



Cyber Photonic Platform Consortium

Program Manual



Manual for Topology Description Generator based on Functional Block based Disaggregation Model (TDG based on FBD model)

V.1.0 2020/2/27

Please download the latest version at <https://unit.aist.go.jp/esprit/cppc/>

Contact: cppc-secretariat-ml@aist.go.jp

※Please note that we do not accept questions or inquiries regarding how to use the TDG.



Disclaimer of Warranties:

Topology Description Generator is provided AS IS, with all faults, without any warranty of any kind.

License:

Topology Description Generator is licensed under the Apache License Version 2.0 (<http://www.apache.org/licenses/LICENSE-2.0>).

© 2020 CPPC

All rights reserved. No part of this publication may be reproduced, by any means whatsoever, without the prior written permission of CPPC.

1. INTRODUCTION

Topology Description Generator ver.1.0 with AIST intellectual property management number 2020PRO-2467, called ‘TDG’ hereafter was developed as a topology description generating tool for the Functional Block-based Disaggregation (FBD) model. Its previous version was the DOPN testbed topology data generator program ver.1.0 (AIST intellectual property management number H30PRO-2232), which was developed under the VICTORIES¹ project. The system overview and the corresponding section of TDG are shown in Fig. 1.

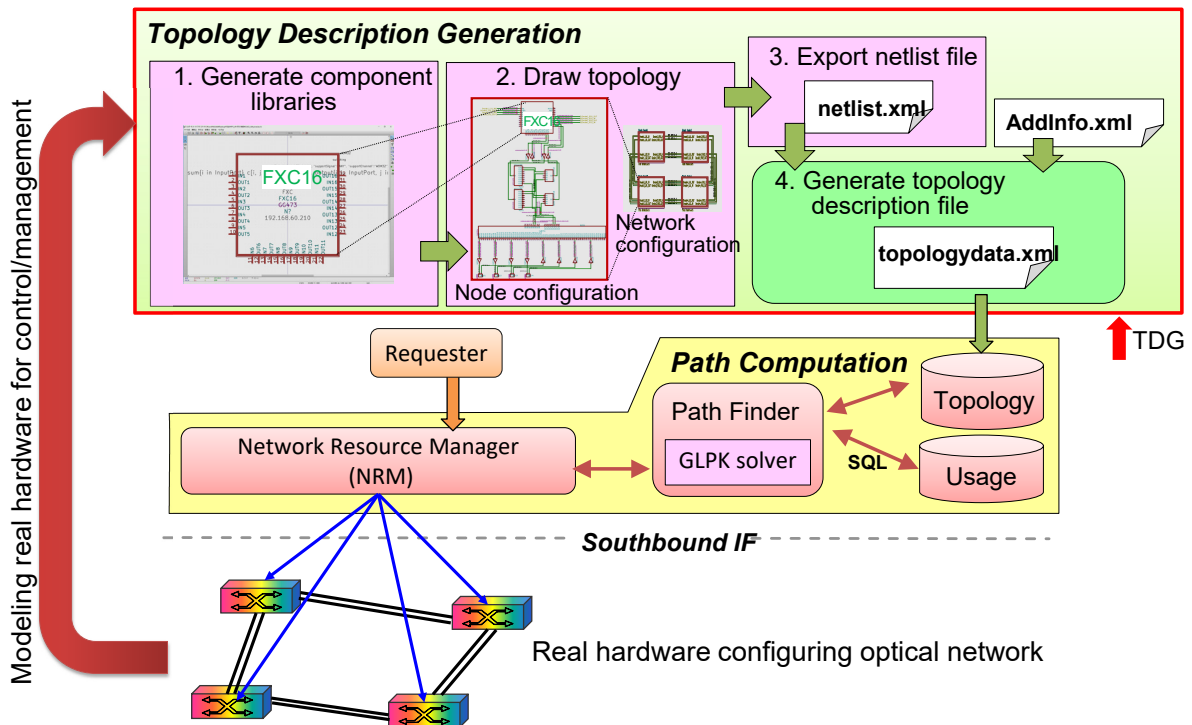


Fig. 1: A system overview of the disaggregated optical networks and the corresponding section of TDG

¹ <https://unit.aist.go.jp/esprit/victories/en/>

2. SOFTWARE OVERVIEW

2.1. FILE LIST

TDG is designed for drawing details of the topology of optical networks and exporting the complete information as a topology description file. The list of files of TDG is shown in Fig. 2. Apart from these files, an open-source software KiCAD is required for drawing the topology. The TDG consists of KiCAD library files (three .lib files under the KiCADLibrary directory), which include basic optical component libraries, text files describing optical channel information (three .xml files under the src directory), a python program file for combining the netlist file with the optical channel information and refactoring for human readability (one .py file under the src directory). Three sets of KiCAD project files for sample topologies (under SampleTopology directory) are also included.

```

¥---TDG
+---doc
|   CPP-TPDG_manual.v.1.pdf
|   LICENSE-2.0.txt
|
+---KiCADLibrary
|   OptNetModel100GHz.v1.lib
|   OptNetModel12.5GHz.v1.lib
|   OptNetModel50GHz.v1.lib
|
+---SampleTopology
| +---OptNetSampleModel100GHz
| |   Dnode1.sch      OptNetSampleModel100GHz.kicad_pcb
| |   Dnode2.sch      OptNetSampleModel100GHz.pro
| |   Dnode3.sch      OptNetSampleModel100GHz.sch
| |   Dnode4.sch      sym-lib-table
| |   OptNetSampleModel100GHz.pdf
| |   OptNetSampleModel100GHz.xml
| |   OptNetSampleModel100GHz_tpl.xml
| |
| +---OptNetSampleModel12.5GHz
| |   Dnode1.sch      OptNetSampleModel12.5GHz.kicad_pcb
| |   Dnode2.sch      OptNetSampleModel12.5GHz.pro
| |   Dnode3.sch      OptNetSampleModel12.5GHz.sch
| |   Dnode4.sch      sym-lib-table
| |   OptNetSampleModel12.5GHz.pdf
| |   OptNetSampleModel12.xml
| |   OptNetSampleModel12_tpl.xml
| |
| ¥---OptNetSampleModel50GHz
| |   Dnode1.sch      OptNetSampleModel50GHz.kicad_pcb
| |   Dnode2.sch      OptNetSampleModel50GHz.pro
| |   Dnode3.sch      OptNetSampleModel50GHz.sch
| |   Dnode4.sch      sym-lib-table
| |   OptNetSampleModel50GHz.pdf
| |   OptNetSampleModel50GHz.xml
| |   OptNetSampleModel50GHz_tpl.xml|
¥---src
  AdditionalInfoFLEX386.xml
  AdditionalInfoWDM32.xml
  AdditionalInfoWDM96.xml
  xml2topology2.py
  
```

Fig. 2: TDG directory structure and the file list

TDG does not include KiCAD² software or Python3³. Before starting TDG, users have to install these software. The software operation check was done with python 3.6 and KiCAD5.1.2.

2.2 LOGICAL STRUCTURE

In the FBD model, optical functional blocks such as the WSSs or optical couplers are modeled as the elemental building unit. The distinctive feature of the FBD model is that the optical switching functionalities of the individual optical functional blocks (i.e., internal connectivity) are formulated in the Integer Linear Programming (ILP) method and written in machine-readable GNU MathProg Modeling Language⁴. The detailed description of an entire optical node or optical network can be structured with the individual optical components and optical fiber connection information among their optical ports (i.e., external connectivity). With internal connectivity formulated in the machine-readable ILP and the external optical fiber connections, we can analyze the optical switching functionalities of the entire optical node/network or compute optical paths. TDG does not include tools for analyzing the topology description files currently; we plan to publish them in the future.

In TDG, the optical functional blocks are implemented as KiCAD Libraries. The KiCAD Libraries providing TDG are separated according to the supporting channel tables (i.e., 100GHz grid, 50GHz grid, and Flex-grid). We can draw the desired optical network topology and generate its topology description XML file by using KiCAD software, importing a desired optical functional block library, putting the optical functional blocks as required, and wiring among the optical input/output ports of the optical functional blocks as required.

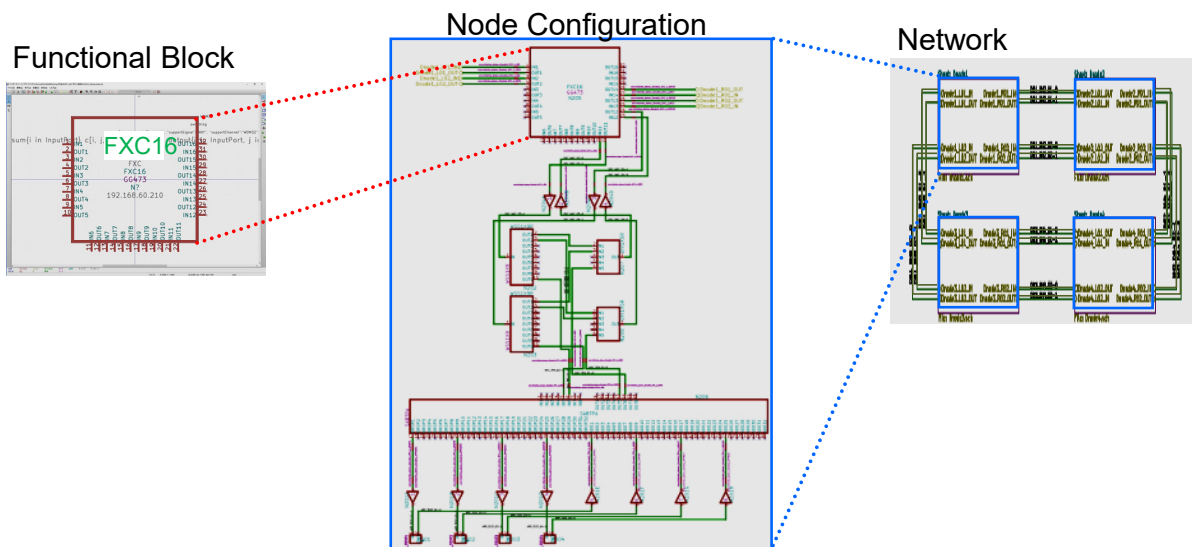


Fig. 3: Logical structure of drawing an optical network topology with TDG. Optical functional blocks are the elemental building units in KiCAD libraries.

² <http://kicad-pcb.org/download/windows/>

³ <https://www.python.org/downloads/>

⁴ <https://www.gnu.org/software/glpk/>

3. HOW TO USE

For simple usage with the sample topologies, please refer to the “Topology Description Generator Quick Start Guide.”

3.1. ADDING A REFERENCE PATH TO THE KICAD LIBRARY

Open the KiCAD software. Click on “preferences” and then on “Manage Symbol Libraries.” Add one of OptNetModel50GHz.v1.lib/ OptNetModel100GHz.v1.lib / OptNetModel12.5GHz.v1.lib under the KiCADLibrary directory to the “Project Specific Libraries.” Note that TDG v.1.0 assumes that only one optical channel table is included for one optical network. If the user wants to use multiple optical channel tables within an optical network, the file “AdditionalInfo{WDM21,WDM96,FLEX386}.xml” under the src directory must be modified. The components and library in the KiCAD library file can be modified with the KiCAD’s symbol editor, as required.

3.2. DRAWING THE NETWORK TOPOLOGY

Open “Schematic Layout Editor” in KiCAD and draw the desired optical network topology. Put link labels using the “Place net label” function on a pair of links according to the following format. *LINKNAME* should be unique in the sheet.

One link of the pair of links:	{“name”: <i>LINKNAME</i> -0}
The other link of the pair of links:	{“name”: <i>LINKNAME</i> -1}

After drawing, click on “Annotate schematic symbols” to put unique references for all the optical components. Regarding the “Numbering” option, it is recommended to select “First free after sheet number X 100.” Then, click on “Perform electrical rules check” and confirm that there are no errors. If errors are found, then resolve them.

3.3. EXPORTING TOPOLOGY DESCRIPTION

Click on “Generate netlist” and then click on “Add Plugin...” Enter a name to the “Name:” field (e.g., TPDwithFBD). Enter the command given below to the “Netlist command:” field. The **PATH** should be modified according to the user’s system environment. **AdditionalInfoXXX.xml** should be put as AdditionalInfoWDM96.xml, AdditionalInfoWDM32.xml, or AdditionalInfoFLEX386.xml if the library used to draw the topology is OptNetModel50GHz.v1.lib, OptNetModel100GHz.v1.lib, or OptNetModel12.5GHz.v1.lib, respectively.

Netlist command:

```
python “PATH\src\xml2topology2.py” -a “PATH\src\AdditionalInfoXXX.xml” -l “%I” “%O”
```

Click on “OK.” Select the newly generated tub that the user named (e.g., TPDwithFBD) and then click on “Generate netlist.” Set the desired save directory and file name. Two .xml files are generated: one is the file that the user named, and the other is the file with a suffix ‘_tpl’; the former file describes the schematic circuit diagram content, and the latter describes the optical network topology description including the channel table information.

An error might occur while performing the above operations as an old version of Python bundled with KiCAD software might be called. In that case, the error might be rectified by copying python.exe, python.exe, python3.dll, python36.dll, vcruntime140.dll of python3.6 into the bin directory of the KiCAD software.

4. LIBRARY

4.1. LIBRARY CATALOG

The KiCAD libraries included in TDG are listed in Tables 1, 2, and 3.

Table 1: The optical components included in OptNetModel50GHz.v1.lib

WSS / FXC / TPA	AWG / Divider / Coupler	EDFA / ATT	TERMINAL
WSS1X9_50GHz	DEMUX_50GHz	EDFA8array_50GHz	TPND_50GHz
WSS9X1_50GHz	MUX_50GHz	ATT5DB_50GHz	
FXC32_50GHz	CPL9X1_50GHz		
MCS8X8_2array_50GHz	DIV1X9_50GHz		

Table 2: The optical components included in OptNetModel100GHz.v1.lib

WSS / FXC / TPA	AWG / Divider / Coupler	EDFA / ATT	TERMINAL
WSS1X9_100GHz	DEMUX_100GHz	EDFA8array_100GHz	TPND_100GHz
WSS9X1_100GHz	MUX_100GHz	ATT5DB_100GHz	
FXC32_100GHz	CPL9X1_100GHz		
MCS8X8_2array_100GHz	DIV1X9_100GHz		

Table 3: The optical components included in OptNetModel12.5GHz.v1.lib

WSS / FXC / TPA	AWG / Divider / Coupler	EDFA / ATT	TERMINAL
WSS1X9_F	CPL9X1_F	EDFA8array_F	TPND_F
WSS9X1_F	DIV1X9_F	ATT5DB_F	
FXC32_F			
MCS8X8_2array_F			

4.2. FIELDS

The component fields embedded in the optical components are shown in Table 4.

Table 4: Common field information included in optical components

Field Name	Value Examples	Description
Reference	N, P	Instance reference number prefix
Value	FXC32_F	Device name in the library
Footprint		Not used. (These cannot be deleted due to KiCAD's specification.)
Datasheet		
GLPK	$\text{set AvailableConnection} := \{i \text{ in InputPort}, j \text{ in Channels}, k \text{ in OutputPort}, l \text{ in Channels} : j = l\}; \text{s.t. input}\{j \text{ in Channels}, k \text{ in OutputPort}\} : \sum\{i \text{ in InputPort}\} c[i, j, k, j] \leq 1; \text{s.t. output}\{i \text{ in InputPort}, j \text{ in Channels}\} : \sum\{k \text{ in OutputPort}\} c[i, j, k, j] \leq 1; \text{s.t. wavelength}\{i \text{ in InputPort}, k \text{ in OutputPort}, j \text{ in Channels} : j+1 \text{ in Channels}\} : c[i, j, k, j] = c[i, j+1, k, j+1];$	These describe the switching functionalities of the component with Integer Linear Programming (ILP) method, written in GNU MathProg Modeling Language format.
GLPKtype	switching	Used for future extensibility for leveling functionality. Currently, only switching.
GLPKchannelTableId	WDM32	Indicate the channel table ID the component supports.
pinAttribute	<code>{"pinAttribute":[{"pin":"*","supportSignal":"ANY","supportChannel":"FLEX386"}]}</code>	Describes the pin support signal and channel
Model	FXC32_F	For intermediate controller ⁵ .
Type	WSS, AWG	
Controller	192.168.60.1	
Socket	55000	
LocalConfig		

⁵ CPPC Technical White Paper, “Cyber Photonic Platform: Automating the Physical Layer for Total Network Automation.”

5. CHANNEL TABLES

The channel tables defined in AdditionalInfoWDM32.xml, AdditionalInfoWDM96.xml, and AdditionalInfoFLEX386.xml, respectively, are shown in Table 5-7.

Table 5: The 100GHz grid channel table defined in AdditionalInfoWDM32.xml

Channel Number	Center Frequency (THz)	Channel Number	Center Frequency (THz)
1	195.5	17	193.9
2	195.4	18	193.8
3	195.3	19	193.7
4	195.2	20	193.6
5	195.1	21	193.5
6	195.0	22	193.4
7	194.9	23	193.3
8	194.8	24	193.2
9	194.7	25	193.1
10	194.6	26	193.0
11	194.5	27	192.9
12	194.4	28	192.8
13	194.3	29	192.7
14	194.2	30	192.6
15	194.1	31	192.5
16	194.0	32	192.4

Table 6: The 50GHz grid channel table defined in AdditionalInfoWDM96.xml

Channel Number	Center Frequency (THz)	Channel Number	Center Frequency (THz)
1	191.35	49	193.75
2	191.4	50	193.8
3	191.45	51	193.85
4	191.5	52	193.9
5	191.55	53	193.95
6	191.6	54	194
7	191.65	55	194.05
8	191.7	56	194.1
9	191.75	57	194.15
10	191.8	58	194.2
11	191.85	59	194.25
12	191.9	60	194.3
13	191.95	61	194.35
14	192	62	194.4
15	192.05	63	194.45
16	192.1	64	194.5
17	192.15	65	194.55

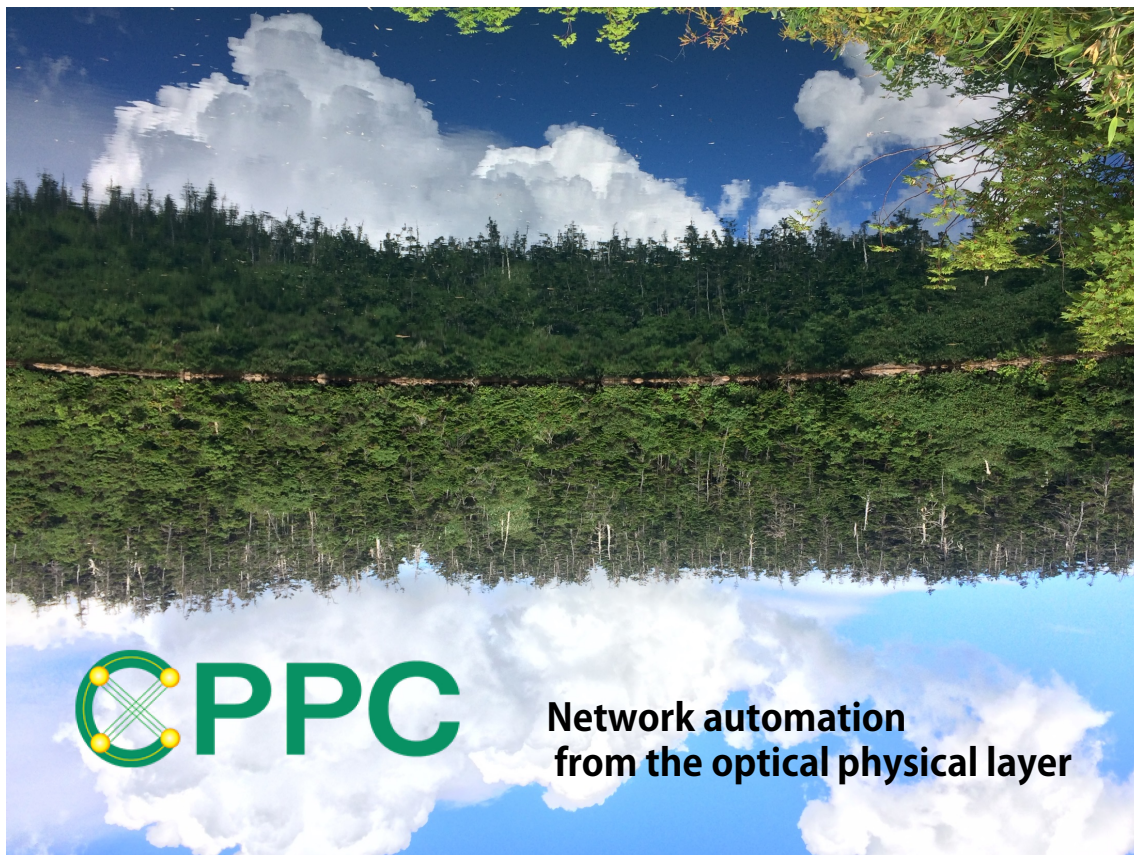
18	192.2	66	194.6
19	192.25	67	194.65
20	192.3	68	194.7
21	192.35	69	194.75
22	192.4	70	194.8
23	192.45	71	194.85
24	192.5	72	194.9
25	192.55	73	194.95
26	192.6	74	195
27	192.65	75	195.05
28	192.7	76	195.1
29	192.75	77	195.15
30	192.8	78	195.2
31	192.85	79	195.25
32	192.9	80	195.3
33	192.95	81	195.35
34	193	82	195.4
35	193.05	83	195.45
36	193.1	84	195.5
37	193.15	85	195.55
38	193.2	86	195.6
39	193.25	87	195.65
40	193.3	88	195.7
41	193.35	89	195.75
42	193.4	90	195.8
43	193.45	91	195.85
44	193.5	92	195.9
45	193.55	93	195.95
46	193.6	94	196
47	193.65	95	196.05
48	193.7	96	196.1

Table 7: The flexible grid channel table defined in AdditionalInfoFREX386.xml

Ch. #	Cntr. Freq	Ch. #	Cntr. Freq	Ch. #	Cntr. Freq	Ch. #	Cntr. Freq
1	191.33125	98	192.5438	195	193.7563	292	194.9688
2	191.34375	99	192.5563	196	193.7688	293	194.9813
3	191.35625	100	192.5688	197	193.7813	294	194.9938
4	191.36875	101	192.5813	198	193.7938	295	195.0063
5	191.38125	102	192.5938	199	193.8063	296	195.0188
6	191.39375	103	192.6063	200	193.8188	297	195.0313
7	191.40625	104	192.6188	201	193.8313	298	195.0438
8	191.41875	105	192.6313	202	193.8438	299	195.0563
9	191.43125	106	192.6438	203	193.8563	300	195.0688
10	191.44375	107	192.6563	204	193.8688	301	195.0813
11	191.45625	108	192.6688	205	193.8813	302	195.0938

12	191.46875	109	192.6813	206	193.8938	303	195.1063
13	191.48125	110	192.6938	207	193.9063	304	195.1188
14	191.49375	111	192.7063	208	193.9188	305	195.1313
15	191.50625	112	192.7188	209	193.9313	306	195.1438
16	191.51875	113	192.7313	210	193.9438	307	195.1563
17	191.53125	114	192.7438	211	193.9563	308	195.1688
18	191.54375	115	192.7563	212	193.9688	309	195.1813
19	191.55625	116	192.7688	213	193.9813	310	195.1938
20	191.56875	117	192.7813	214	193.9938	311	195.2063
21	191.58125	118	192.7938	215	194.0063	312	195.2188
22	191.59375	119	192.8063	216	194.0188	313	195.2313
23	191.60625	120	192.8188	217	194.0313	314	195.2438
24	191.61875	121	192.8313	218	194.0438	315	195.2563
25	191.63125	122	192.8438	219	194.0563	316	195.2688
26	191.64375	123	192.8563	220	194.0688	317	195.2813
27	191.65625	124	192.8688	221	194.0813	318	195.2938
28	191.66875	125	192.8813	222	194.0938	319	195.3063
29	191.68125	126	192.8938	223	194.1063	320	195.3188
30	191.69375	127	192.9063	224	194.1188	321	195.3313
31	191.70625	128	192.9188	225	194.1313	322	195.3438
32	191.71875	129	192.9313	226	194.1438	323	195.3563
33	191.73125	130	192.9438	227	194.1563	324	195.3688
34	191.74375	131	192.9563	228	194.1688	325	195.3813
35	191.75625	132	192.9688	229	194.1813	326	195.3938
36	191.76875	133	192.9813	230	194.1938	327	195.4063
37	191.78125	134	192.9938	231	194.2063	328	195.4188
38	191.79375	135	193.0063	232	194.2188	329	195.4313
39	191.80625	136	193.0188	233	194.2313	330	195.4438
40	191.81875	137	193.0313	234	194.2438	331	195.4563
41	191.83125	138	193.0438	235	194.2563	332	195.4688
42	191.84375	139	193.0563	236	194.2688	333	195.4813
43	191.85625	140	193.0688	237	194.2813	334	195.4938
44	191.86875	141	193.0813	238	194.2938	335	195.5063
45	191.88125	142	193.0938	239	194.3063	336	195.5188
46	191.89375	143	193.1063	240	194.3188	337	195.5313
47	191.90625	144	193.1188	241	194.3313	338	195.5438
48	191.91875	145	193.1313	242	194.3438	339	195.5563
49	191.93125	146	193.1438	243	194.3563	340	195.5688
50	191.94375	147	193.1563	244	194.3688	341	195.5813
51	191.95625	148	193.1688	245	194.3813	342	195.5938
52	191.96875	149	193.1813	246	194.3938	343	195.6063
53	191.98125	150	193.1938	247	194.4063	344	195.6188
54	191.99375	151	193.2063	248	194.4188	345	195.6313
55	192.00625	152	193.2188	249	194.4313	346	195.6438
56	192.01875	153	193.2313	250	194.4438	347	195.6563
57	192.03125	154	193.2438	251	194.4563	348	195.6688
58	192.04375	155	193.2563	252	194.4688	349	195.6813
59	192.05625	156	193.2688	253	194.4813	350	195.6938

60	192.06875	157	193.2813	254	194.4938	351	195.7063
61	192.08125	158	193.2938	255	194.5063	352	195.7188
62	192.09375	159	193.3063	256	194.5188	353	195.7313
63	192.10625	160	193.3188	257	194.5313	354	195.7438
64	192.11875	161	193.3313	258	194.5438	355	195.7563
65	192.13125	162	193.3438	259	194.5563	356	195.7688
66	192.14375	163	193.3563	260	194.5688	357	195.7813
67	192.15625	164	193.3688	261	194.5813	358	195.7938
68	192.16875	165	193.3813	262	194.5938	359	195.8063
69	192.18125	166	193.3938	263	194.6063	360	195.8188
70	192.19375	167	193.4063	264	194.6188	361	195.8313
71	192.20625	168	193.4188	265	194.6313	362	195.8438
72	192.21875	169	193.4313	266	194.6438	363	195.8563
73	192.23125	170	193.4438	267	194.6563	364	195.8688
74	192.24375	171	193.4563	268	194.6688	365	195.8813
75	192.25625	172	193.4688	269	194.6813	366	195.8938
76	192.26875	173	193.4813	270	194.6938	367	195.9063
77	192.28125	174	193.4938	271	194.7063	368	195.9188
78	192.29375	175	193.5063	272	194.7188	369	195.9313
79	192.30625	176	193.5188	273	194.7313	370	195.9438
80	192.31875	177	193.5313	274	194.7438	371	195.9563
81	192.33125	178	193.5438	275	194.7563	372	195.9688
82	192.34375	179	193.5563	276	194.7688	373	195.9813
83	192.35625	180	193.5688	277	194.7813	374	195.9938
84	192.36875	181	193.5813	278	194.7938	375	196.0063
85	192.38125	182	193.5938	279	194.8063	376	196.0188
86	192.39375	183	193.6063	280	194.8188	377	196.0313
87	192.40625	184	193.6188	281	194.8313	378	196.0438
88	192.41875	185	193.6313	282	194.8438	379	196.0563
89	192.43125	186	193.6438	283	194.8563	380	196.0688
90	192.44375	187	193.6563	284	194.8688	381	196.0813
91	192.45625	188	193.6688	285	194.8813	382	196.0938
92	192.46875	189	193.6813	286	194.8938	383	196.1063
93	192.48125	190	193.6938	287	194.9063	384	196.1188
94	192.49375	191	193.7063	288	194.9188	385	196.1313
95	192.50625	192	193.7188	289	194.9313	386	196.1438
96	192.51875	193	193.7313	290	194.9438		
97	192.53125	194	193.7438	291	194.9563		



ABOUT CPPC

Cyber Photonic Platform Consortium (CPPC) was established on 2018/4/1 as one of the AIST consortia. The purpose of CPPC is driving the automation of the optical network layer, which leads to the creation of new markets and pursuing sustainable development of the future information communication industry. For more information about CPPC, please visit <https://unit.aist.go.jp/esprit/cppc/>

AIST developed this manual and TDG.