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CWDM Uncooled Solution for 500m SMF: Cost Saving resulting from uncooled solution in CWDM at Product Maturity

Tek Ming Shen and Xueyan zheng

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Outline

- Cost difference with and without TEC using matured 40G transceivers in mass production as cost model.
- Re-visit Oplinks cost data of matured products in mass production of 2.5G and 10G CWDM and DWDM.
- Advantages of CWDM versus PSM4.
- Conclusion: These historical data serves as examples that significant cost saving can be realized using uncooled CWDM solutions, when these products reach maturity and in mass production.

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Objective of Analysis

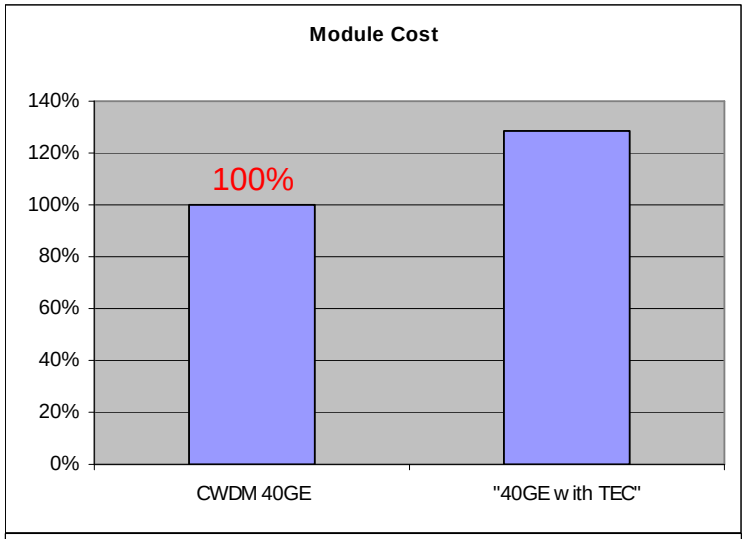
- **Use matured CWDM 40GE technology as an example to examine percentage cost reduction by eliminating TEC in uncooled CWDM technologies in mature stage.**
- Methodology: TEC is added to (uncooled) 40GE TOSA intentionally (as a virtual product) to compare the percentage cost increasing compared to CWDM 40G module cost. The answer provides a cost saving example for products using uncooled CWDM technologies in maturity.

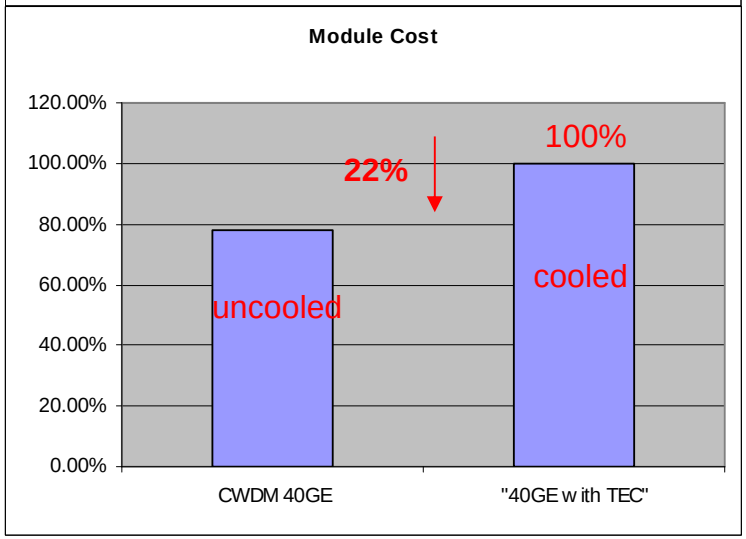
Analysis using 40GE as cost baseline

- **CWDM 40GE comprises of matured 10G electrical and optical parts in mass production. It is believed that 25G components used in 100GE will be at the similar situation in 3 years.**
  - **Parts such as CWDM laser, PD array, o-Mux, o_DeMux, isolator, ceramic carriers, driver array, TIA array, CDR, FPC, and receptacle shall be at mature state with low cost;**
  - **However, gold box and TEC cost are still high due to complexity**
- TEC is added to 40GE TOSA intentionally to compare the cost increase , it is normalized to CWDM 40G module cost. The cost includes:
  - BOM, yield and labor.
  - O-Mux and O-Demux with the lowest cost are considered
  - No overhead and R&D cost is included.

There is ~ 28% cost increase by adding TEC (or ~22% cost reduction going to uncooled)

	CWDM 40GE	CWDM 40GE **IF** with TEC
TOSA	42.73%	67.72%
ROSA	28.53%	28.53%
Electrical and mechanical parts	12.23%	12.23%
Labor	16.51%	20.18%
TOSA Yield	85.00%	80.00%
Relative cost to CWDM 40GE	100.00%	128.66%
Relative cost to CWDM 40GE **IF** with TEC	77.72%	100.00%





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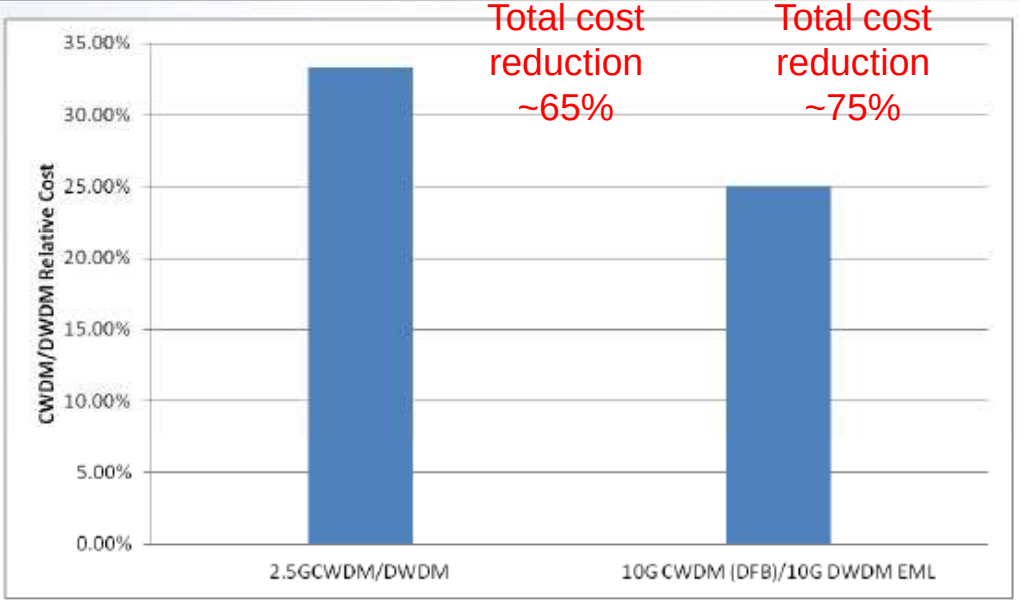
2.5 and 10G CWDM/DWDM cost comparison

FROM “yu_01_0313_optx” from Orlando meeting in March/2013.”

2.5G/10G CWDM/DWDM Cost Reference



- **2.5G CWDM/DWDM, 10G CWDM/DWDM products are used as a cost reference for mature product cost comparison, with each type running ~ several 100K/yr**
- **2.5G CWDM and 10G CWDM types are using directly modulated (DM) DFB lasers, while 2.5G and 10G DWDM are wit.. .EC cooled DFBs and EMLs**
- **Uncooled CWDM cost ~ 25% to 35% of cooled DWDM counter parts**

2.5 and 10G CWDM/DWDM cost comparison

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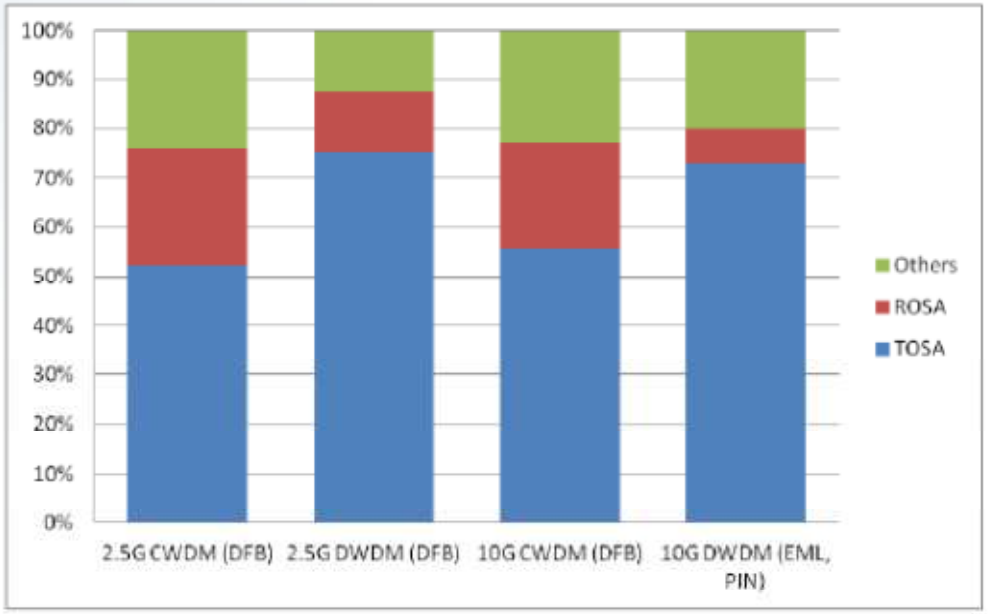
2.5G/10G TOSA/ROSA Cost vs. Other Cost Elements



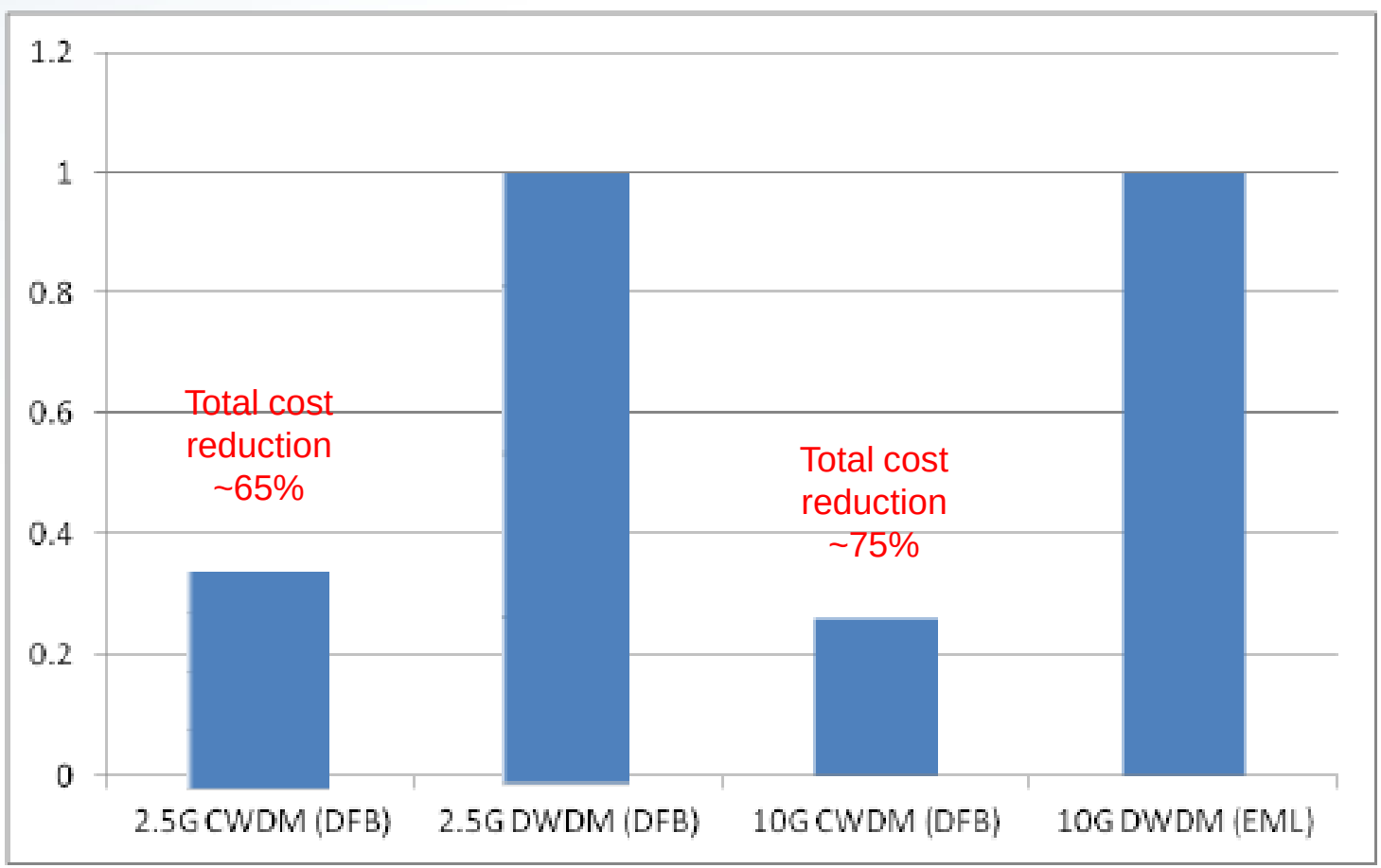
For relative mature products 2.5G/10G CWDM/DWDM Products

- **TOSA/ROSA cost ~ 75-85% of total BOM cost**
- **TOSA ~ 50% to 75% of total cost**

→ TOSA/ROSA cost reduction most critical in transceiver cost reduction

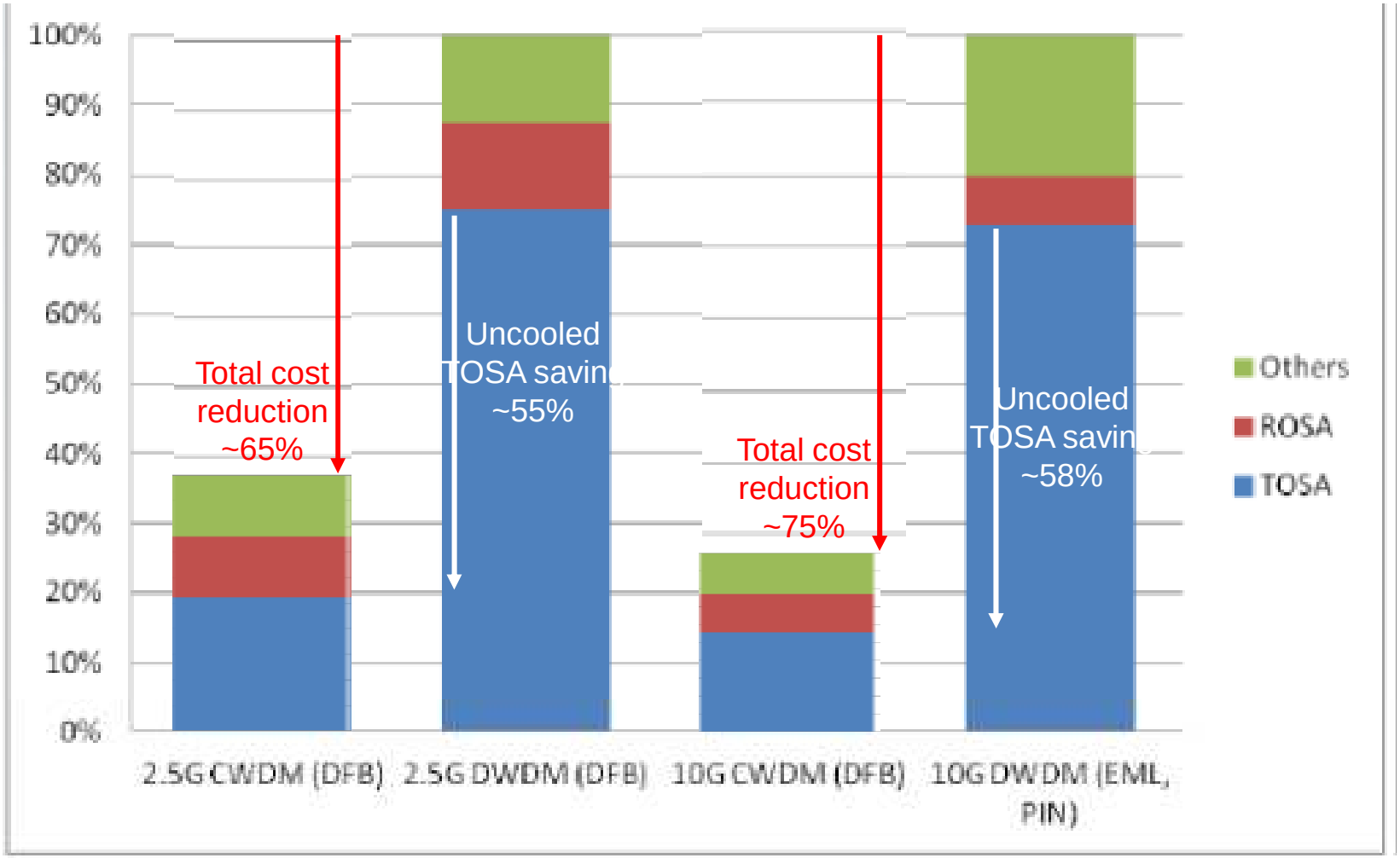
Re-visit: "yu_01_0313_optx" from Orlando meeting in March/2013.

Re-plot of slide #9



Re-visit: "yu_01_0313_optx" from Orlando meeting in March/2013.

Re-plot of slide #10



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Advantages of CWDM versus PSM4

CWDM solution is a better solution over PSM4:

- **No FEC means no concern of latency issue:**
  - **Latency is always a big concern in communication networks.**
- **No FEC means no concern of increasing power consumption and interoperability issues.**
- **Better cost structure at reach of "at least 500m" as well as, cover 2 km IP application.**
  - **It saves investment of components vendors, data center operator and IP carrier**
  - **Compatibility of CWDM with installed-fiber base in Data Center avoids new parallel fiber installation and benefits upgrading existing networks.**

Recommendation ITU-T G.693 Optical interfaces for intra-office systems

Table 4 – Optical interface parameters specified for applications with 2 km target distance and attenuation category R

Application code	Unit	VSR2000-2R1	VSR2000-3R1[d)]	VSR2000-3R1F[d, f)]
ITU-T G.691 application code		I-64.1		
ITU-T G.959.1 application code		P1I1-2D1		
Target distance	km	2	2	2
Bit rate/line coding of optical signals	–	NRZ 10G	NRZ 40G	NRZ OTU3 FEC enabled
Fibre type	–	G.652	G.652	G.652
Transmitter at reference point MPI-S				
Source type		SLM	SLM	SLM
Operating wavelength range	nm	1290-1330	1290-1330	1290-1330
Maximum mean output power	dBm	–1	+3	+3
Minimum mean output power	dBm	–6	0	0
Spectral characteristics:				
– maximum RMS width (σ)	nm	NA	NA	NA
– maximum –20 dB width	nm	1	ffs	ffs
– minimum SMSR	dB	30	35	35
Minimum EX	dB	6	8.2	8.2
Main optical path, MPI-S to MPI-R				
Maximum attenuation	dB	4	4	4
Minimum attenuation	dB	0	0	0
Maximum chromatic dispersion at upper wavelength limit[a)]	ps/nm	–6.6 to +5.3	–6.6 to +5.3	–6.6 to +5.3
Maximum chromatic dispersion at lower wavelength limit	ps/nm	–6.6 to +5.3	–6.6 to +5.3	–6.6 to +5.3
Maximum DGD	ps	30	7.5	7.5
Minimum ORL of cable plant at MPI-S, including any connectors	dB	14	24	24
Maximum discrete reflectance between MPI-S and MPI-R	dB	–27	–27	–27
Polarization-dependent loss	dB	ffs	ffs	ffs

Target distance km 2

Maximum attenuation dB 4

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Conclusions

- **Based on CWDM 40GE TOSA and transceiver cost, it save ~ 22% cost by removing TEC in TOSA.**

- **Based on Oplinks historical data, cost of 2.5 G and 10G CWDM transceivers (uncooled and using DML) compared with the cost of DWDM (cooled EML) 40GE TOSA transceivers, it saves ~ 55% to 58% cost by removing TEC in TOSA; and an overall cost saving of ~65% to 75% have been realized.**

- **This cost saving is consistent with our CWDM cost model presented in January and March IEEE meetings, that CWDM 100G SMF PMD can be ~62% lower cost than LR4.** "shen_01_0313_optx" from Orlando meeting in March/2013."

- **CWDM has the advantage over PSM4 having no latency issue (no FEC) and applicable to a broader market (intra-office).**

CWDM 802.3 100GBASE Link Budget Proposal

Transmitter and Receiver Characteristics Parameter	IEEE Std 802.3ba 100GBASE-LR4 10km	100GBASE-CWDM 500m	Unit
Signaling rate, each lane (range)	25.78125 ± 100 ppm	25.78125 ± 100 ppm	Gbd
Lane wavelength (range) (nm)	1294.53 to 1296.59 1299.02 to 1301.09 1303.54 to 1305.63 1308.09 to 1310.19	1264.5 to 1277.5 1284.5 to 1297.5 1304.5 to 1317.5 1324.5 to 1337.5	
Optical modulation amplitude (OMA), each lane (min)	-1.3	-2.0	dBm
Launch power in OMA minus TDP, each lane, (min)	-2.3	-3.0	dBm
Transmitter and dispersion penalty (TDP), each lane (max)	2.2	2.2	dB
Extinction ratio (min)	4	4	dB
Receiver sensitivity (OMA), each lane (max)	-8.6	-7.0	dBm

Link Power Budget Parameter	IEEE Std 802.3ba 100GBASE-LR4 10km	100GBASE-CWDM 500m	Unit
Power budget (for maximum TDP)	8.5	6.2	dB
Operating distance	10	0.5	km
Channel insertion loss	6.3	4.0[a]	dB
Allocation for penalties (for maximum TDP)	2.2	2.2[b]	dB
Additional insertion loss allowed	0	0	dB

[a] The channel insertion loss is calculated using maximum distance of 0.5km and fiber attenuation of 0.5dB/km at 1264.5nm plus an allocation for connection and splice loss of 3.75dB

[b] Assumes 1dB CD max penalty and 1.2dB other penalties.

Thank you

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