs) in active / standby operation mode will be installed at the CRV user site.

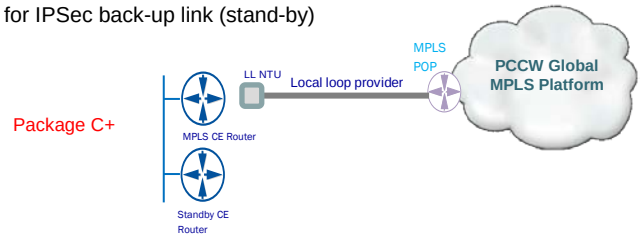




Package B – single link and single CE router (NID) will be installed at the CRV user site. In addition, PCCW Global will provide an IPSec port at MPLS IPSec gateway for back-up and CRV user will provide a dedicated Internet link for connection.

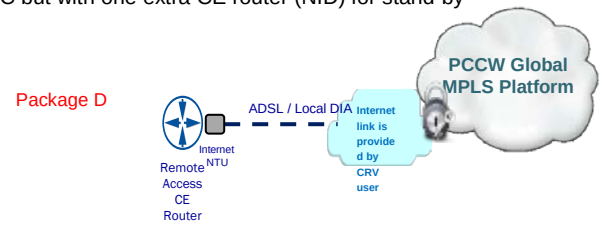
Package B+ – same as Package B but with one extra CE router (NID) for IPSec back-up link (stand-by)





Package C – single link and single CE router (NID) will be installed at the CRV user site.

Package C+ – same as Package C but with one extra CE router (NID) for stand-by



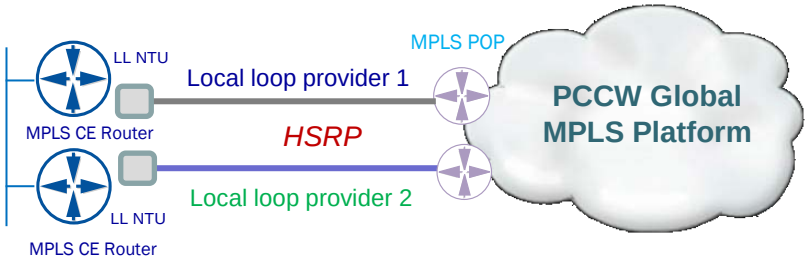
Package D – PCCW Global will provide an IPSec port at MPLS IPSec gateway and CRV user will provide a dedicated Internet link for connection.

Network Design for CRV (cont'd)

- **4 major packages plus 2 variations are proposed as below:**

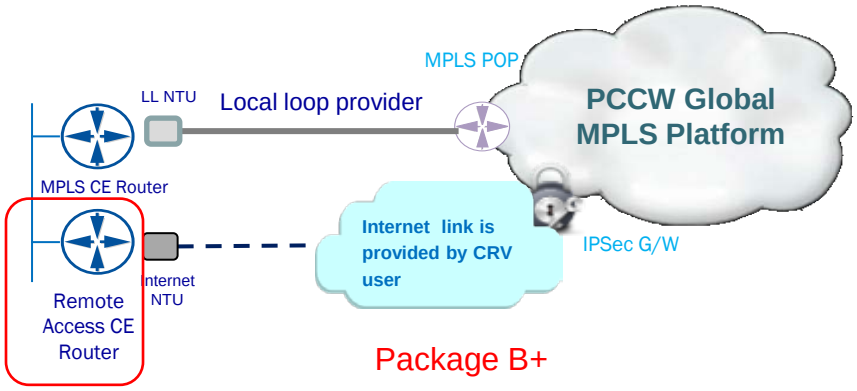
  - **Package A** – dual links and dual CE routers (NIDs) in active / standby operation mode will be installed at the CRV user site. The local accesses are from different providers or from the same provider but with different paths if feasible. Each local access is a dedicated single unprotected terrestrial or VSAT access and will be terminated at different PCCWG PoPs/ICIs/PEs where applicable to achieve access resilience

Package A



Network Design for CRV Network (cont'd)

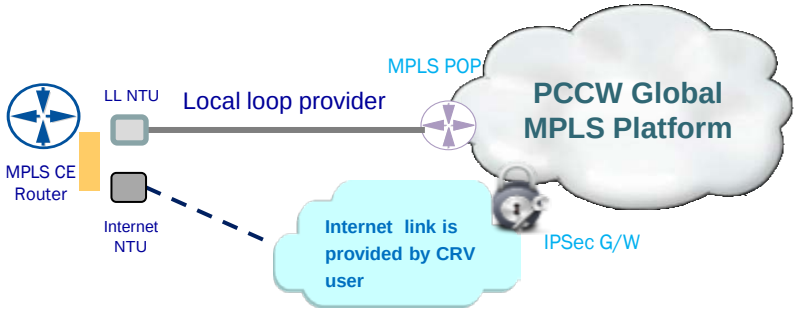
- **Package B+** – it is same as Package B but with one extra CE router (NID) to connect the Internet link for IPSec remote access. Both MPLS CE router and Remote Access CE router will work in active / standby mode



Package B+

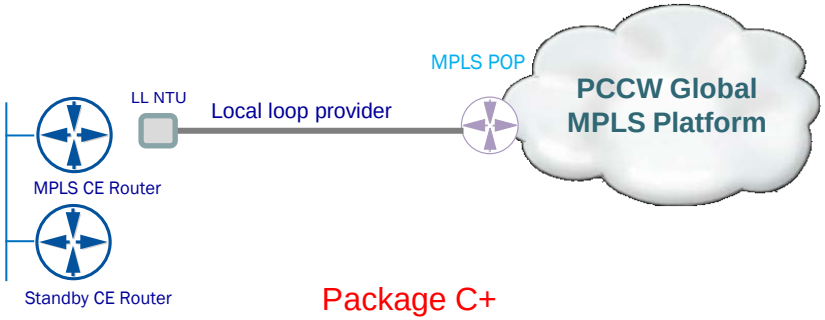
- **Package B** – Single link and single CE router (NID) will be installed at the CRV user site. The local access is a dedicated single unprotected terrestrial or VSAT access and will be terminated at PCCWG PoP/ICI where applicable. In addition, PCCW Global will provide an IPSec port (2M port speed and 100% Bronze) at MPLS IPSec gateway and an Ethernet port at the CE router (NID) for connecting customer owned Internet link. The CE router will automatic switch over to this IPSec link in case the primary MPLS link is failure. The Internet link provided by the customer has to fulfill the requirements below:
  - Ethernet hands-off with at least one fixed public IP address assigns to the CE router
  - only use for connecting PCCW Global MPLS Layer3 VPN service

Package B



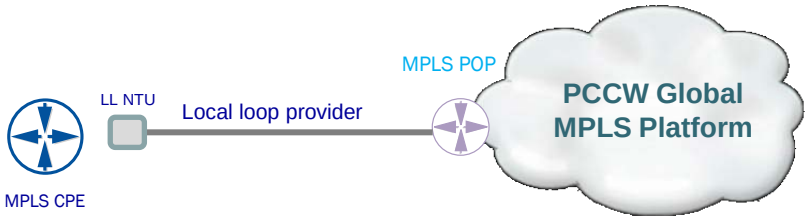
Network Design for CRV Network (cont'd)

- **Package C+** - It is same as Package C but with one standby CE router (NID). The standby CE router is same configuration as the primary MPLS CE router. Assistance from the customer is required to switch over LAN/WAN cables under the instructions from PCCW Global NOC in case of the primary router failure



Package C+

- **Package C** – Single link and single CE router (NID) will be installed at the CRV user site. The local access is a dedicated single unprotected terrestrial or VSAT access and will be terminated at PCCWG PoP/ICI where applicable



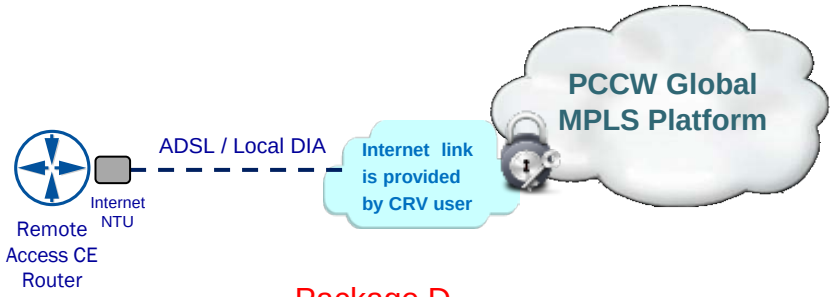
Package C

Network Design for CRV Network (cont'd)

- **Package D** - PCCW Global will configure IPSec port at MPLS IPSec gateway and install a CE router (NID) for connecting customer owned Internet link on site. User will connect to the CRV network via a point-to-point encrypted IPSec tunnel which supports 100% Bronze QoS only.

  The Internet link provided by the customer has to fulfill the requirements below:

  - Ethernet hands-off with at least one fixed public IP address assigns to the CE router
  - only use for connecting PCCW Global MPLS Layer3 VPN service



Package D

Comparison on different connection packages

Highest Availability

SLA Package	Package A	Package B+	Package B	Package C+	Package C	Package D
Local loop connection	2	1	1	1	1	NIL (customer self provided internet)
NID	2	2	1	2	1	1
IP Sec Gateway (backup)	NIL	Yes (customer provides internet)	Yes(customer provides internet)	No	No	Yes (customer provide internet)
Availability	99.97% (connectivity + router)	99.95% (connectivity+ router)	99.5% (connectivity+ router)	99.7% (connectivity+ router)	99.5% (connectivity+ router)	99.5% (IPSec gateway port only)
Site to Site Round Trip Delay by zone	200ms / 600ms	200ms / 600ms	200ms / 600ms	200ms / 600ms	200ms / 600ms	PoP to PoP 200ms / PoP to PoP 600ms
Site to Site Packet Drop rate	<0.1% for Voice; <0.5% for Data	<0.1% for Voice; <0.5% for Data		<0.5% for Data		PoP to PoP <0.5% for Data
Site to Site Jitter	15ms for Voice; 250ms for Data	15ms for Voice; 250ms for Data		250ms for Data		250ms for Data (PoP to PoP)
Rebate	Yes	Yes		Yes		No

5. How to proceed

Proposed process to contract

- 1. State notifies CRV OG Chair(s) and ICAO Regional Office the intention to join – update CRV implementation plan
- 2. State contact Mr. Benny Cheng (PCCW) who sends the High level survey
- 3. State downloads the Common Package from CRV portal
- 4. State submits the High level survey to PCCW
- 5. PCCW recommends a package (design) and submits a Project Plan
- 6. State cross checks with its peers and starts coordination of implementation (CRV OG can facilitate)
- 7. State and PCCW discuss Price, Schedule and Terms and Conditions:
  - Local optimizations and additional requirements may be required
- 8. State and PCCW agree and record any variation from the common provisions in the Order Form
  - State and PCCW sign the Order Form which is governed by:
    - (a) Terms and Conditions between PCCW Global and CRV Authority ;
    - (b) The CRV Terms of Reference (including all annexes);
    - (c) Specific Terms for MPLS VPN Service, Specific Terms for Managed Router Service and Specific Terms for Satellite VSAT Services (the "Specific Terms");
    - (d) Addendum to the Specific Terms;
    - (e) The price schedule in their latest applicable version;
    - (f) The Project Management Plan in its latest applicable version; and
    - (g) The CRV implementation plan in its latest applicable version.
- 9. Installation occurs
- 10. Testing is carried out
- 11. Service Commencement Notice provided from PCCW to the State, includes all drawings and documentation
- 12. State notifies CRV OG about the service commencement
- 13. State carries out service migrations in coordination with peers

high level
idual site question

Note: the engineering package is made applicable through the PMP

Questionnaire from MID

Bahrain


Option 1

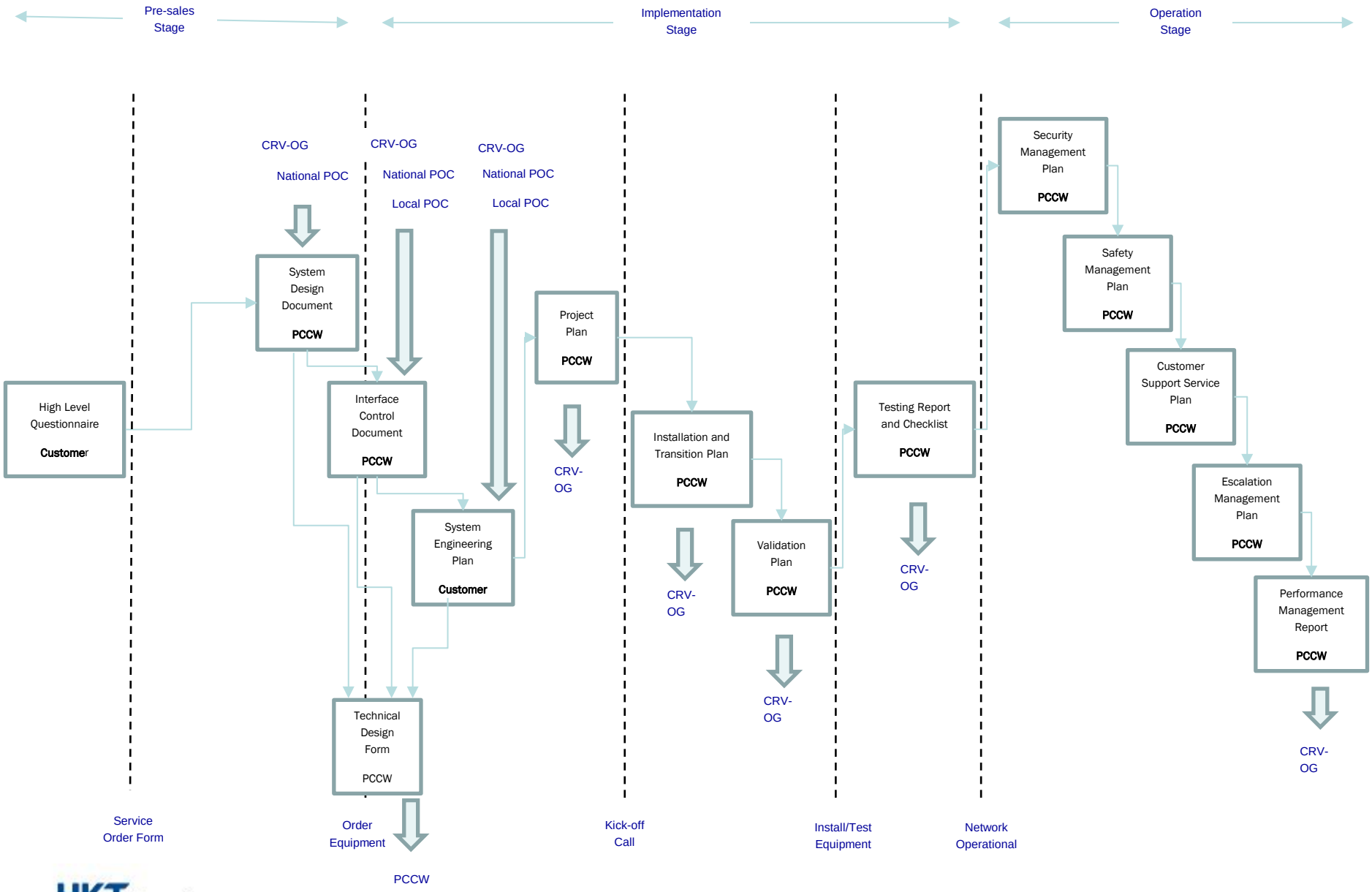

Option 2

Jordan


Jordan

Kuwait


Kuwait

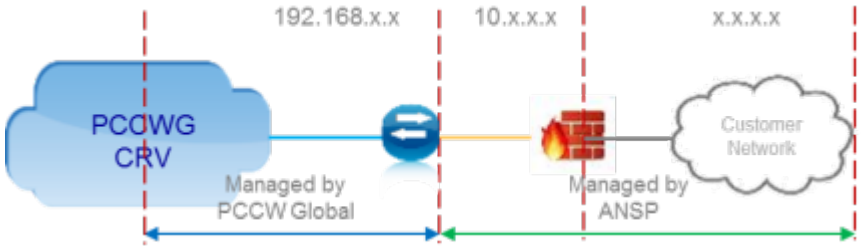

Pre-sales Stage
Implementation Stage
Operation Stage
CRV-OG
National POC
Local POC
CRV-OG
National POC
Local POC
CRV-OG
National POC
Local POC
High Level Questionnaire
Customer
System Design Document
PCCW
Interface Control Document
PCCW
System Engineering Plan
Customer
Technical Design Form
PCCW
Project Plan
PCCW
CRV-OG
Installation and Transition Plan
PCCW
CRV-OG
Validation Plan
PCCW
CRV-OG
Testing Report and Checklist
PCCW
CRV-OG
Security Management Plan
PCCW
Safety Management Plan
PCCW
Customer Support Service Plan
PCCW
Escalation Management Plan
PCCW
Performance Management Report
PCCW
CRV-OG
Service Order Form
Order Equipment
PCCW
Kick-off Call
Install/Test Equipment
Network Operational

Q&A from MID regions

Q&A

- Are all connections managed services?
  - all subscribed services are managed by PCCWG. The managed service elements provisioned by PCCWG for the MPLS based IPVPN service includes:
    - MPLS core network
    - Local loop (including NTU) between MPLS core and customer site
    - NID (Customer Edge router)

- Can voice and data services be configured on a dedicated/unmanaged client router behind the CE router?
  - Our service demarcation point is upto the NID (CE Router). The additional requirement of voice and data configuration on a dedicated/unmanaged client router behind the CE router can be discussed case by case. Would you please kindly provide the SOW (Scope of Work)?



- PCCW offers Class C address for WAN link but then requires NAT to the pre-defined 10.x.x.x addresses? Why? What about the ICAO recommended Class A addressing for WAN links?
  - PCCW Global will manage and allocate IPv4 addresses in the range of 192.168.x.x for the purpose of addressing each connection between the CE & PE routers, and network monitoring services (e.g. loop back interfaces, WAN interfaces, tunnel interfaces, etc.)

Q&A (cont'd)

- CRV user shall use the IP address scheme (10.x.x.x) as defined in the "Common regional VPN (CRV) Implementation Plan v0.4" and be no overlapping of IP addresses among the sites.
- CRV users will only need to perform "NAT" if their existing internal network does not fall in the ICAO pre-defined IP address scheme (10.x.x.x /19)

- How are E1 vhf radio channels configured including the applicable timeslot for control and monitoring?
  - The proposed CE router (NID) for the CRV network will support ground-to-ground data & voice communication only, the support interfaces include Ethernet, FXO/FXS, E&M (2-wire/4-wire) and T1/E1 voice interfaces.

- Target switchover time is 180s. Is this the best switchover time provided?
  - The switchover time (180s) is the default configuration for BGP protocol.

- If a state joined CRV with certain bandwidth "ex. 256", can they have direct connection to all other CRV states? Or they to predefine it? I guess it's a star topology once you join it you can exchange messages with all, assume the bandwidth is sufficient and no restriction on data flow from other states
  - The CRV is a fully mesh MPLS/IP network which allows users to communicate directly. However, it is one of the security measures that only agreed ICAO states can communicate with each other via the overlay GRE tunnels.

6. Investment Summary

Investment summary

All prices shall be stated in US dollars.

Concerning the Core Services Usage: the Tenderers shall fill in the schedule assuming that all applications as per matrices of flow have transitioned to CRV for all

ADDITIONAL SERVICES

State/Administration	ANSP/Civil Aviation Site	City	If "last mile" network Infrastructure is not owned, name the "last mile" Subcontractor	Terrestrial/ VSAT	Monthly price for managed voice and data gateway: Monthly price of additional managed router(s)	Monthly additional price for interfaces (if voice channel > 4, need to further discuss): Monthly price per E1 interface	Monthly price per E&M interface	Monthly price per FXS interface	Monthly price per FXO interface	Monthly price per Ethernet Interface
Bahrain	Bahrain Civil Aviation Affairs Air Navigation Directorate P.O.Box: 586 Muharraq, Bahrain	Manama	Viva Bahrain	Terrestrial	880	140	32	64	64	60
Egypt	National Air Navigation Services Company (NANSC) Cairo Air Navigation Centre	Cairo	Te Data	Terrestrial	740	140	32	64	64	60
Iran	Civil Aviation Organization P.O. Box 1798, 13445 Mehrabad Intl Airport Tehran	Tehran	Turk Telekom	Terrestrial	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
Iraq		Baghdad	Blink	Terrestrial	920	140	32	64	64	60
Jordan	Civil Aviation Authority P.O.Box 7547 Amman -Jordan	Amman	Zain Jordan	Terrestrial	740	140	32	64	64	60
Kuwait	Directorate General of CA	Kuwait	Zajil	Terrestrial	740	140	32	64	64	60
Lebanon	CAA Beirut International Airport Telecom Department	Beirut	Ministry Telecommunication of Lebanon	Terrestrial	740	140	32	64	64	60
Libya	CAA	Tripoli	Telecom Italia Sparkle	Terestrial/NNI	910	140	32	64	64	60
Oman	Public Authority for CA P.O. BOX 1 Postal Code 111 Seeb Int. Airport Sultanate of Oman	Muscat	Omantel	Terrestrial	740	140	32	64	64	60
Qatar	Civil Aviation Authority P.O.Box 3000 Doha Qatar	Doha	Ooredoo	Terrestrial	345	100	24	44	44	40
Saudi Arabia	General Authority of Civil Aviation (GACA) ATS Comm. Ops and Procedures P.O. Box 929 JEDDAH 21421 SAUDI ARABIA	Jeddah	Nour Global	Terrestrial	740	140	32	64	64	60
Saudi Arabia	General Authority of CA	Riyadh	Nour Global	Terrestrial	740	140	32	64	64	60
Sudan	CAA	Khartoum	Canar	Terrestrial/IPLC	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
Syria	CAA	Damascus	Nour Global	Terrestrial	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
UAE	General CA Authority P.O. Box 6558 Abu Dhabi United Arab Emirates	AbuDhabi	Etisalat	Terrestrial/Ethernet	690	100	24	44	44	40
Yemen	CA and Met Authrority Sanaa International Airport	Sanaa	TeleYemen	Terrestrial	1084	140	32	64	64	60

State/Administration	City	Package A: 64 k	128 k	256 k	512 k	1024 k	2048 k	Once off Installation(64K to 2M)	Package B: 64 k	128 k	256 k	512 k	1024 k	2048 k	Once off Installation(64K to 2M)
Bahrain	Manama	9,012	9,061	9,772	10,646	11,322	13,302	11,889	4,280	4,306	4,680	5,140	5,496	6,538	5,944
Egypt	Cairo	7,542	7,747	8,188	8,931	9,506	11,417	1,571	3,580	3,688	3,920	4,311	4,614	5,620	786
Iran	Tehran	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
Iraq	Baghdad	9,614	9,614	9,614	9,614	9,614	16,508	17,143	4,576	4,576	4,576	4,576	4,576	8,204	8,571
Jordan	Amman	6,254	6,254	6,444	8,344	11,764	13,728	5,714	2,902	2,902	3,002	4,002	5,802	6,836	2,857
Kuwait	Kuwait	7,200	7,580	7,960	9,100	6,410	14,481	5,714	3,400	3,600	3,800	4,400	2,984	7,232	2,857
Lebanon	Beirut	17,810	17,810	17,810	17,810	17,810	17,954	9,029	8,984	8,984	8,984	8,984	8,984	9,060	4,514
Libya	Tripoli	26,598	26,598	26,598	26,598	26,598	32,592	11,314	13,520	13,520	13,520	13,520	13,520	16,675	5,657
Oman	Muscat	11,182	12,144	14,143	16,841	21,640	29,160	1,114	5,496	6,002	7,054	8,474	11,000	14,958	557
Qatar	Doha	28,564	30,274	32,326	53,978	74,707	100,403	34,286	14,852	15,752	16,832	28,228	39,138	52,662	17,143
Saudi Arabia	Jeddah	6,824	8,724	11,004	14,044	15,184	20,834	17,143	3,202	4,202	5,402	7,002	7,602	10,576	8,571
Saudi Arabia	Riyadh	5,953	7,853	10,133	13,173	14,313	19,963	17,143	3,202	4,202	5,402	7,002	7,602	10,576	8,571
Sudan	Khartoum	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
Syria	Damascus	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
UAE	AbuDhabi	8,738	8,738	14,032	20,952	31,443	48,771	3,203	4,236	4,236	7,022	10,664	16,186	25,306	1,601
Yemen	Sanaa	91,266	91,266	91,266	91,266	91,266	91,266	29,429	47,464	47,464	47,464	47,464	47,464	47,464	14,714

State/Administration	City	Package B+: 64 k	128 k	256 k	512 k	1024 k	2048 k	Once off Installation(64K to 2M)	Package C: 64 k	128 k	256 k	512 k	1024 k	2048 k	Once off Installation(64K to 2M)
Bahrain	Manama	5,160	5,186	5,560	6,020	6,376	7,418	5,944	4,280	4,306	4,680	5,140	5,496	6,538	5,944
Egypt	Cairo	4,320	4,428	4,660	5,051	5,354	6,360	786	3,580	3,688	3,920	4,311	4,614	5,620	786
Iran	Tehran	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
Iraq	Baghdad	5,496	5,496	5,496	5,496	5,496	9,124	8,571	4,576	4,576	4,576	4,576	4,576	8,204	8,571
Jordan	Amman	3,642	3,642	3,742	4,742	6,542	7,576	2,857	2,902	2,902	3,002	4,002	5,802	6,836	2,857
Kuwait	Kuwait	4,140	4,340	4,540	5,140	3,724	7,972	2,857	3,400	3,600	3,800	4,400	2,984	7,232	2,857
Lebanon	Beirut	9,724	9,724	9,724	9,724	9,724	9,800	4,514	8,984	8,984	8,984	8,984	8,984	9,060	4,514
Libya	Tripoli	14,430	14,430	14,430	14,430	14,430	17,585	5,657	13,520	13,520	13,520	13,520	13,520	16,675	5,657
Oman	Muscat	6,236	6,742	7,794	9,214	11,740	15,698	557	5,496	6,002	7,054	8,474	11,000	14,958	557
Qatar	Doha	15,197	16,097	17,177	28,573	39,483	53,007	17,143	14,852	15,752	16,832	28,228	39,138	52,662	17,143
Saudi Arabia	Jeddah	3,942	4,942	6,142	7,742	8,342	11,316	8,571	3,202	4,202	5,402	7,002	7,602	10,576	8,571
Saudi Arabia	Riyadh	3,942	4,942	6,142	7,742	8,342	11,316	8,571	3,202	4,202	5,402	7,002	7,602	10,576	8,571
Sudan	Khartoum	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
Syria	Damascus	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
UAE	AbuDhabi	4,926	4,926	7,712	11,354	16,876	25,996	1,601	4,236	4,236	7,022	10,664	16,186	25,306	1,601
Yemen	Sanaa	48,548	48,548	48,548	48,548	48,548	48,548	14,714	47,464	47,464	47,464	47,464	47,464	47,464	14,714

State/Administration	City	Package C+: 64 k	128 k	256 k	512 k	1024 k	2048 k	Once off Installation(64K to 2M)	Package D: 64 k	128 k	256 k	512 k	1024 k	2048 k	Once off Installation(64K to 2M)
Bahrain	Manama	5,160	5,186	5,560	6,020	6,376	7,418	5,944	1,742	1,748	1,822	1,914	1,986	2,194	500
Egypt	Cairo	4,320	4,428	4,660	5,051	5,354	6,360	786	1,490	1,512	1,558	1,637	1,697	1,898	500
Iran	Tehran	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
Iraq	Baghdad	5,496	5,496	5,496	5,496	5,496	9,124	8,571	1,834	1,834	1,834	1,834	1,834	2,559	500
Jordan	Amman	3,642	3,642	3,742	4,742	6,542	7,576	2,857	1,355	1,355	1,375	1,575	1,935	2,142	500
Kuwait	Kuwait	4,140	4,340	4,540	5,140	3,724	7,972	2,857	1,454	1,494	1,534	1,654	1,371	2,221	500
Lebanon	Beirut	9,724	9,724	9,724	9,724	9,724	9,800	4,514	2,683	2,683	2,683	2,683	2,683	2,698	500
Libya	Tripoli	14,430	14,430	14,430	14,430	14,430	17,585	5,657	3,000	3,000	3,000	3,000	3,000	3,000	500
Oman	Muscat	6,236	6,742	7,794	9,214	11,740	15,698	557	1,874	1,975	2,185	2,469	2,974	3,766	500
Qatar	Doha	15,197	16,097	17,177	28,573	39,483	53,007	17,143	3,000	3,000	3,000	3,000	3,000	3,000	500
Saudi Arabia	Jeddah	3,942	4,942	6,142	7,742	8,342	11,316	8,571	1,415	1,615	1,855	2,175	2,295	2,890	500
Saudi Arabia	Riyadh	3,942	4,942	6,142	7,742	8,342	11,316	8,571	1,415	1,615	1,855	2,175	2,295	2,890	500
Sudan	Khartoum	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
Syria	Damascus	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
UAE	AbuDhabi	4,926	4,926	7,712	11,354	16,876	25,996	1,601	1,582	1,582	2,139	2,867	3,000	3,000	500
Yemen	Sanaa	48,548	48,548	48,548	48,548	48,548	48,548	14,714	3,000	3,000	3,000	3,000	3,000	3,000	500

MID pricing

CRV – MID states

Use Egypt as an example

Use Egypt as an example

Monthly (A,B,C,D,E)+potential F,G,H,I

Once connect CRV, it is ready to connect others,
Can replace your existing point to point circuits.
And can connect to other countries(CRV users) subject to both countries confirmation without extra cost.

Package A : Monthly rental = USD$ 9,506

Package C : Monthly rental = USD$ 4,614

One time = USD$ 1,571

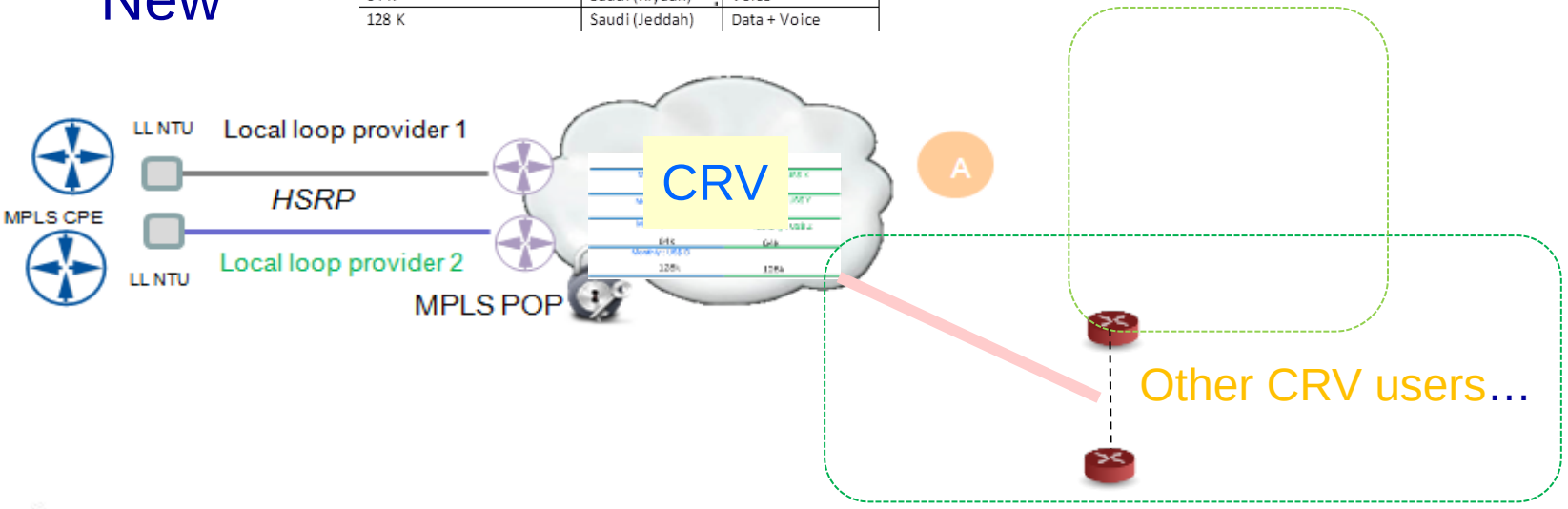
5 or more circiuts

Current configurations are:

Egypt		
Current Situation		
64 K	Lebanon	Data
64 K	Jordan (Amman)	Data + Voice
64 K	Syria	Data
64 K	Saudi (Riyadh)	Voice
128 K	Saudi (Jeddah)	Data + Voice

New

Egypt



Thank you