



East Micronesia Cable System Request for Information Package

The issuance of this RFI does not constitute a commitment to issue a request for bids/proposals, award a contract, or pay any costs incurred in preparation of a response to this RFI.

Objectives

- The purpose of this package is to solicit input from Subsea Telecom Cable System Suppliers regarding the technical feasibility and risks associated with Architecture Options for the East Micronesia Cable System (EMCS).

Introduction and Background

- The Federated States of Micronesia (FSM), Kiribati, and Nauru are being provided funding by the World Bank (WB) and the Asian Development Bank (ADB) to develop and deploy a region submarine cable system that will provide connectivity to all three nations.
- This regional submarine cable system is called the East Micronesia Cable System (EMCS), and is notionally depicted in Figure 1. It provides connectivity for South Tarawa, Kiribati in the east, Nauru, and the State of Kosrae, FSM.
- EMCS will take advantage of the existing Hantru-1 Cable System (Shown in Figure 2) for connectivity to Guam.

Notional Concept of the EMCS

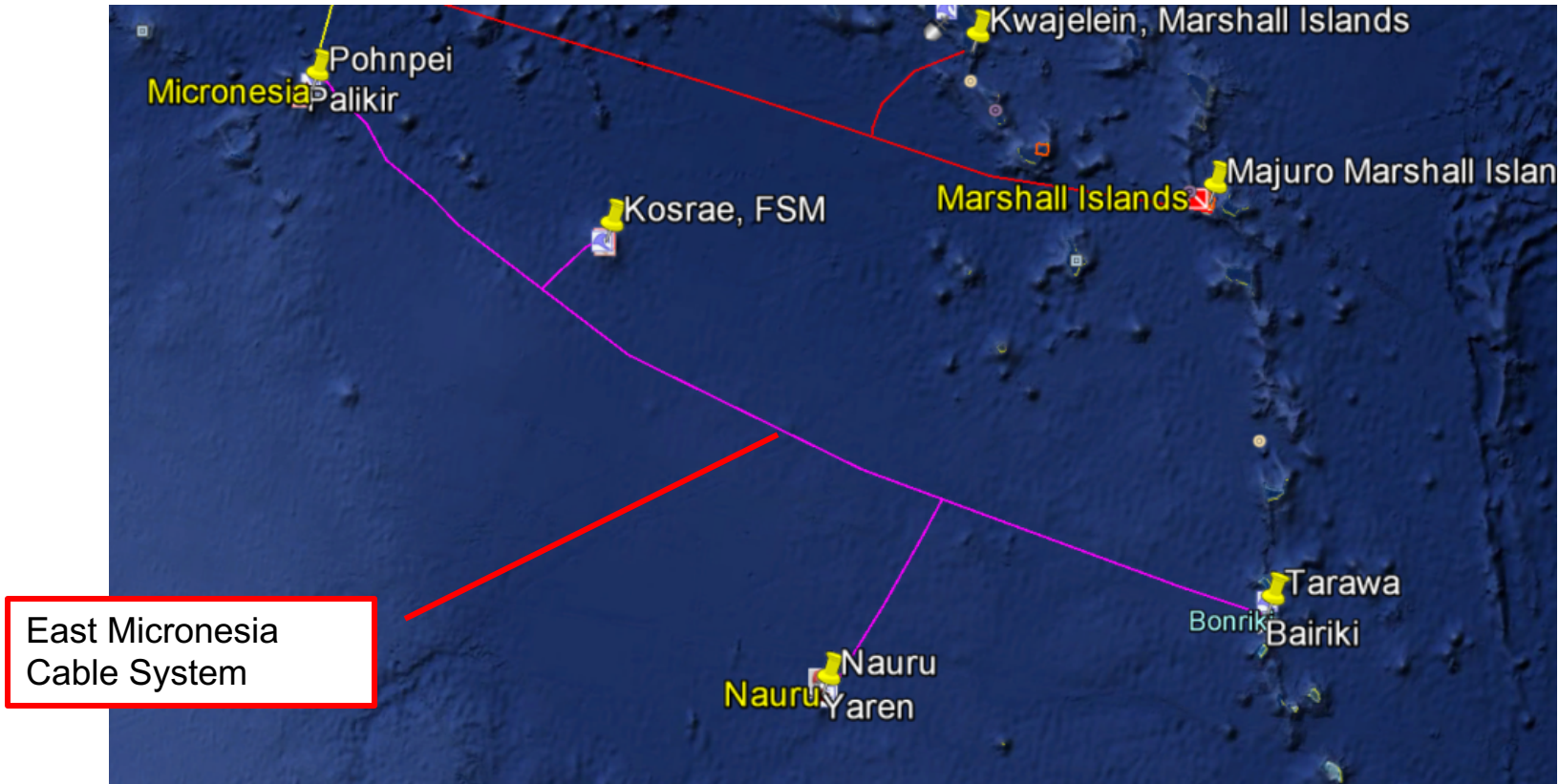


Figure 1: Notional Concept of EMCS

Hantru-1 Cable System

The Hantru-1 Cable System owned by Hannon Armstrong and operated by Truestone, achieved RFS in 2010 and consists of two fiber pairs.

- One fiber pair is leased exclusively to the United States Department of Defense
- The second fiber pair is shared between MINTA and FSMTC, with each allocated 8 wavelengths

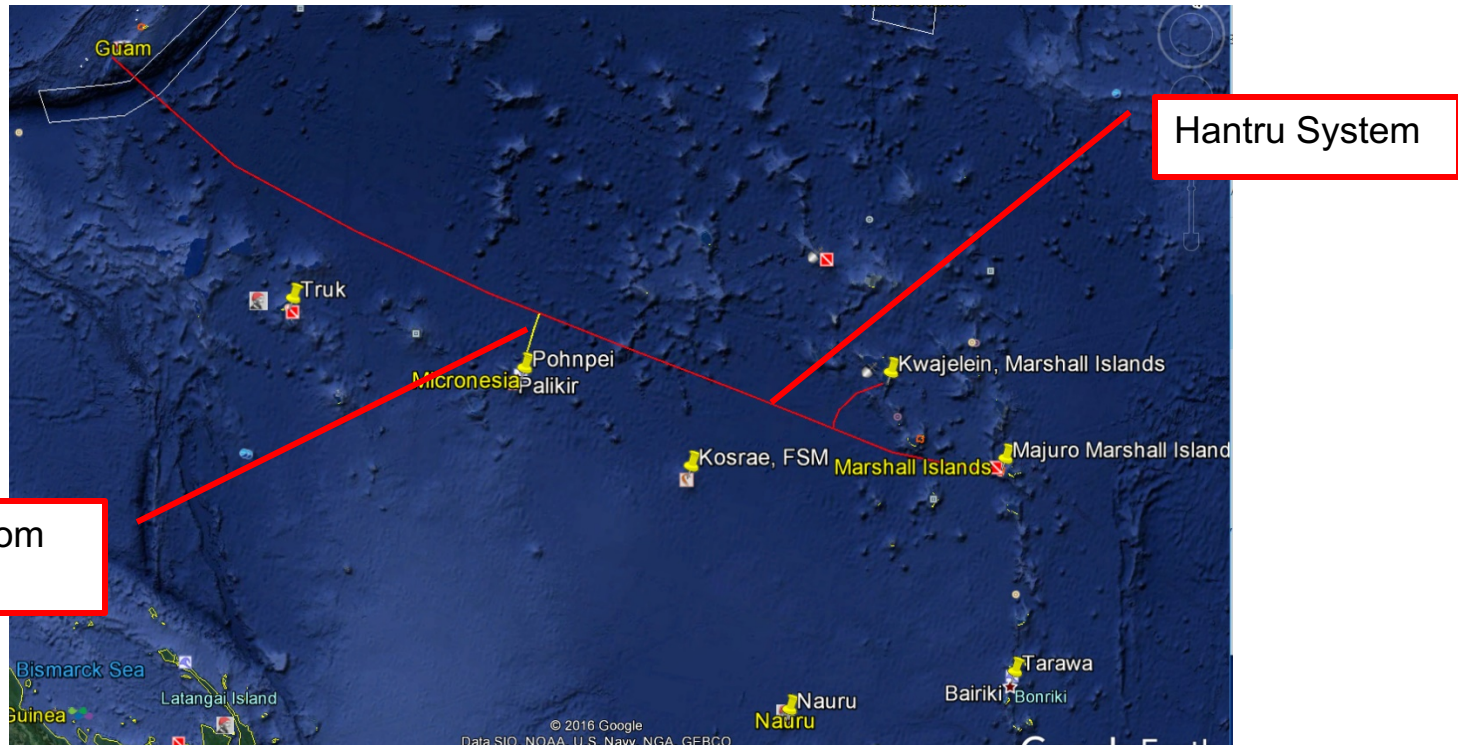


Figure 2: Hantru-1 Cable System

Introduction and Background

- Pohnpei was connected to the Hantru-1 System via the Pohnpei Extension shown as a line diagram in Figure 3.
 - As shown, the Pohnpei Extension is ~ 174km in length,
 - Installed with a Pre-Lay Shore End (PLSE) and a Deep Water Section
 - The PLSE was installed with 3 Fiber Pair; 1 pair for connectivity to the Hantru-1 System, and the other 2 pair for future use. However, as it has been determined that the PLSE is no longer on level ground, additional connections will not be made.
 - The Pohnpei Extension also has a single repeater at 115km from the Pohnpei Cable Landing Station (CLS)

Pohnpei Extension Connecting into Hantru-1

5.4 PFE Specification Tables

Table 5.1 – PFE Specification Tables - PFE Polarity Configuration Table

Cable Station	PFE Polarity
Guam	Positive
Pohnpei	Negative

Table 5.2 – PFE Specification Tables – Pohnpei PFE Set Points and Shutdowns Parameters Table

Regulation Levels & Shutdown Set Point	Percentage	Value
Dist. Circle and Feed Voltage (A)	N/A	155
System Current (A)	N/A	0.650
Converter Voltage Regulation (V)	105%	164
Converter Current Regulation (A)	100%	0.650
Converter High Voltage Shutdown	110%	172
Converter High Current Shutdown	120%	0.780
Converter Low Current Shutdown	N/A	Disabled
Plant High Voltage Shutdown	115%	179
Plant Low Current Shutdown	N/A	Disabled
Maximum Converter Voltage	N/A	5,000

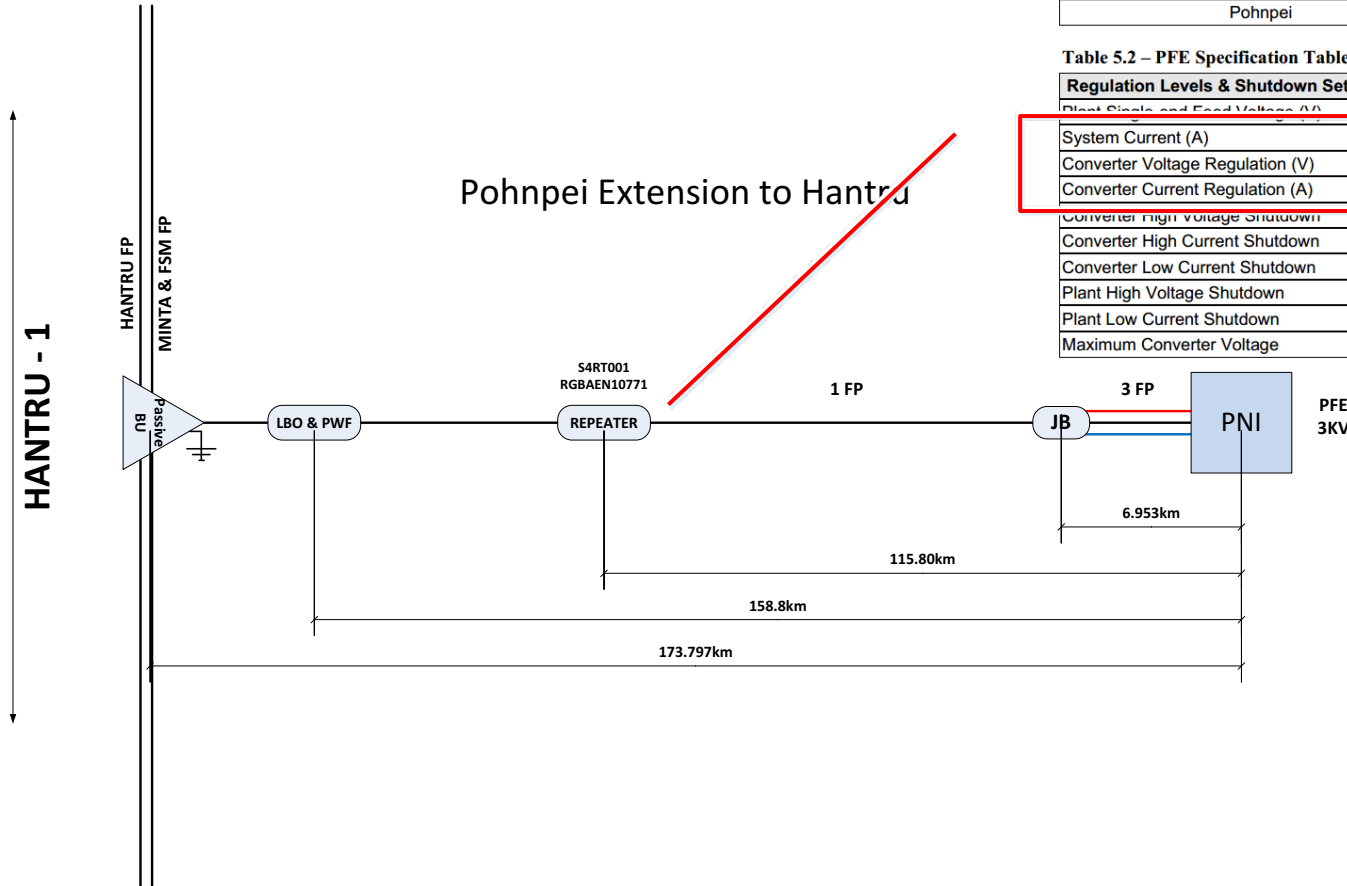


Figure 3: Pohnpei Extension Line Diagram

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Introduction and Background

- Separate, but related, the FSM is also in the process of implementing a cable system between Chuuk and Pohnpei (C-P Cable System) which utilizes a separate PLSE that is terminated into the same BMH as the Pohnpei Extension. This cable system is shown in Figure 4.

The Chuuk – Pohnpei Cable System

The C-P System is a single fiber pair system designed to have a single PFE in Chuuk, and terminate at the Pohnpei Extension via a Passive Branching Unit

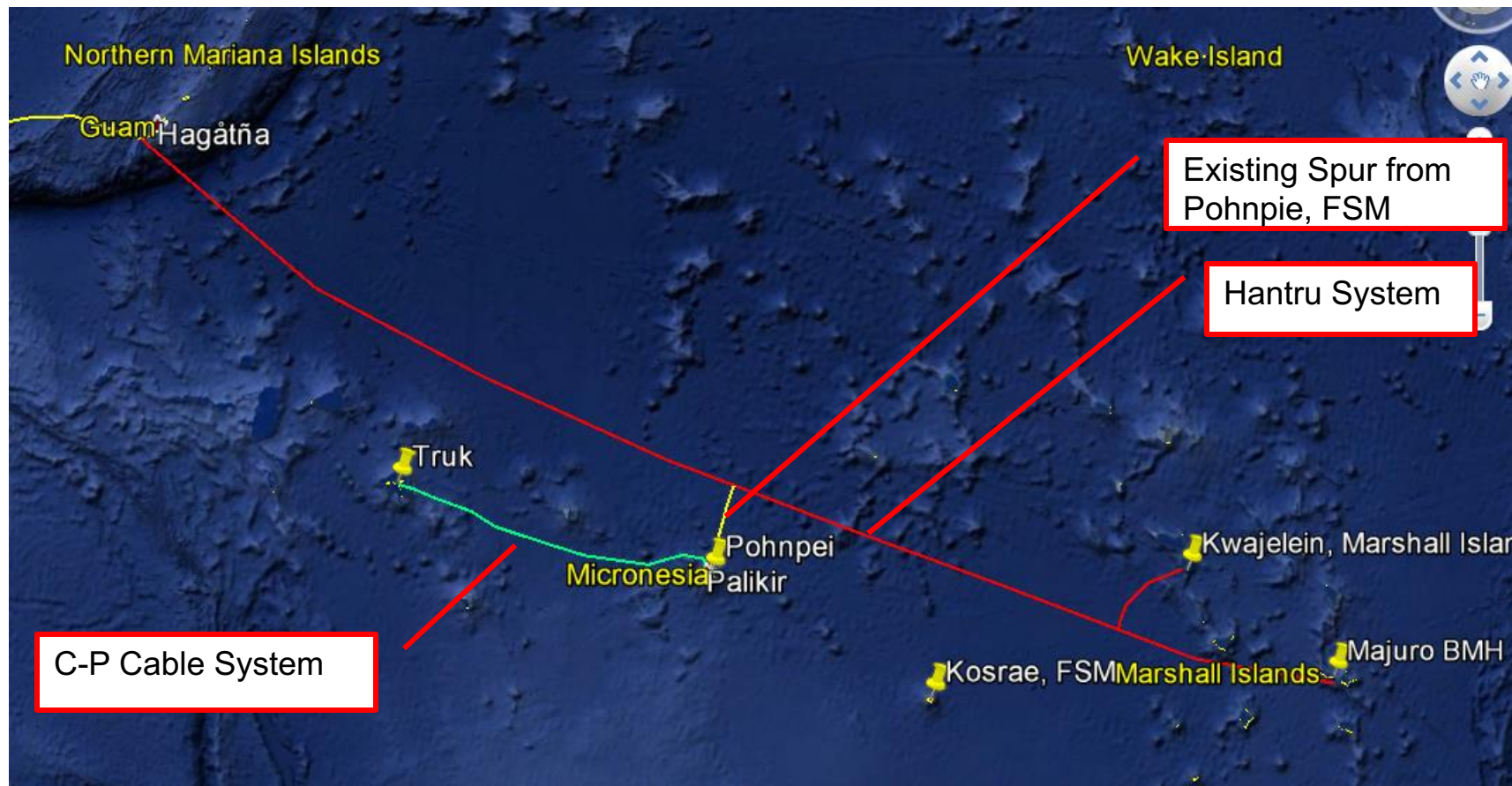


Figure 4: Chuuk – Pohnpei Cable System

Introduction and Background

- Figure 5 depicts the line diagram for the interconnection of C-P Cable System with the Pohnpei Extension.
 - While most of the C-P Cable System is composed of single fiber pair cable, within 50km of Pohnpei, the C-P Cable System will implement cable with a minimum of 2 fiber pair, for potential use by a future system.
 - As shown, the C-P Cable System also contains 7 dual-polarity repeaters which operate at 1.2 amps with a typical spacing of approximately 108km
 - Design capacity for the C-P Cable System is 5 x 100Gbps Channels, with initial provision of 1x 100Gpbs Channel.
 - C-P Cable System is single-end fed from a PFE in Chuuk. PFE is capable of upgrade.

C-P Cable System Interconnect into Pohnpei Extension

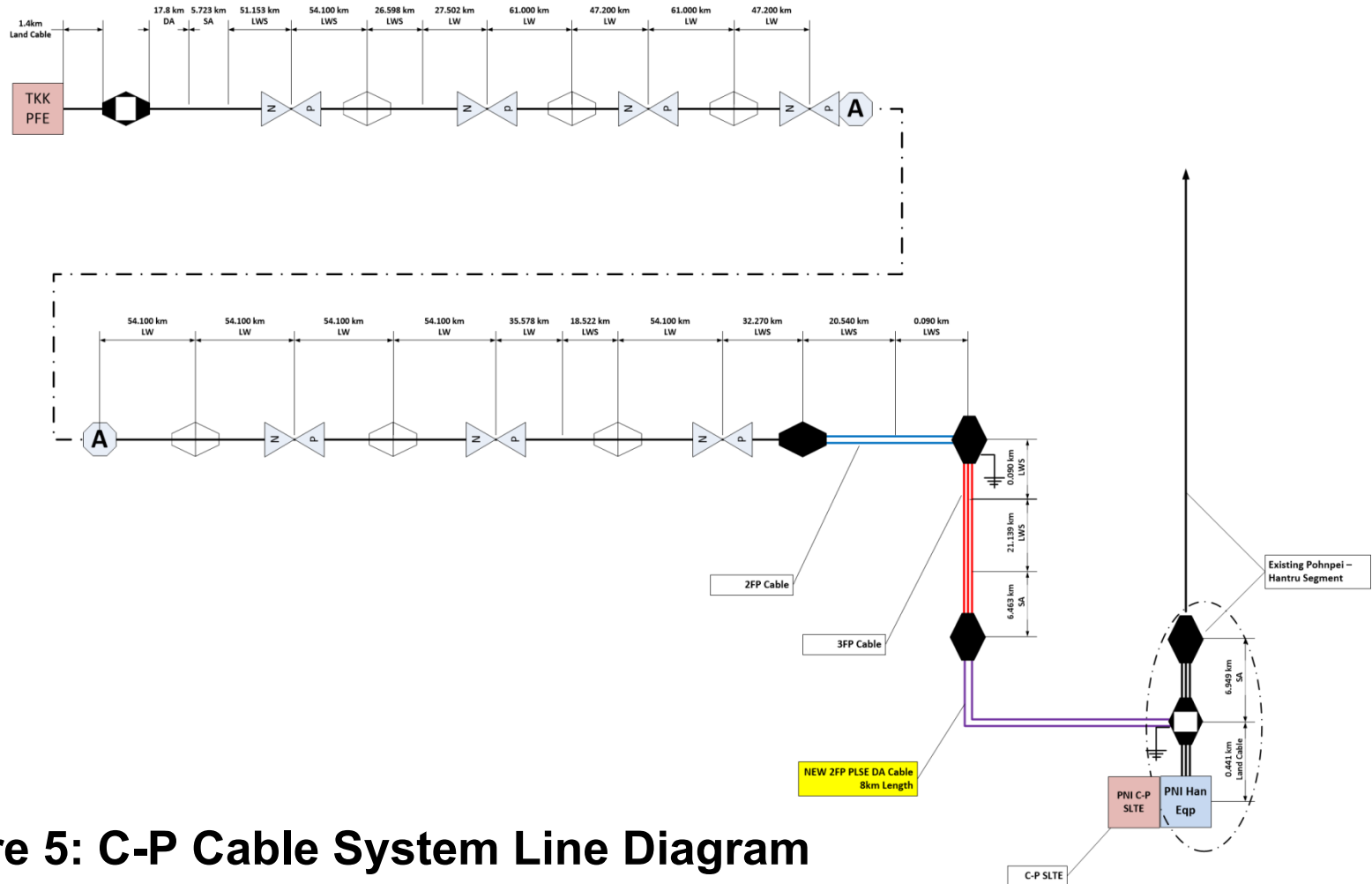


Figure 5: C-P Cable System Line Diagram Interconnect with Pohnpei Extension

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Guidelines 1/3

- For Nauru the Supplier shall consider the following guidelines, if feasible:
 - Powering the EMCS main trunk from remote islands Tarawa (max. 3 meters above sea level) and/or Chuuk (in 2015 typhoon destroyed 95% of the houses) bears some risks (regular power outages, expected rising water levels and waves over 25 years, expected stronger typhoons over 25 years, etc.). For this case for Nauru supplier shall consider independent PFE. That is not required, if main trunk is powered (in addition) from Pohnpei.

Guidelines 2/3

- The Supplier in general shall consider the following:
 - There is just one weekly flight between the islands (may impact spare parts, tools, test equipment, technical training)
 - For final implementation, NOC must be integrated in existing Hantru-1 NOC
 - In the final implementation, end-to-end guarantees for connectivity; Kosrae – Pohnpei, Nauru – Guam, Tarawa – Guam, are desirable
 - For every of the following 3 EMCS configuration options supplier shall confirm, if supplier will provide full end-to-end guarantees during warranty period between Tarawa CLS / Nauru CLS / Kosrae CLS and Pohnpei CLS and/or Guam CLS.
 - Strategic Risk: Supplier shall consider different RfS dates (Hantru-1 RfS 2010, C-P Cable RfS app. end of 2017, EMCS RfS app. end of 2019) and expected lifespans (25 years) for the cables, and recommend a preferred solution / migration options so that EMCS expected lifespan of 25 years with connectivity to Guam can be achieved.
 - Minimized O&M costs and procedures

Guidelines 3/3

- Technical system solutions proffered should:
 - Provide a high degree of resiliency for the EMC System,
 - Resiliency to Shunt Faults
 - To the extent possible each sovereignty should be able to transmit to Pohnpei independent of the other sovereignties and the status of their CLS.
 - Faulted Branch
 - Faulted PFE
 - Faulted SLTE
 - Ensure seamless transmission from Kiribati, Nauru, and Kosrae to Guam,
 - Have the ability to monitor transmission performance end to end (Kiribati, Nauru, Kosrae to Guam)
 - Minimize O&M Costs and Procedures
- The Supplier in general shall consider the following:
 - There is just one weekly flight between the islands (may impact spare parts, tools, test equipment, technical training)

Directions to the Suppliers

- The Purchasers of the EMC System have contemplated a number of potential architectures and options for the EMC System design and implementation.
- These options are described in detail in the following sections, and the Supplier is asked to provide their expert opinions on the following:
 - Ordering of Options with respect to:
 - Technical Feasibility
 - Technical Risk
 - Resiliency to both Optical and Shunt Faults
 - Strategic Risk (EMCS connectivity to Pohnpei or better to Guam until end of expected lifespan of 25 years), full end-to-end guaranties during warranty period
 - Estimated Cost
 - Latency from Kiribati and Nauru to Guam

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Directions to the Suppliers

- While the Purchasers have contemplated the Options that follow, the Supplier is encouraged to provide reasonable alternative system architecture options or system parameters.

RFI Options

- This section of the document describes the Options which the Purchaser would like the Supplier to consider for implementation of the EMC System.
- Figure 6 Depicts the family tree of Options which the Supplier should consider.
- These options are described separately in later sections, with the explanation of the Purchaser's intent regarding the option.
- Options are described individually, but a combination of options are permissible.

Family Tree of Options

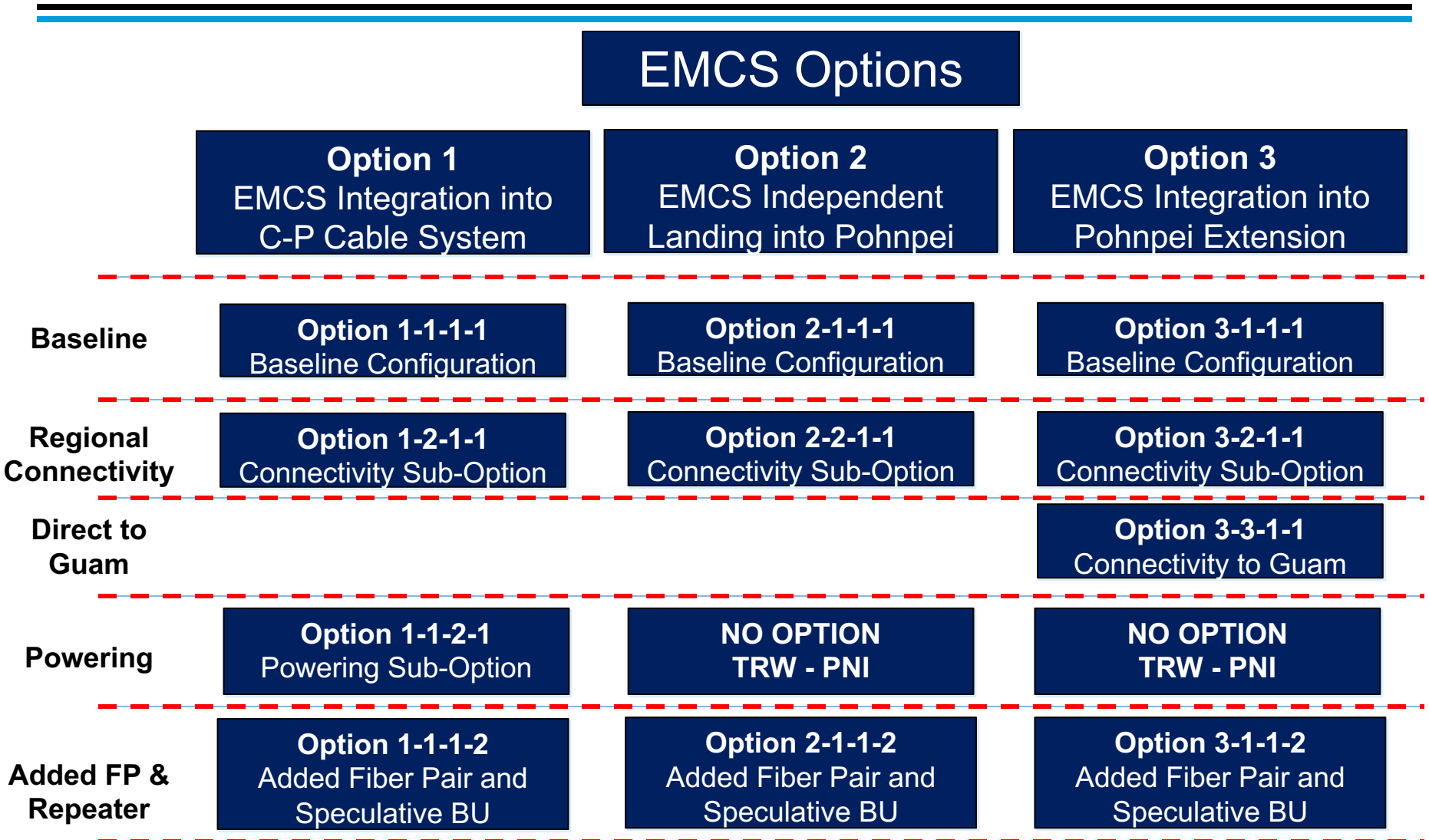


Figure 6: Family Tree of Options

RFI Options

- As shown in Figure 6, the Three Primary Options are:
 1. Integration of EMCS with the Chuuk-Pohnpei Cable System,
 2. Independent Landing of the EMCS onto Pohnpei
 3. Integration of EMCS with the Pohnpei Extension directly.

RFI Options – Baseline Configuration

- Baseline EMCS configuration for each of these Options consists of the following attributes:
 - Single Fiber Pair shared between the three states (Kiribati, Nauru, and Kosrae)
 - Initial Capacity for each state 1 x 100Gbps Channel
 - Ultimate Design Capacity for each state 10 x 100Gbps Channels
 - Desired Direct Connectivity:
 - Kosrae to Pohnpei Connectivity
 - Nauru to Pohnpei Connectivity
 - Kiribati to Pohnpei Connectivity

RFI Options

- The following Sub-Options to the Primary Options should be considered by the Supplier
- Enabling the following Connections
 - Kiribati to Pohnpei (Baseline)
 - Nauru to Pohnpei (Baseline)
 - Kosrae to Pohnpei (Baseline)
 - Kiribati to and from Nauru
 - Kiribati to and from Kosrae
 - Nauru to and from Kosrae
 - For Option 3 only – Direct Connectivity to Guam
 - i.e. Transmission directly to Guam, bypassing Pohnpei
- Powering Schemes for EMCS
- Additional Fiber Pair and Optional BU between Nauru and Kiribati for future use to other planned Pacific Systems

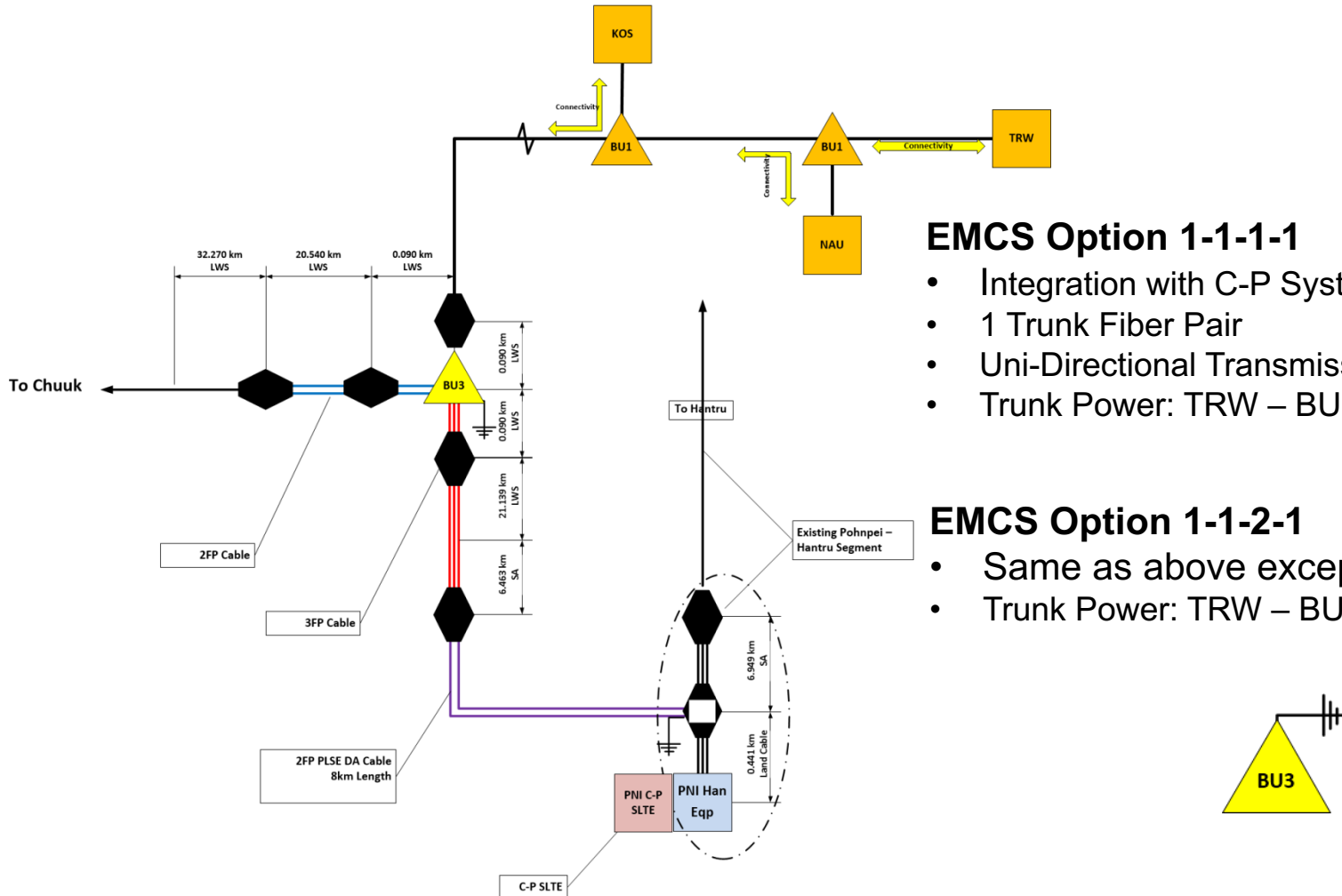
Detailed Descriptions of Options

- This section provides detail regarding Purchaser's intent for each Option and Sub-Options identified.
- Option Code: A-B-C-D
 - A: Primary Option
 - B: Branch Connectivity Option
 - C: Powering Option
 - D: Trunk Fiber Pair (and Potential Speculative Branching Unit)

Option 1: Integration of EMCS with Chuuk-Pohnpei Cable System

- Option 1-B-C-D is the option that integrates the EMCS with the Chuuk – Pohnpei Cable System
- Figure 7 Option 1-1-1-1 and Option 1-1-2-1
 - Option 1-1-1-1
 - Integration with Chuuk – Pohnpei Cable System via a Non-Power Switched Passive Branching Unit (BU3 CP- EMCS).
 - Single Fiber Pair Branches at Kosrae and Nauru that enable connectivity between Kosrae and Nauru with Pohnpei only.
 - Trunk Powering Option that enables a Trunk Powering Scheme between Chuuk and Tarawa
 - Single Fiber Pair Trunk with No Option BU for future use.
 - Option 1-1-2-1
 - Same as above, But BU3 now grounds the EMCS System at BU3 resulting in non-redundant single ended Powering from Tarawa.

Option 1: Integration of EMCS with Chuuk-Pohnpei Cable System



EMCS Option 1-1-1-1

- Integration with C-P System
- 1 Trunk Fiber Pair
- Uni-Directional Transmission from Branches
- Trunk Power: TRW – BU3 - Chuuk

EMCS Option 1-1-2-1

- Same as above except
- Trunk Power: TRW – BU3

Figure 7: Option 1-1-1-1 and Option 1-1-2-1

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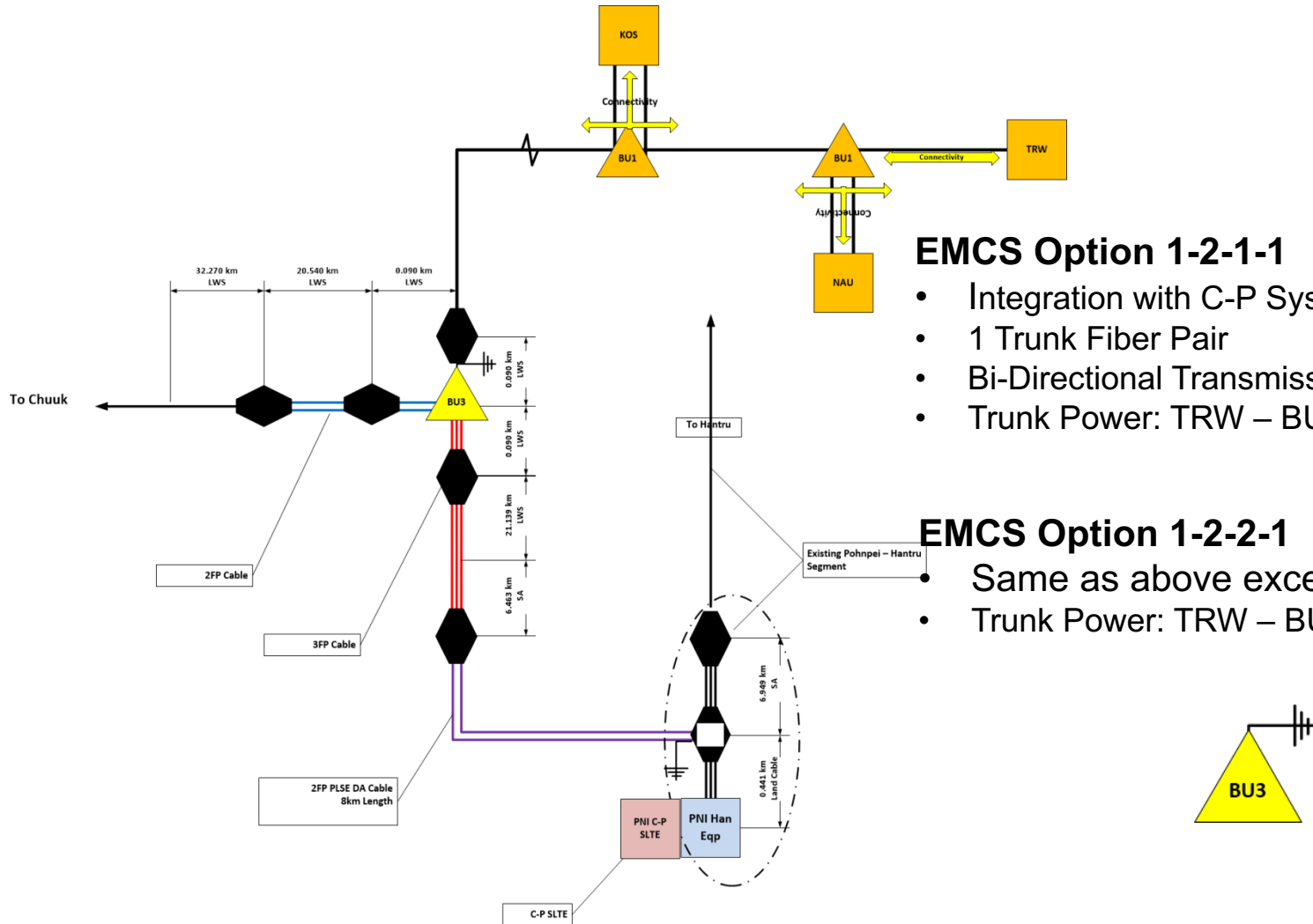
Option 1: Integration of EMCS with Chuuk-Pohnpei Cable System

- Discussion
 - The intent of Option 1-1-1-1 is to:
 - Provide connectivity between Kosrae, Nauru, and Kiribati with Pohnpei
 - Provide for Trunk Powering between Chuuk and Tarawa to add resilience to both the C-P Cable System and EMCS for single shunt faults
 - Option 1-1-2-1 is less desirable since it appears that both the C-P Cable System and EMCS would be vulnerable to shunt faults
 - C-P Cable System along its entire length, and
 - EMCS between Kosrae and the Pohnpei Extension
 - Branch Powering:
 - The Supplier is requested to determine if there are advantages in resilience for Branch Powering from Kosrae and Nauru in conjunction with Power Switched Branching Units at BU1 and BU2

Option 1: Integration of EMCS with Chuuk-Pohnpei Cable System

- Figure 8 Option 1-2-1-1 and Option 1-2-2-1
 - Option 1-2-1-1
 - Option 1-2-1-1 is similar to Option 1-1-1-1, except that this Option enables **regional connectivity** between
 - Nauru and Kosrae,
 - Nauru and Kiribati, and
 - Kosrae and Kiribati
 - Without taking traffic to Pohnpei and “hair pinning” the traffic back.
 - Provide for Trunk Powering between Chuuk and Tarawa to add resilience to both the C-P Cable System and EMCS for single shunt faults
 - Option 1-2-2-1
 - Same as above, But BU3 now grounds the EMCS System at BU3 resulting in non-redundant single ended Powering from Tarawa.

Option 1: Integration of EMCS with Chuuk-Pohnpei Cable System



EMCS Option 1-2-1-1

- Integration with C-P System
- 1 Trunk Fiber Pair
- Bi-Directional Transmission from Branches
- Trunk Power: TRW – BU3 - Chuuk

EMCS Option 1-2-2-1

- Same as above except
- Trunk Power: TRW – BU3

Figure 8: Option 1-2-1-1 and Option 1-2-2-1

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Option 1: Integration of EMCS with Chuuk-Pohnpei Cable System

- Discussion

- The intent of Option 1-2-1-1 is the following:

- Provide connectivity not only between Kosrae, Nauru, and Kiribati with Pohnpei, but between each of those states with each other, without need for reversing that “regional” traffic in Pohnpei
- Provide for Trunk Powering between Chuuk and Tarawa to add resilience to both the C-P Cable System and EMCS for single shunt faults

- Option 1-2-2-1 (as with Option 1-1-2-1) is less desirable since it appears that both the C-P Cable System and EMCS would be vulnerable to shunt faults

- C-P Cable System along its entire length, and
- EMCS between Kosrae and the Pohnpei Extension

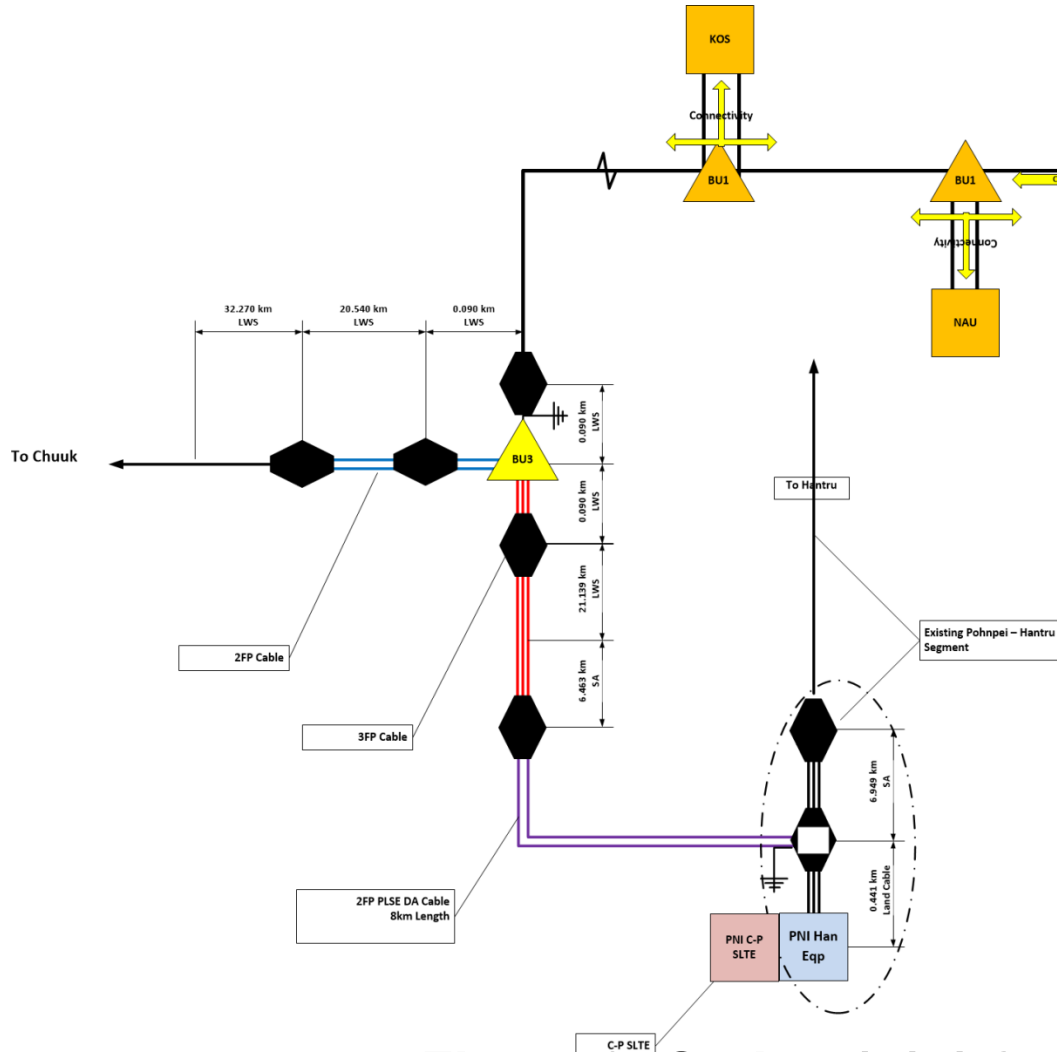
- Branch Powering:

- Again, the Supplier is requested to determine if there are advantages in resilience for Branch Powering from Kosrae and Nauru in conjunction with Power Switched Branching Units at BU1 and BU2

Option 1: Integration of EMCS with Chuuk-Pohnpei Cable System

- Figure 9 Option 1-1-1-2 and Option 1-1-2-2
 - Option 1-1-1-2
 - Option 1-1-1-2 provides for a 2nd fiber pair in the Trunk of the EMCS, with an Optional Branching Unit between Kiribati and Nauru intended for future connectivity with other planned Pacific Cable Systems.
 - The intended use of this 2nd Fiber Pair and Branching Unit is:
 - » Provide an alternative path for international connectivity of the EMCS in addition to the Hantru System, and
 - Powering discussions (Options 1-1-1-2 and Option 1-1-2-2) are similar to those previously provided.
- Option 1-2-1-2 is not shown, but the discussion is similar to Option 1-2-1-1.

Option 1: Integration of EMCS with Chuuk-Pohnpei Cable System



EMCS Option 1-1-1-2

- Integration with C-P System
- 2 Trunk Fiber Pair w/ Optional Southeast Branching Unit for future use
- Uni-Directional Transmission from Branches
- Trunk Power: TRW – BU3 - Chuuk

EMCS Option 1-1-2-2

- Same as above except
- Trunk Power: TRW – BU3

Figure 9: Option 1-1-1-2 and Option 1-1-2-2

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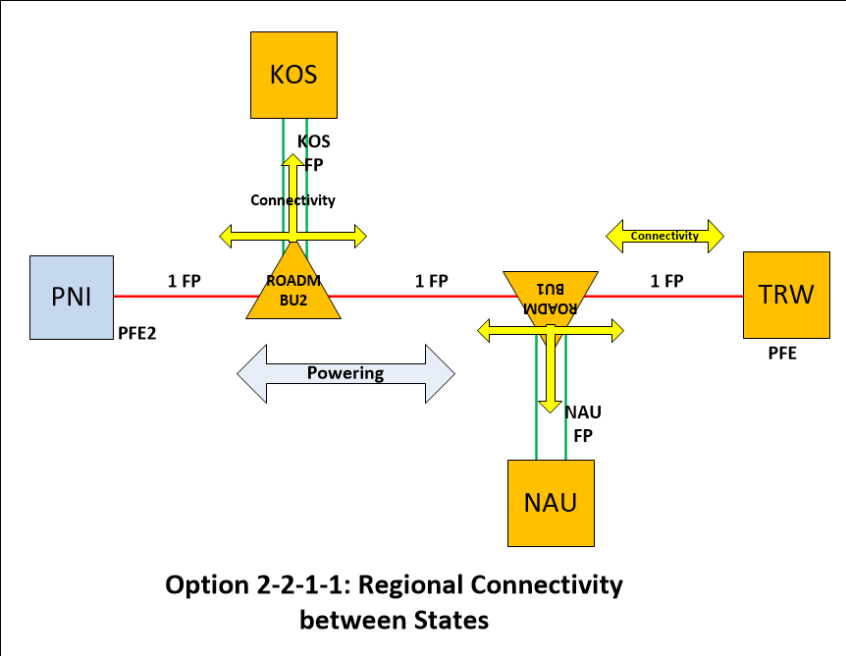
Option 1: Integration of EMCS with Chuuk-Pohnpei Cable System

- Discussion of Option 1-1-1-2
 - The intended use of this 2nd Fiber Pair and Branching Unit is:
 - Provide an alternative path for international connectivity of the EMCS in addition to the Hantru System, and
 - Powering discussions (Options 1-1-1-2 and Option 1-1-2-2) are similar to those previously provided.
 - Option 1-2-1-2 is not shown, but the discussion is similar to Option 1-2-1-1, regional connectivity between the states.

Option 2: Independent Landing of EMCS into Pohnpei

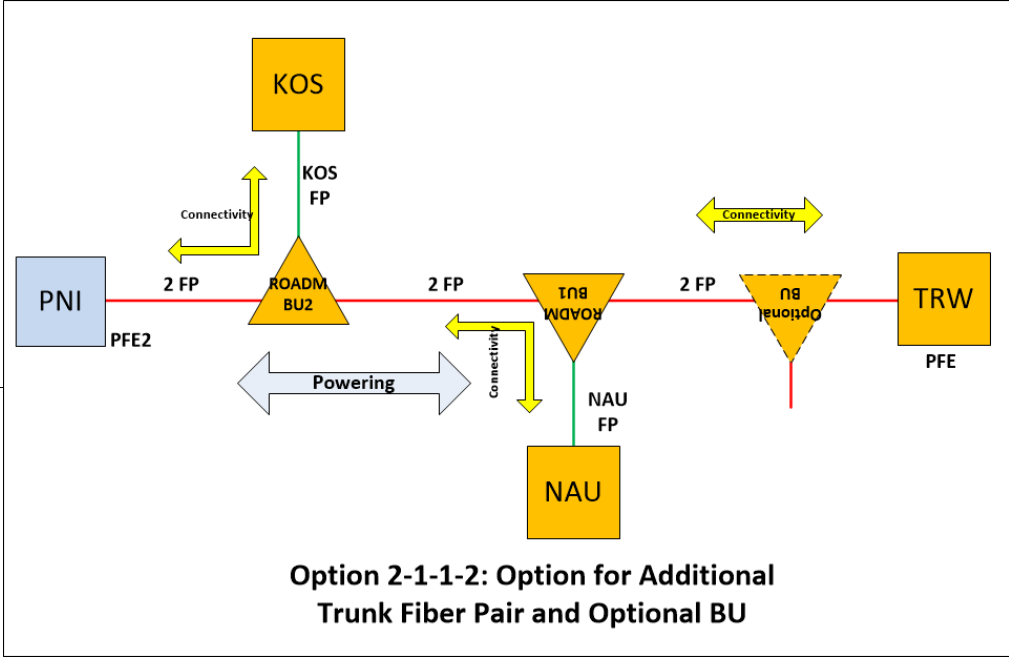
- Option 2-B-C-D is the option that considers an independent Landing of EMCS into Pohnpei with separate BMH and separate duct to Pohnpei CLS
- Figure 11 depicts Options 2-1-1-1 and 2-1-1-2
 - Option 2-1-1-1
 - Regional Connectivity between States
 - Independent landing into Pohnpei
 - Single Fiber Pair Branches at Kosrae and Nauru that enable connectivity between Kosrae and Nauru with Pohnpei only.
 - A standard system powering scheme with PFEs in Pohnpei and Tarawa (No other powering option)
 - Option 2-1-1-2
 - Same as above, but with
 - 2nd Fiber Pair on Trunk with Optional BU

Option 2: Independent Landing of EMCS at Pohnpei



EMCS Option 2-2-1-1

- Same as 2-2-1-1, but
- 2nd Fiber Pair and Optional BU



EMCS Option 1-1-1-2

- Regional Connectivity between States
- Independent Landing into Pohnpei
- Single Fiber Pair on Trunk
- Standard System Powering

Figure 11: Option 2-2-1-1 and Option 2-1-1-2

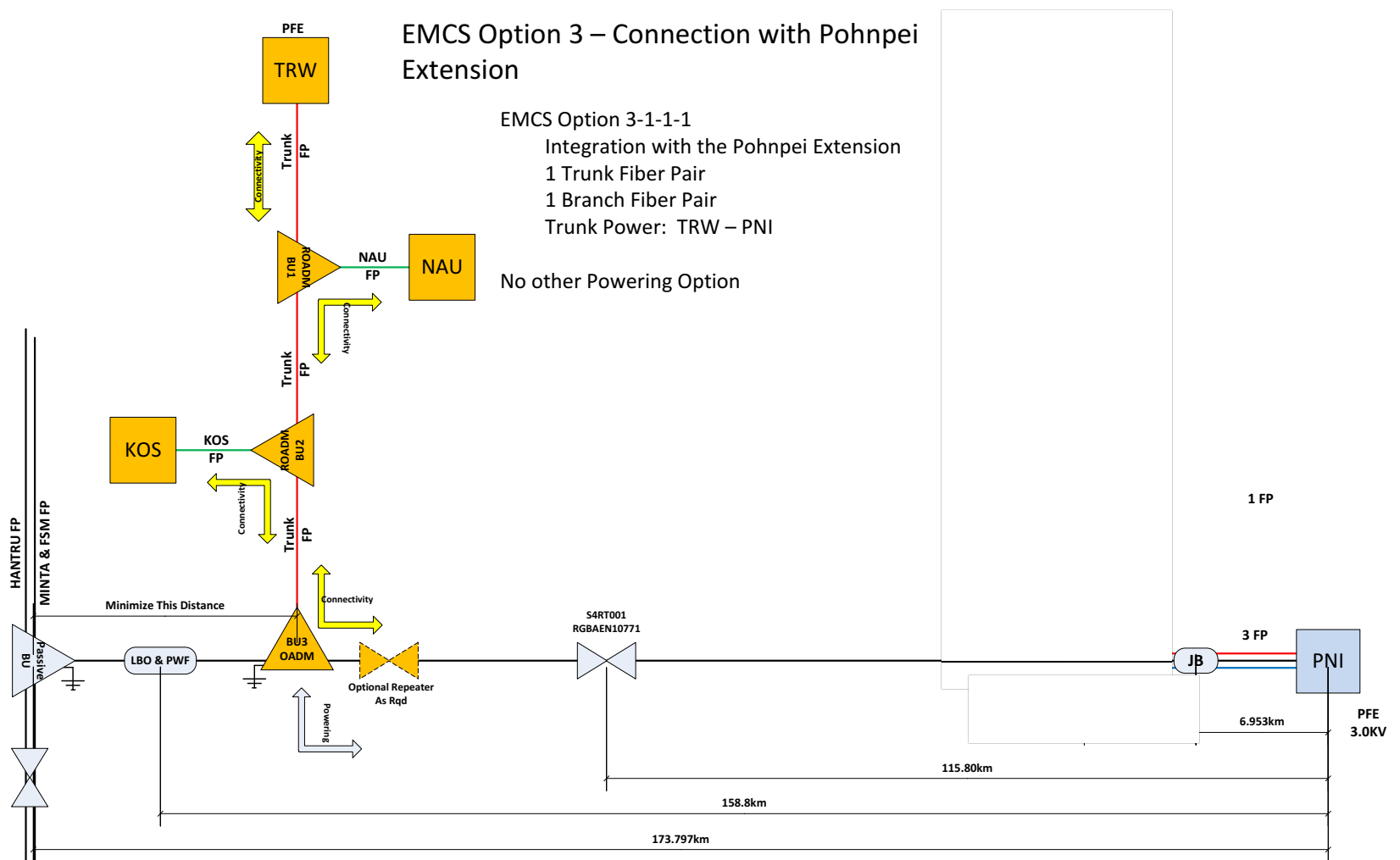
Option 2: Independent Landing of EMCS into Pohnpei

- Discussion of Option 2
 - Option 2 results in a “typical” submarine cable system installation consisting of two far end landing points with PFEs associated with each end, thus providing shunt fault resiliency for the system. There are no other Power Options for the Trunk.
 - Option 2-2-1-1 is intended to provide regional connectivity between the states without need for sending all traffic to either endpoint (Pohnpei and Tarawa).
 - Option 2-2-1-2, as described in previous primary options, provides for:
 - An alternative path for international connectivity of the EMCS in addition to the Hantru System, and
 - A more direct path from planned Pacific Systems east of EMCS to Guam and Asia , with potential to generate revenue.
 - Branch Powering:
 - Again, the Supplier is requested to determine if there are advantages in resilience for Branch Powering from Kosrae and Nauru in conjunction with Power Switched Branching Units at BU1 and BU2

Option 3: Integration of EMCS directly with the Pohnpei Extension

- Option 3-B-C-D is the option that considers integrating the EMCS directly into the Pohnpei Extension
- Figure 12 depicts Option 3
 - EMCS is integrated directly into the Pohnpei Extension via Power Switched OADM Branching Unit (BU3) located in close proximity to the Hantru-1 Trunk.
 - An OADM is required since there is only the single fiber pair in the Pohnpei extension at this location.
 - It is noted that there may also be a need for an additional repeater on the Pohnpei side of BU3 to compensate for additional insertion losses of BU3.
- Figure 13 depicts both
 - Option 3-2-1-1: Regional Connectivity between States, and
 - Option 3-3-1-1: Direct Connectivity of EMCS with Guam

Option 3: Integration of EMCS directly with the Pohnpei Extension



EMCS Option 3 – Connection with Pohnpei Extension

EMCS Option 3-1-1
 Integration with the Pohnpei Extension
 1 Trunk Fiber Pair
 1 Branch Fiber Pair
 Trunk Power: TRW – PNI
 No other Powering Option

Figure 12: Option 3-1-1-1

Replaced BUs with ROADM Bus Added 2nd FP to Branches

Option 3: Integration of EMCS directly with the Pohnpei Extension

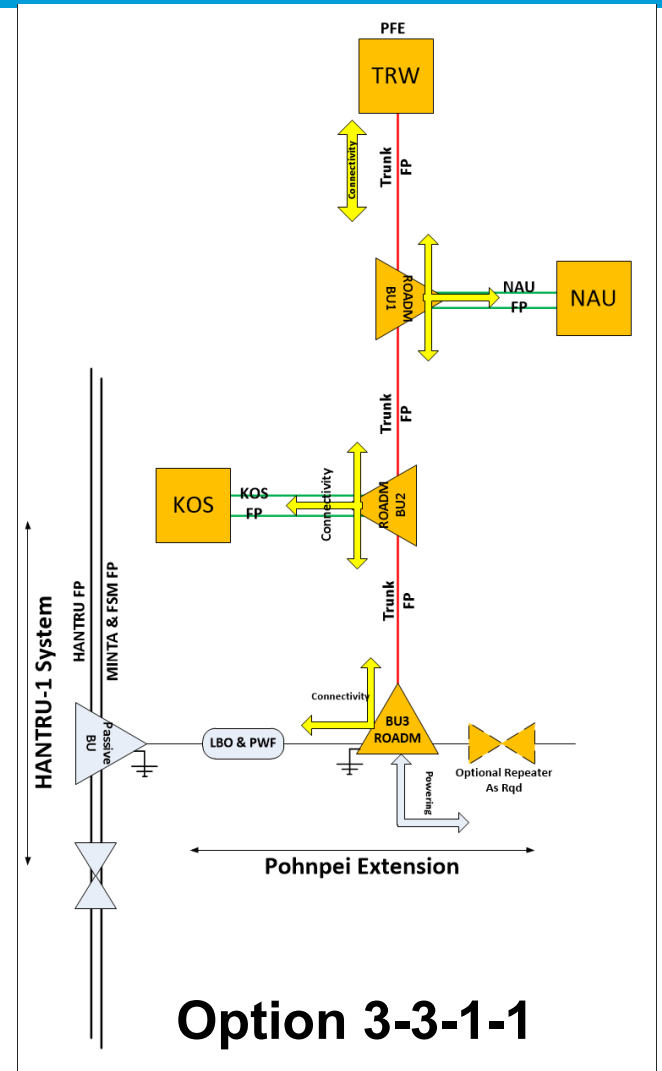
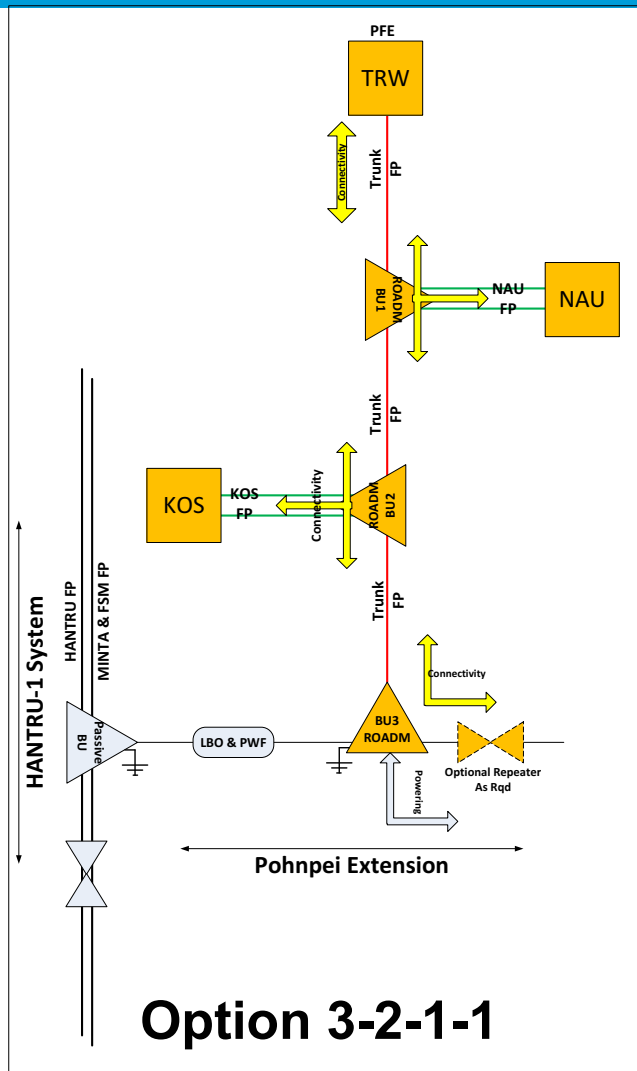


Figure 13: Option 3-2-1-1 and Option 3-3-1-1

Option 3: Integration of EMCS directly with the Pohnpei Extension

- Additional Information: Pohnpei Extension OADM Implementation
- The Pohnpei Extension was designed for an:
 - initial provisioning of 1x 10Gbps channel between Pohnpei and Guam
 - Ultimate provisioning of 8 x10 Gbps channels between Pohnpei and Guam
 - Shared Fiber Pair with MINTA on the Hantru-1 Cable System.
- Wavelength allocations for the shared FP on the Hantru System are provided in the following table.

Option 3: Integration of EMCS directly with the Pohnpei Extension

- Additional Information: Pohnpei Extension OADM Implementation

Table 1-5. Full Loading Wavelength Allocations for MCS Fiber Pair

Entry Number	Optical Center Frequency (THz)	Center Wavelength (nm)	Loading	Receive Station
1	194.500	1541.349	LME1	LME1
2	194.400	1542.142	Data3	Ebeye
3	194.367	1542.407		
4	194.333	1542.671		
5	194.300	1542.936		
6	194.267	1543.201	Data16	Ebeye
7	194.233	1543.466		
8	194.200	1543.730		
9	194.167	1543.995		
10	194.133	1544.261	Data15	Majuro
11	194.100	1544.526		
12	194.067	1544.791		
13	194.033	1545.056		
14	194.000	1545.322	Data14	Majuro
15	193.967	1545.588		
16	193.933	1545.853		
17	193.900	1546.119		
18	193.867	1546.385	Data13	Pohnpei
19	193.833	1546.651		
20	193.800	1546.917		
21	193.767	1547.183		
22	193.733	1547.449	Data12	Pohnpei
23	193.700	1547.715		
24	193.667	1547.982		
25	193.633	1548.248		
26	193.600	1548.515	Data11	Pohnpei
27	193.567	1548.781		
28	193.533	1549.048		
29	193.500	1549.315		
30	193.467	1549.582	Data10	Pohnpei
31	193.433	1549.849		
32	193.400	1550.116		
33	193.367	1550.383		

Table 1-5. Full Loading Wavelength Allocations for MCS Fiber Pair (Cont'd)

Entry Number	Optical Center Frequency (THz)	Center Wavelength (nm)	Loading	Receive Station
34	193.333	1550.651	Data2	Pohnpei
35	193.300	1550.918		
36	193.267	1551.186		
37	193.233	1551.453		
38	193.200	1551.721	Data1	Majuro
39	193.167	1551.989		
40	193.133	1552.256		
41	193.100	1552.524		
42	193.067	1552.792	Data4	Pohnpei
43	193.033	1553.061		
44	193.000	1553.329		
45	192.967	1553.597		
46	192.933	1553.866	Data5	Majuro
47	192.900	1554.134		
48	192.867	1554.403		
49	192.833	1554.671		
50	192.800	1554.940	Data6	Pohnpei
51	192.767	1555.209		
52	192.733	1555.478		
53	192.700	1555.747		
54	192.667	1556.016	Data7	Pohnpei
55	192.633	1556.285		
56	192.600	1556.555		
57	192.567	1556.824		
58	192.533	1557.094	Data8	Majuro
59	192.500	1557.363		
60	192.467	1557.633		
61	192.433	1557.903		
62	192.400	1558.173	Data9	Majuro
63	192.367	1558.443		
64	192.333	1558.713		
65	192.300	1558.983	DT-ILE ^(a)	
66	192.200	1559.794	LME2	LME2

(a) For the FSMTC/MINTA Extensions, DT-ILE will be required at full loading only.

Wavelengths highlighted in Yellow are FSM wavelengths on Hantru

Option 3: Integration of EMCS directly with the Pohnpei Extension

- Discussion
- The intent for this integration is to achieve the following:
 - Locating the Power Switched OADM BU 3 close to Hantru and Seaward of the only repeater on the Hantru Extension, reduces the cable length on the Pohnpei Extension susceptible to a single shunt fault (Distance between BU3 and the Hantru System)
 - Provide for Shunt resiliency for both EMCS and the Pohnpei Extension by establishing a powering scheme between Pohnpei and Tarawa.
 - Option 3-2-1-1, as in previous discussions, would like to establish regional connectivity between the States.
 - Option 3-3-1-1 addresses the possibility of direct connectivity between EMCS to Guam without directing traffic to Pohnpei via the BU3 OADM. [Note Traffic Direction from EMCS to Guam.]