

# Considerations on the Telecom Application for 400GbE

---

**IEEE 802.3 400GbE Study Group**  
**11 November 2013**  
**Dallas, Texas**

<b>Xiaolu Song,</b>	<b>Huawei</b>
<b>Xiangkun Man,</b>	<b>China Unicom</b>
<b>Shikui Shen,</b>	<b>China Unicom</b>



# Supporter

---

- Charlie Chen Titan Photonics
- Keith Conroy MultiPhy
- Dan Dove Dove Networking Solutions
- Qianggao Hu Accelink
- Ryan Latchman Mindspeed
- Yueqiang Qiao China Unicom
- Peter Stassar Huawei
- Song Shang Semtech
- Nathan Tracy TE Connectivity
- Tomoo Takahara Fujitsu
- Haijun Wang China Unicom
- Hongchun Xu Accelink
- Ryan Yu Oplink

# Introduction and Purpose

## Summary of Stated “Reach” Needs

Presentation	100m	500m	1km	2km	10km	40km
maki_400_01a_0513	x	x				
song_400_01_0513	x					
trowbridge_400_01_0513	x	x		x	x	x
hirai_400_01_0713					x	x
issenhuth_400_01_0713		x	x	Beyond 1km		
jewell_400_01a_0713	x (200m)	x				
nicholl_400_01_0713	←————→					
palkert_400_01_0713	x	x		x	x	x
song_400_01a_0713				x	x	
takahara_400_01_0713		x			x	x
vijn_400_01a_0713	←————→					
wenyu_400_01_0713		x		x	x	x
palkert_400_01_0913	←————→					
song_x_400_01_0913				x	x	x

Source: dambrosia\_app\_01\_1013.

## Straw poll of SMF Applications (Sep interim meeting)

I would support SMF “inside building” reach objectives.

	Chicago Rules	Single Choice
500m	30	18
1km	13	1
2km	34	27
Undecided	11	16

I would support SMF “outside building” reach objectives.

	Chicago Rules	Single Choice
2km	10	4
Between 2km and 10km	5	0
10km	39	34
Between 10km and 40km	8	1
40km	31	11
Undecided	10	12

- What do we really need and when?
- Perhaps more “end user data” are needed for these “application” and “objective” discussions?

# Introduction and Purpose (Cont'd)

---

## To analyze the application space

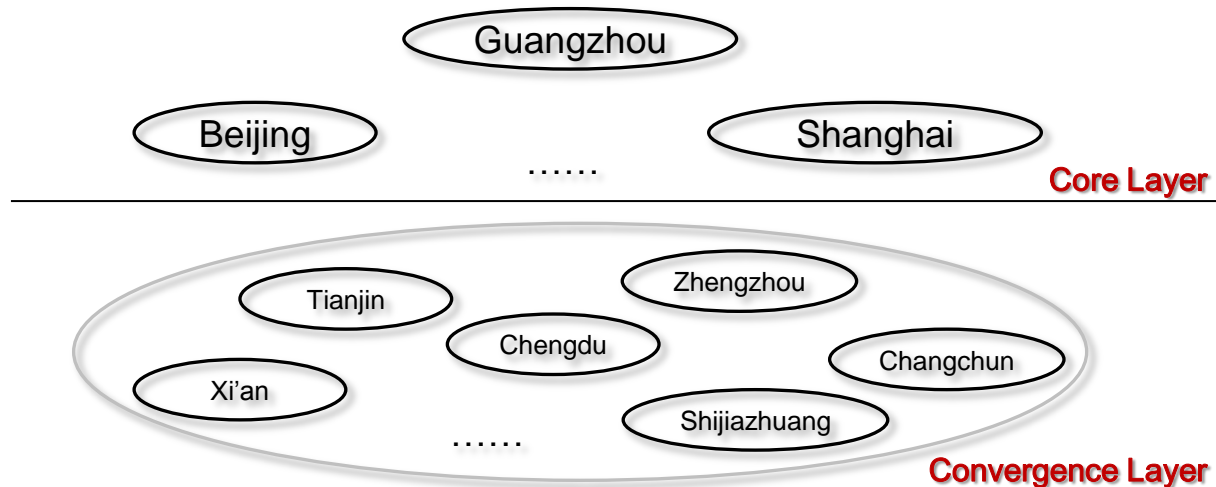
- 400GbE will address multiple applications over its lifecycle.
- As indicated in song\_400\_01a\_0713 and song\_x\_400\_01\_0913, the early market PMD types should include the telecom applications.
- In this presentation, we would like to show the “source data” and analysis for:
  - Core router to transport application
  - Core router to core router application

## Take link budget into considerations for different application

- Only emphasizing the link distance will cause the “infinite subdivision” of 400GbE market, link budget will be a good complement for clarifying and optimizing the “reach” targets.

# Background: CHINA169

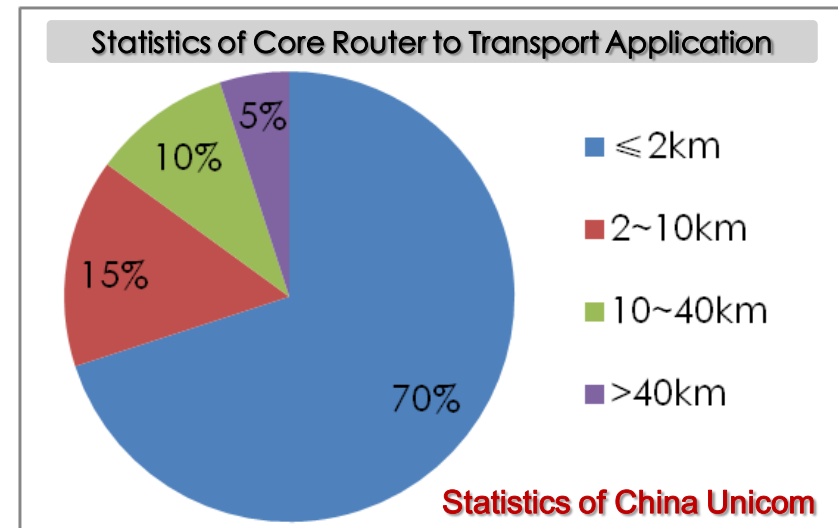
- CHINA169 is the strategy project "Broadband China CHINA169" of China Unicom.
- "Broadband China CHINA169" is based upon the former China Broadband Internet "China-net", which is based upon the network of ten northern provinces. After a massive renovation and expansion, a new structure that can provide greatly broadband services was formed, which can support flexible application services communication services for China Unicom's customers and provide customized services to large customers and corporate customers by private network.
- CHINA169 backbone network covered the whole country including the municipalities, provincial capitals and other developed cities, including nearly 70 cities, serves over 60,000,000 customers.



# Application Space of 400GbE (Core router to transport application)

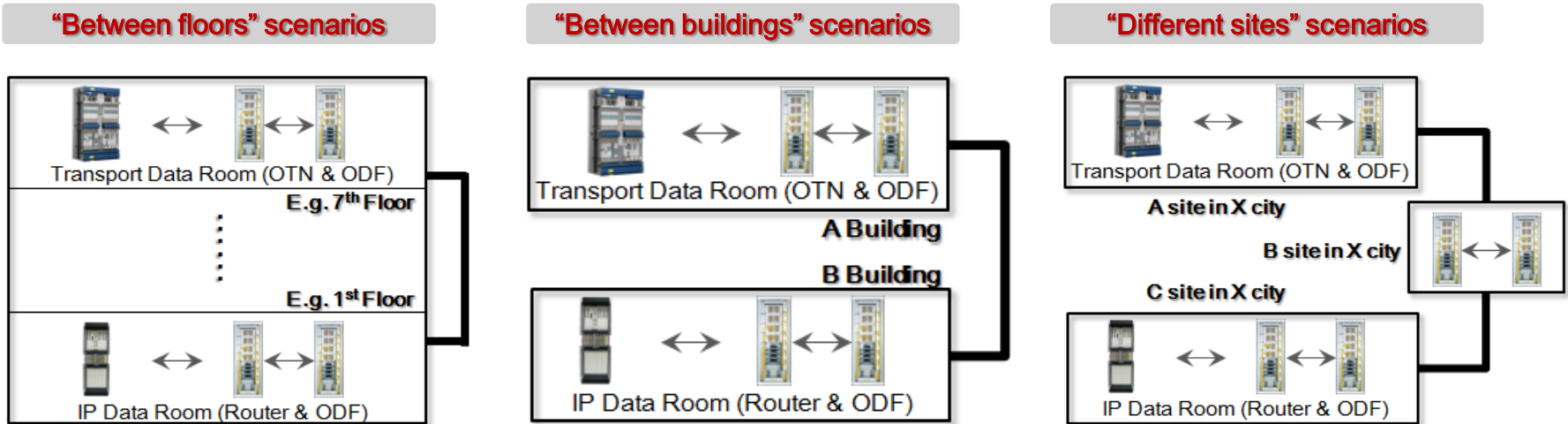
- As the infrastructure, the carrier sites are not expected to change with the upgrade of capacity. The modes of 10G / 40G interconnection (especially considering CHINA169 Network) and other carrier sites' information are of great value for reference.
- China Unicom investigated the distance of ~70 sites for the interconnect between CHINA169 backbone transport room and core router room.
  - 2km can cover about 70% of the connections;
  - 10km can cover about 85% of the connections;
  - 40km can cover at least 95% of the connections.

- Notes: Even the router rooms and the transport rooms are in the same location, 500m can cover only <50% applications in the core router to transport scenario, it is not enough for the most of telecom applications, because of considerations on the “between floors” and “between buildings” scenarios.



# Application Space of 400GbE (Core router to transport application)

- Based upon the data from China Unicom, 2km will cover 70% of the core router to transport application most of them are the insider building scenarios. 10km will cover most of the application, including the outside building scenarios.
- Examining the connections between core routers and transports we see that
  - Duplex fiber channels connect the Router and the OTN via their ODF inside the respective data room for the “between floors” scenarios.
  - Duplex fiber channels connect the Router and the OTN via their ODF inside the respective data room for the “between buildings” but inside the same “site” scenarios.
  - Duplex fiber channels connect the router and the OTN in different sites in a city (A and C) via their ODF and the site B.



# Application Space of 400GbE (Core router to transport application)

- According to ITU-T G.693 and the “between floors” / “between buildings” scenarios, optical interfaces for 2km application, recommended maximum attenuation is 4dB with the consideration of 2dB connector loss. The G.693 2km/4dB combination fits with results of discussions during BM for a 2km SMF PMD.
- For 10km, if the solution will continue to use the 1310nm-band, the similar fiber attenuation could be considered as 100GBASE-LR4 and more than four connectors should be considered.

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

Application code	Unit	VSR2000-2R1	VSR2000-3R1 <sup>(d)</sup>	VSR2000-3R1F <sup>(d, f)</sup>	VSR2000-3R2 <sup>(e)</sup> VSR2000-3R3 <sup>(d)</sup> VSR2000-3R5 <sup>(d)</sup>	VSR2000-3R2F <sup>(e, f)</sup> VSR2000-3R3F <sup>(d, f)</sup> VSR2000-3R5F <sup>(d, f)</sup>
ITU-T G.691 application code		I-64.1				
ITU-T G.959.1 application code		PII1-2D1				
<b>Target distance</b>	km	2	2	2	2	2
Bit rate/line coding of optical signals	–	NRZ 10G	NRZ 40G	NRZ OTU3 FEC enabled	NRZ 40G	NRZ OTU3 FEC enabled
Fibre type	–	G.652	G.652	G.652	G.652 G.653 G.655	G.652 G.653 G.655

Target distance:  
2km



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

Application code	Unit	VSR2000-2R1	VSR2000-3R1 <sup>(d)</sup>	VSR2000-3R1F <sup>(d, f)</sup>	VSR2000-3R2 <sup>(e)</sup> VSR2000-3R3 <sup>(d)</sup> VSR2000-3R5 <sup>(d)</sup>	VSR2000-3R2F <sup>(e, f)</sup> VSR2000-3R3F <sup>(d, f)</sup> VSR2000-3R5F <sup>(d, f)</sup>
<b>Main optical path, MPI-S to MPI-R</b>						
Maximum attenuation	dB	4	4	4	4	4
Minimum attenuation	dB	0	0	0	0	0

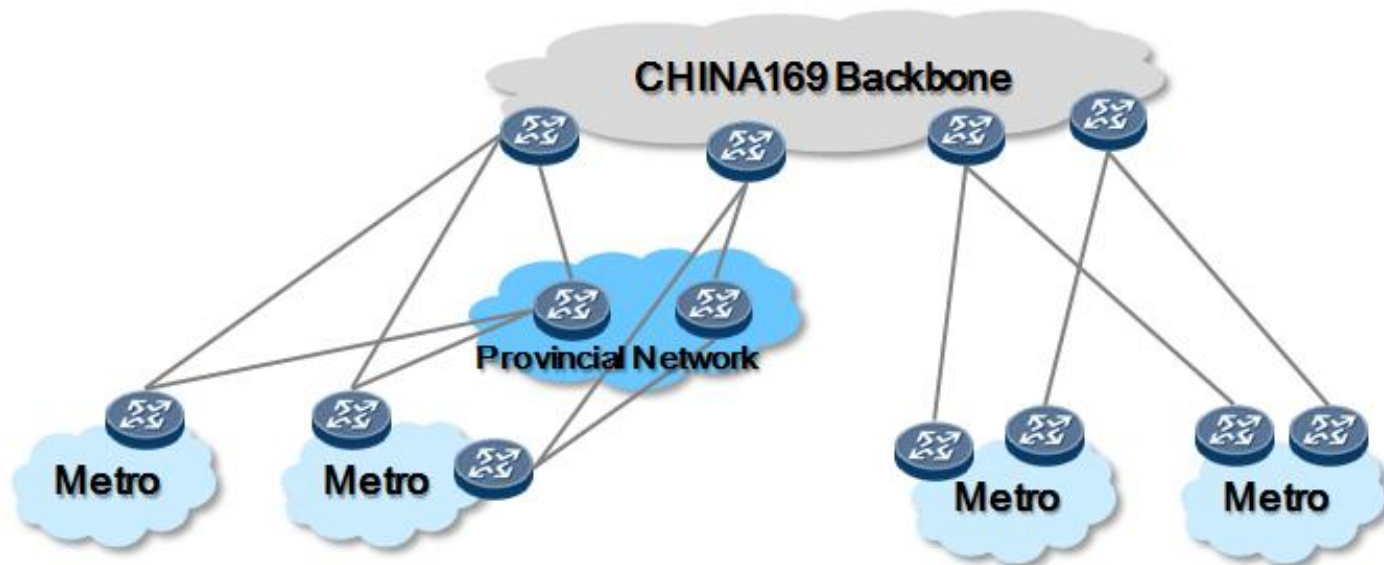
Maximum  
attenuation: 4dB





# Application Space of 400GbE (Core router to core router application)

- Based upon the current 10GbE situations, 10km can cover at least 60% of link requirements and 40km can cover 80%~90% of requirements.
- For 10km and 40km, if the solution will continue to use the 1310nm-band, a similar link loss as 100GBASE-LR4 and ER4 could be referred for 400GbE 10km and 40km applications, but the loss of connectors should be re-considered based upon the applications.



# Why Duplex SMF for Telecom Applications?

- Duplex SMF solutions are regarded necessary for the telecom applications.
- With the considerations of the fiber plant for 10GbE / 40GbE / 100GbE applications and the standards, duplex SMF was adopted as the objective for SMF scenarios.

Bit-rate	Application Code	Target Distance	NOTE
GE	1000BASE-LX	5km	SMF,1310nm
	10GBASE-SW/ 10GBASE-SR	10km	SMF,1310nm
10GE	10GBASE-EW/ 10GBASE-ER	30km/40km	SMF,1550nm
	10GBASE-LX4	10km	SMF,1310nm,WDM
40GE	40GBASE-LR4	10km	SMF,1310nm,CWDM
	40GBASE-ER4 (TBD)	30km/40km	SMF,1310nm,CWDM
	40GBASE-FR	2km	SMF,1550nm
100GE	100GBASE-LR4	10km	SMF,1310nm,WDM
	100GBASE-ER4	30km/40km	SMF,1310nm,WDM
	TBD(802.3bm)	500m	SMF,1310nm,TBD

**All Duplex SMF**

Source: "400GE SMF considerations", July 2013, Zhao (CATR).

- Considering the real applications, the MPO connector and ribbon fiber can incur a significant portion of the network cost, and it can lead to an unmanageable volume and size in the fiber infrastructure for telecom applications.
- Thus, in the telecom applications, when longer reach SMF interconnects are required, the duplex SMF is necessary.

Channel Type	Double-Link (DL)		
	100m	300m	500m
Fiber Type			
2f OS2 SMF	1.5	2	2.5
8f OS2 SMF	6	8	10
12f OS2 SMF	9	12	15

Source: 1. "Cabled Fiber Connectivity Relative Costs", May 2012, Abbott (Corning), Cole (Finisar), Coleman (Corning), Kolesar (CommScope), Swanson (Corning). 2. "100Gb/s SMF PMDs", May 2013, Cole (Finisar).

# Summary

---

- Early market applications for 400GbE will be similar to those to be seen in early market 10Gbps, 40Gbps and 100Gbps optical interconnects.
  - We recommend both 2km and 10km objectives in the early market PMD types for 400GbE.
  - We believe that there is an important application for a 40km SMF PMD, but we would suggest to add an objective for a 40km SMF PMD at this stage only if there is a technically and economically feasible solution.
  - Duplex fiber solutions are regarded necessary for all the telecom applications.
  
- Solicit more input from the end users to support the definition of the 400GbE objective for optical interconnect and bring the results into the coming meetings.
  - Contributions of “end user data” are welcome for core router to transport application and core router to core router application.

**Thank you**