

Consideration on chromatic dispersion from telecom's realistic deployment of optical cables

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Background

- Chromatic dispersion parameters or zero dispersion wavelength (ZDW) ranges play an critical role in 802.3dj's 2km and 10km IMDD specifications.
- The relevant discussions using a statistic method have been proposed and ongoing as the spec's progress
 - cole_3dj_optx_01_230427, liu_3dj_01a_2307, and johnson_3dj_2307
 - castro_3dj_optx_01_240222, rodes_3dj_optx_01a_240222,
 - parsons_3dj_01b_2403, castro_3dj_01a_2403
- Here we present the realistic deployment scenario of telecom's optical cables, and give some suggestions on consideration of chromaitc dispersion parameters.

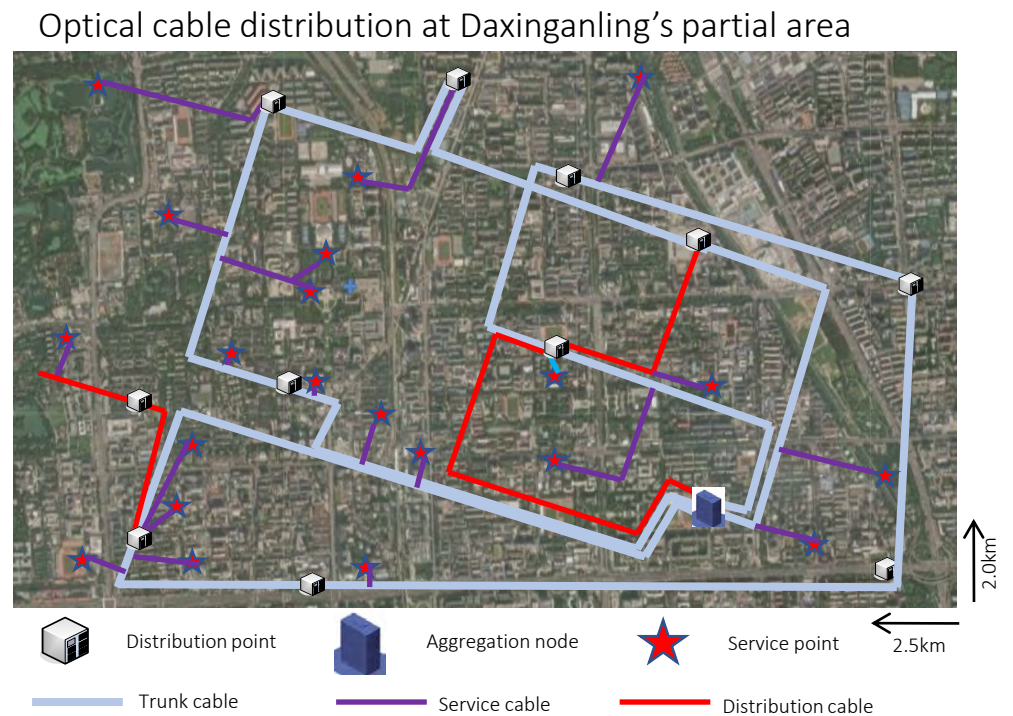
2km and 10km PMDs are widely used in CMCC's network

- As a service provider of telecom and cloud, CMCC uses a wide range of 2km and 10km PMD technologies in IP network and data center network
 - In the IP network, 2km optical PMDs of one pair SMF are used to interconnect between IP routers and optical transport devices in the same building; 10km optical PMDs are used in devices distributed different buildings.
 - In the data center network, especially for AI infrastructures, CMCC also adds 2km PMDs for spine and leaf switches on the same floor, and 10km PMDs for different floors or buildings.
- For this moment, 2km and 10km PMDs are both connected through single-mode optical fibers or cables

Deployment of telecom's optical cables (1)

The optical cables in China Mobile's current IP network are distributed with huge complexity and diversity, with significant differences among different areas or cities

- **Urban areas:** trunk cables are mainly set or buried along roads, underground pipelines, rivers, greenbelts, etc. At the crossing, optical distribution boxes are extensively used for the interconnection of fibers.
- **Non-urban area:** such as forests and mountainous, optical cables are overhead or exposed outside, which suffer from harsh environmental changes.
- The layout of optical cables in different cities is also different. Like Inner Mongolia province, its region is long and narrow, with relatively long and overhead trunk optical cable sections.



Current status of deployed optical cables

- Having been laid for a long period of time
 - The G.652 fiber cables procured by CMCC are required to have a service life of 15 to 20 years
 - Most latest cables of the access network were laid around 2017 for the construction of 5G networks
- Deteriorated performance over time
 - Multiple fusion-splice points may exist at one fiber segment due to the accidental cut off during municipal construction, effectively eating into link margin
 - The trunk cables buried underground are difficult to be replaced in the short term, where the aging process is inevitable.

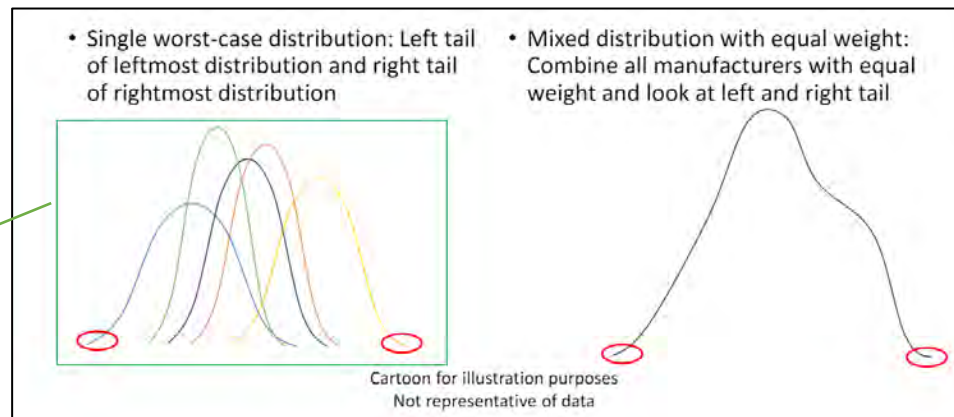
Impacts of link down on metro network

- For the super-cities like Beijing and Shanghai, its metro network generally covers very large density of population.
 - Average density of users in urban areas: 2000 to 4000 per square kilometer.
 - Number of users serviced by one service router: 3000 to 4000.
 - Coverage area of one service router: 0.75 to 2 km².
- Service routers are typically connected to metro core routers through a 2km or 10km link. On condition that the devices are located at different buildings, the links between them are usually necessary to utilize the already laid trunk optical cables.
- Any abrupt link down or signaling loss that occurred at the trunk link could affect tens of thousands of users.

Inputs to the current discussion on dispersion model (1)

- Overall procurement of optical cables from multiple vendors by comparison and selection
- Due to the procurement and construction by stage, the fiber and cable may stem from multiple vendors in CMCC's overall network. Individual link are typically built using optical cables from one vendor.
- Therefore, it is suggested to consider individual vendor distribution when performing statistical analysis.
 - Noting the quite diversified distribution of different vendors data
 - Preventing truncation of some vendor's due to the lump-sum consider of a much bigger data set
 - With both Earl's data and ITU's data anonymous, we can't risk of falling into those dismissed category

✓ Preferred methodology



[parsons_3dj_optx_01_240627](#)

Inputs to the current discussion on dispersion model (2)

- Conservative is always safe
 - Strictly limitation to any link or port down of devices in metro and backbone network: no more than two times in a quarter and four times in a year; Once occurring such accident, huge economic losses will be caused to network operators
 - Given the gradually aging optical cables, relaxing the constraints on dispersion parameters may lead to intolerant link faults.
- Suggested direction for defining the CD model of 802.3dj optical PMDs
 - Consider Distributions of individual vendor separately, based on the fiber cable deployment model
 - Consider a confidence level of at least 99.99%, noting the large impact of decreasing one decimal point raises risks for tens of thousands of our users.

Summary

- Distribution of telecom's optical cables is relatively complex, and required a long service life. Hence, the transmitter specifications being developed should take into account the performance of aging optical cables.
- Narrowing the dispersion parameter range in excess will lower the requirement of transmitter performance, which may lead to intolerant link faults.