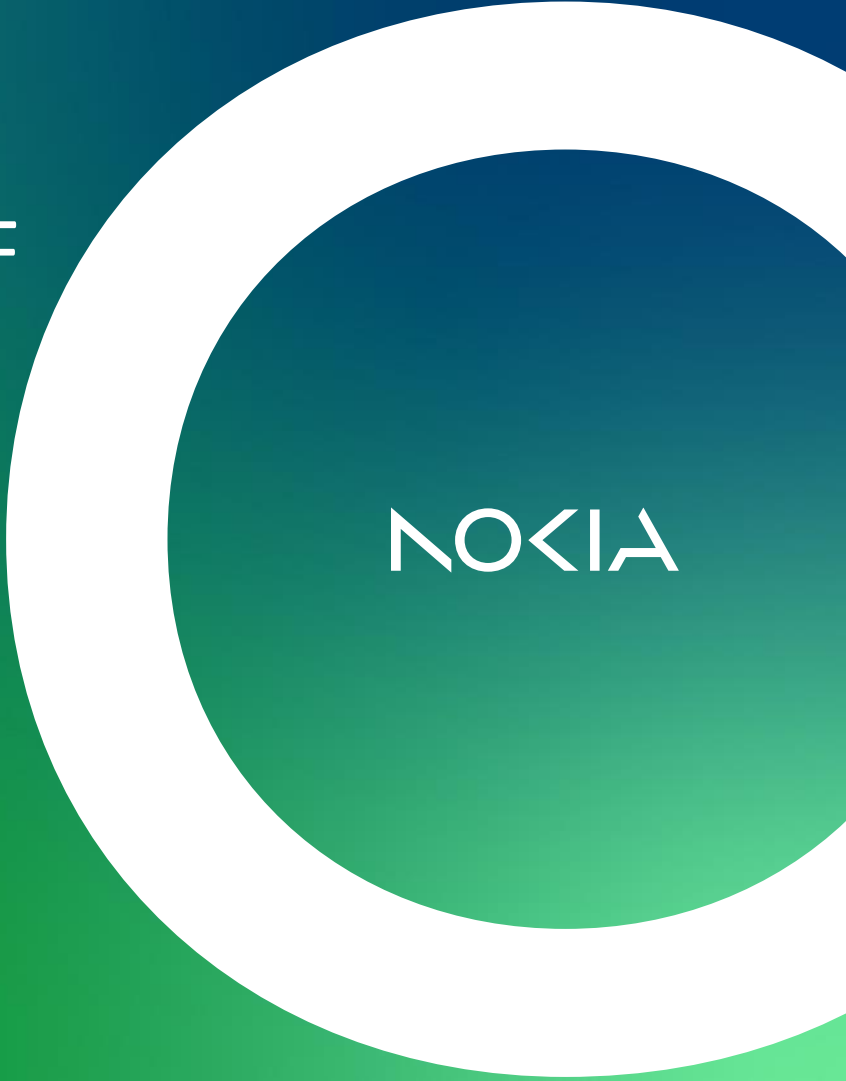


FlexE2.0で夢の1.6Tbps IF

The Nokia logo is centered within a large, stylized circular graphic on the right side of the slide. The graphic consists of two concentric circles: an outer white ring and an inner dark blue circle. The word "NOKIA" is written in white, uppercase letters across the middle of the dark blue circle.

NOKIA

Nokia Solutions&Networks

鹿志村康生

yasuo.kashimura@nokia.com

Flex Ethernet 2.0

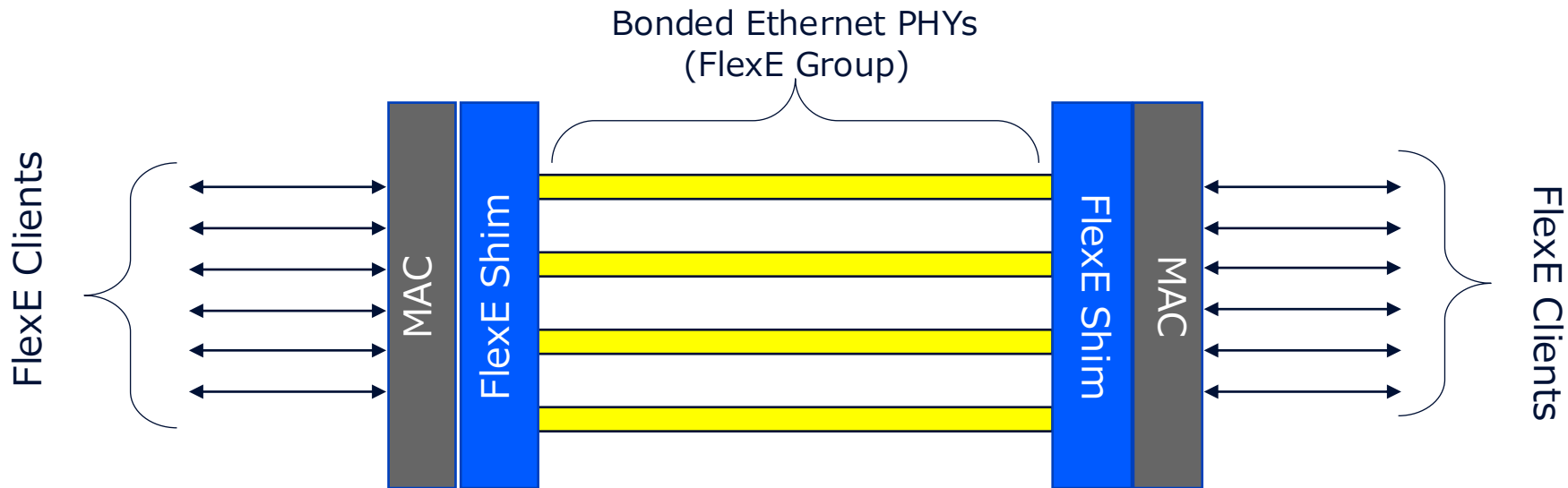
OIFで策定、2018年にFlexE 2.0版をpublish

複数のEthernetリンクをBonding

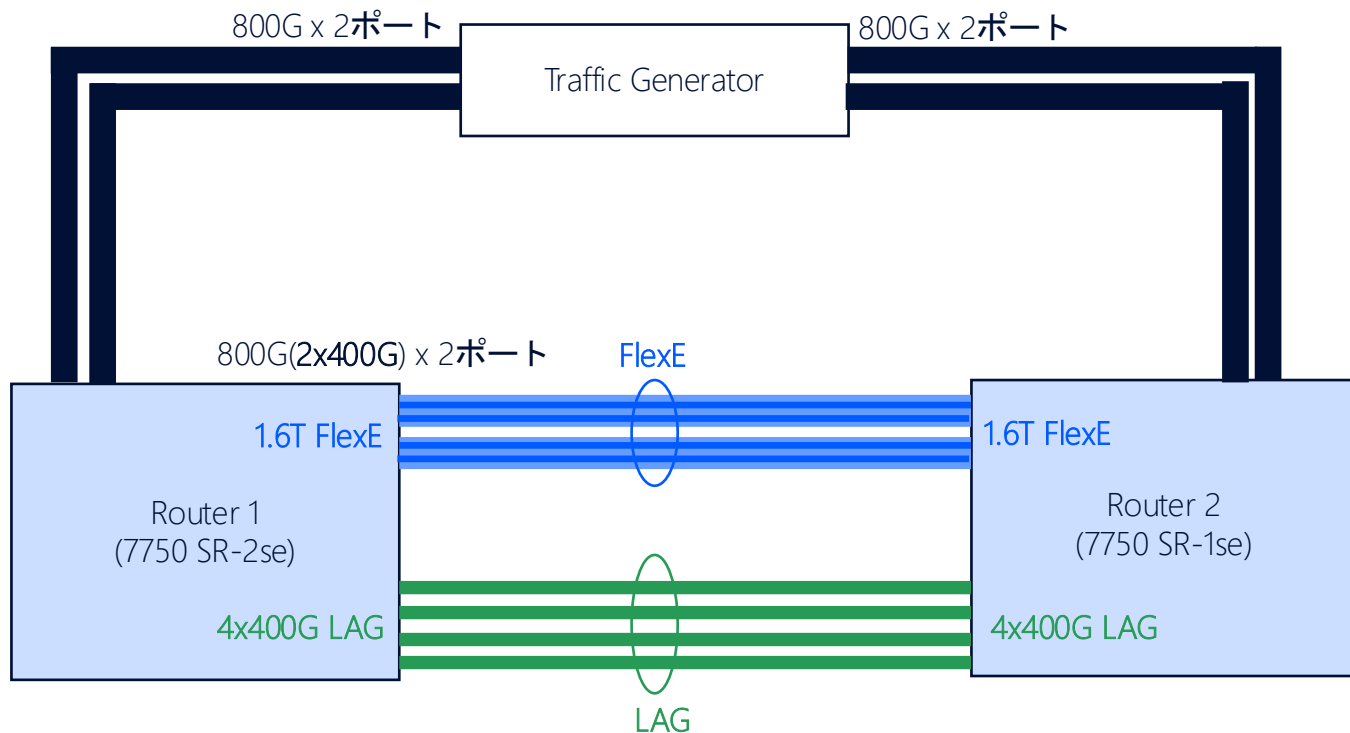
FlexE 2.0で200G/400Gをサポート

クライアント: 10G, 40G, $n \times 25G$

FlowレベルではなくBitstreamレベルでTrafficを分散、Elephant Flowも分散可能でより効率的なリンク帯域利用を可能とする。



テストトポロジー



テストトポロジー

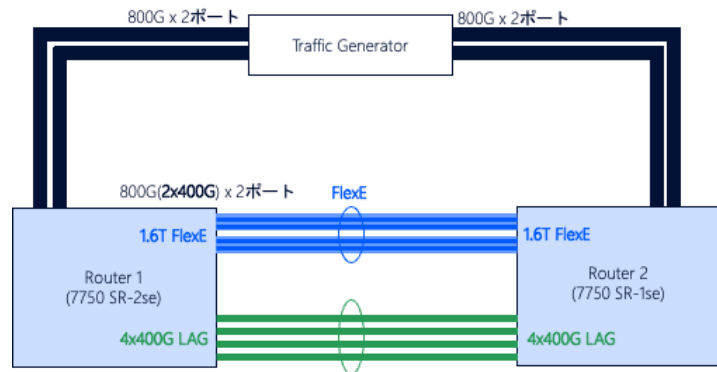
7750 SR-2se

Ports on Slot 1

Port Id	Admin State	Link State	Port State	Cfg MTU	Oper MTU	LAG/ Bndl	Port Mode	Port Encp	Port Type	C/QS/S/XFP/ MDIMDX
1/1/c1	Up	Link up	Up						conn	Reserved (10 ⁹)
1/1/c1/1	Up	Link up	Up						flxbr	
1/1/c1/2	Up	Link up	Up						flxbr	
1/1/c2	Up	Link up	Up						conn	Reserved (10 ⁹)
1/1/c2/1	Up	Link up	Up						flxbr	
1/1/c2/2	Up	Link up	Up						flxbr	
1/1/c3	Down	Down	Down						conn	400G-ZR-Amp
1/1/c4	Down	Down	Down						conn	
1/1/c5	Down	Down	Down						conn	
1/1/c6	Down	Down	Down						conn	
1/1/c7	Down	Down	Down						conn	
1/1/c8	Up	Link up	Up						conn	400G-ZR-Amp
1/1/c8/1	Up	Yes	Up	9212	9212	1	hybr	dotq	cdgige	400G-ZR-Amp
1/1/c9	Up	Link up	Up						conn	
1/1/c9/1	Up	Yes	Up	9212	9212	1	hybr	dotq	cdgige	400G-ZR-Amp
1/1/c10	Down	Down	Down						conn	
1/1/c11	Down	Down	Down						conn	
1/1/c12	Up	Link up	Up						conn	400G-ZR-Amp
1/1/c12/1	Up	Yes	Up	9212	9212	1	hybr	dotq	cdgige	
1/1/c13	Up	Link up	Up						conn	400G-ZR-Amp
1/1/c13/1	Up	Yes	Up	9212	9212	1	hybr	dotq	cdgige	

FlexE メンバー
ポート

LAG メンバー
ポート



テストトポロジ

```
7750 SR-2se

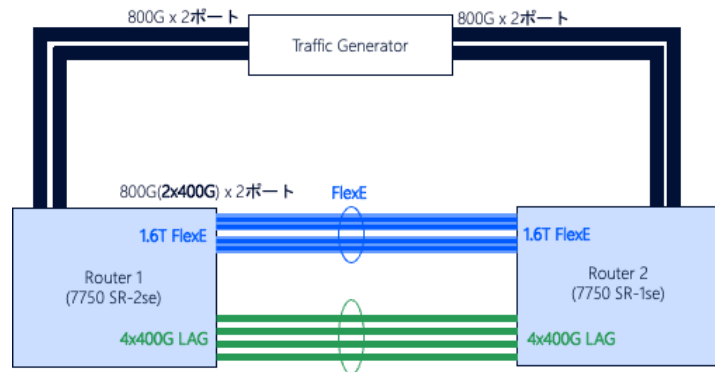
=====
MDA 1/1 Flex Group 11
=====
Description      : (Not Specified)
Admin State      : Up
Oper State       : Up
Group Number     : 0x00001
Hold Time Up     : 0 seconds
Hold Time Down   : 0 seconds
Number of members: 4
Client Configured: 1/1/f11/1
Max Bandwidth    : 1600G
Config Alarms    : overhead-frame-not-locked
                  deskew-failed
                  local-phy-fault
                  remote-phy-fault
                  bad-group-number
                  bad-phy-number
                  bad-phy-instance-number
                  flexe-map-mismatch
                  client-calendar-error
                  calendar-in-use-error

Alarm Status     : None
Reported Alarms  : None
=====

Members
=====
Port      : 1/1/c1/1
PHY Number: 1
Config Alarms: None

PHY Inst Config Alarms : None
Alarm Status          : None
Reported Alarms       : None
=====
Port      : 1/1/c1/2
PHY Number: 2
Config Alarms: None

PHY Inst Config Alarms : None
```



テストトポロジ

```
7750 SR-2se

=====
Ethernet Interface
=====
Description      : Flex-E Client
Interface         : 1/1/F11/1
FP Number         : 1
Link-level        : Ethernet
Admin State       : up
Oper State        : up
Config Duplex     : N/A
Physical Link     : Yes
Single Fiber Mode : No
Ifindex           : 1610895713
Last State Change : 04/25/2025 06:57:07
Hold Time Down Rmng: 0 cs
Last Cleared Time  : N/A
Phys State Chng Cnt: 1
RS-FEC Config Mode : None
RS-FEC Oper Mode  : None

Oper Speed       : 1600 Gbps
MAC Chip Number  : 1
Config Speed     : N/A
Oper Duplex      : full

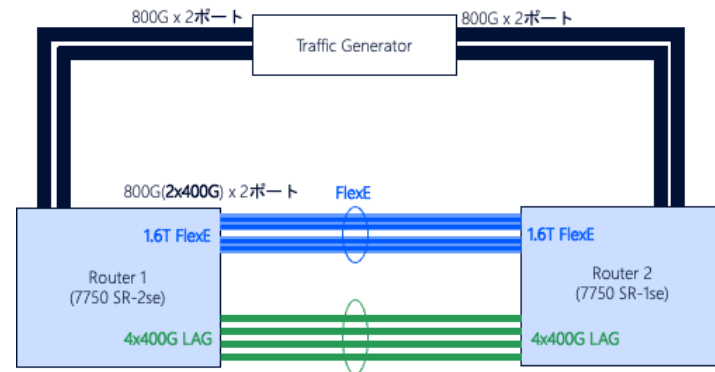
MTU              : 9212
Min Frame Length : 64 Bytes
Hold time up     : 0 seconds
Hold time down   : 0 seconds
Hold Time Up Rmng: 0 cs

Configured Mode  : hybrid
Dot1Q Ethertype  : 0x8100
PBB Ethertype    : 0x88e7
Ing. Pool % Rate : 100
Ing. Acc. Wt.    : 50
Ing. Net. Wt.    : 50
Net. Egr. Queue Pol: default
Egr. Sched. Pol  : n/a
HwAggShaper Sch Pol: n/a
Monitor Port Sched: Disabled
Monitor Agg Q Stats: Disabled
Monitor Oper Group: none
Monitor HwAggShap *: Disabled
Auto-negotiate   : N/A
Oper Phy-tx-clock : not-applicable
Accounting Policy : None
Acct Plcy Eth Phys: None
Egress Rate      : Default
Oper Egress Rate  : Unrestricted
Load-balance-algo : Default
Access Bandwidth  : Not-Applicable
Access Available BW: 0
Access Booked BW  : 0
Sflow             : Disabled
Discard Rx Pause  : Disabled
Tx Pause Frames   : Enabled

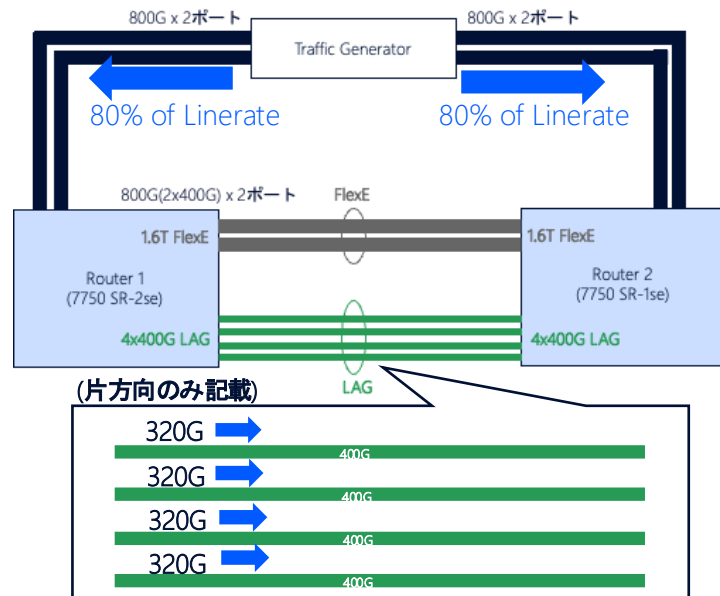
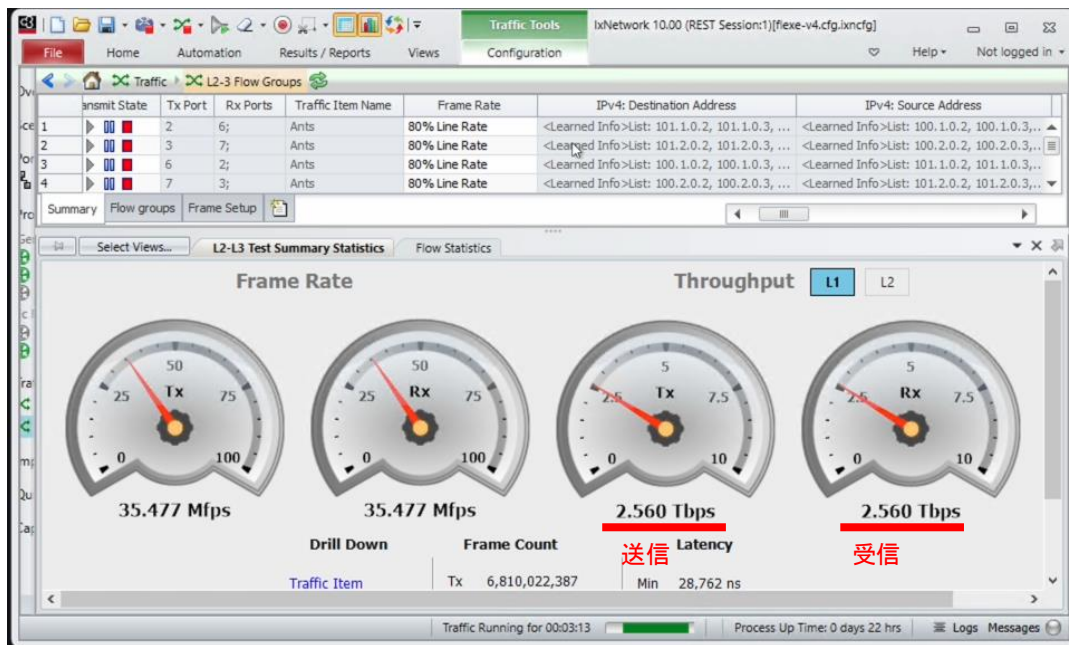
Encap Type       : 802.1q
QinQ Ethertype   : 0x8100

Egr. Pool % Rate : 100
Egr. Acc. Wt.    : 50
Egr. Net. Wt.    : 50

MDI/MDX          : N/A
collect-stats     : Disabled
collect Eth Phys  : Disabled
Ingress Rate      : Default
LACP Tunnel       : Disabled
Booking Factor    : 100
```

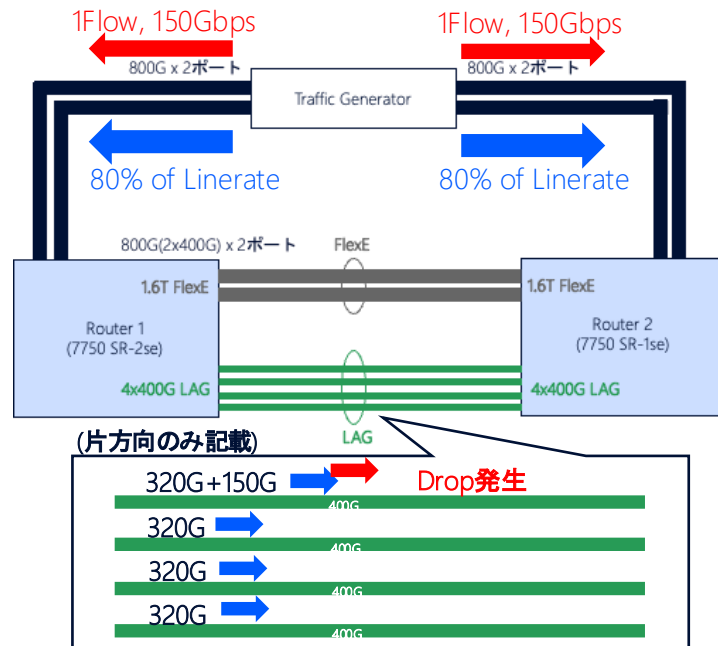
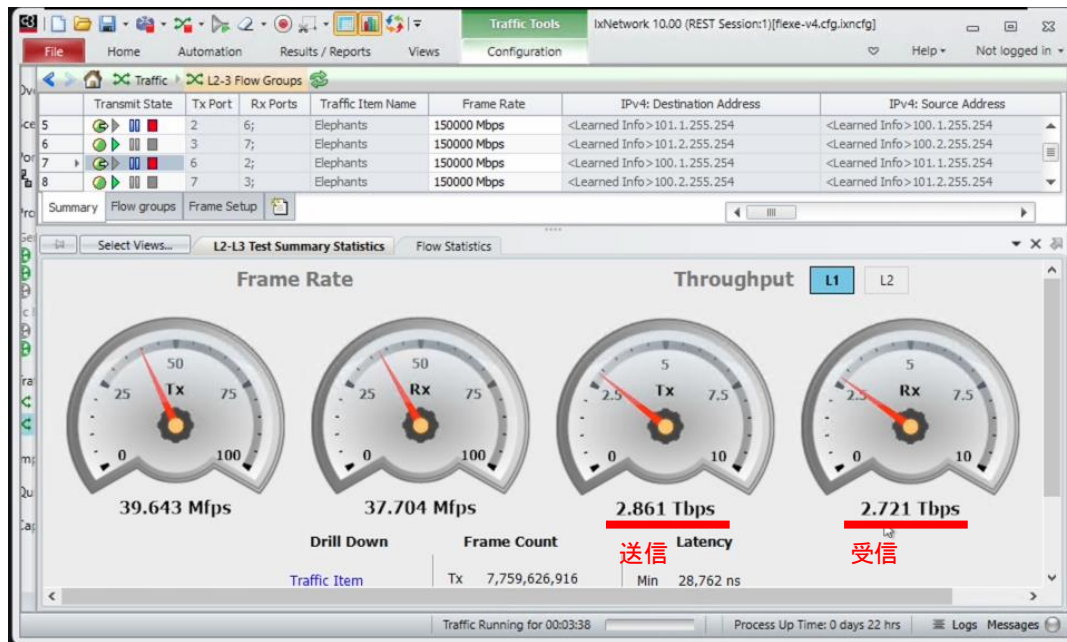


まずはLAG経由でTraffic流してみる



$800\text{Gbps} \times 2\text{port} \times 80\% \times 2(\text{双方向}) = 2.56\text{Tbps}$ <送信>
400G LAG 1portあたり 320Gbps(片方向)

Elephant Flow(150Gbps)を追加

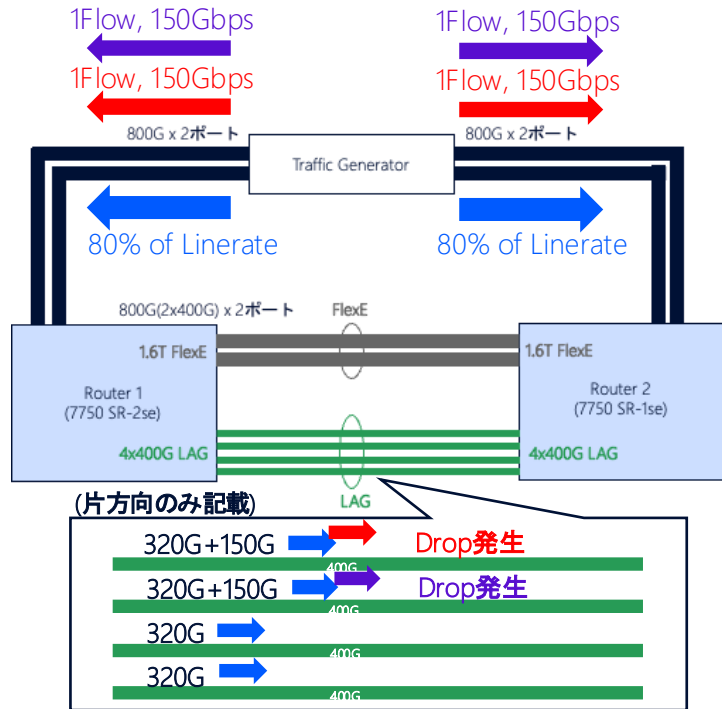
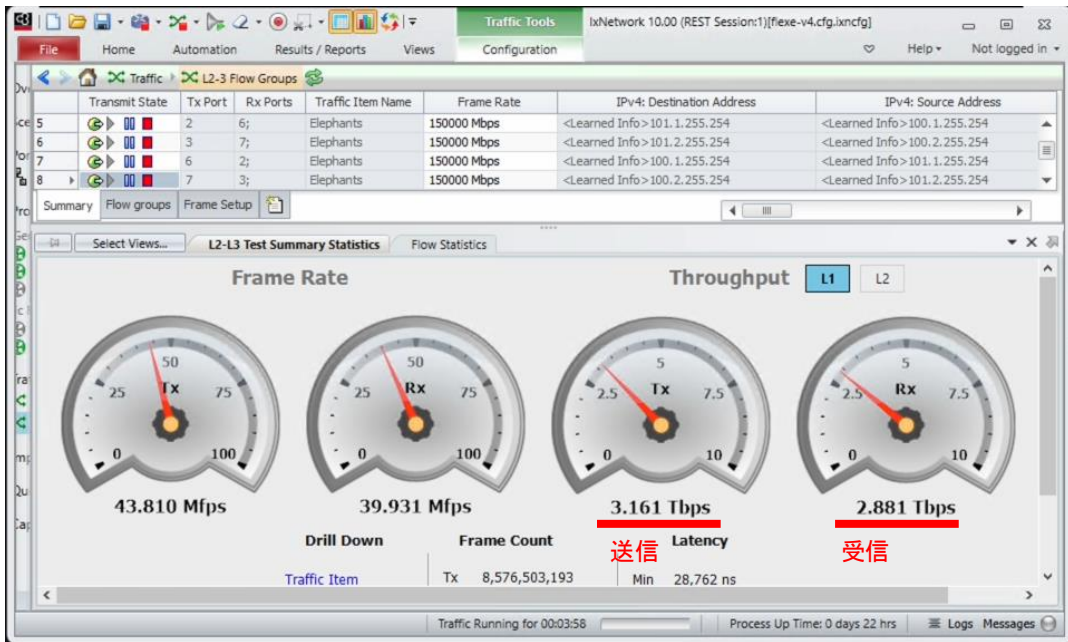


$$800\text{Gbps} \times 2\text{port} \times 80\% \times 2(\text{双方向}) + 150\text{Gbps} \times 2(\text{双方向}) = 2.86\text{Tbps} <\text{送信}>$$

400G LAG 1portあたり320Gbps(片方向)
+ 150Gbpsが1リンクに片寄りDrop発生

$$(320\text{Gbps} \times 3 + 400\text{Gbps}) \times 2 = 2.72\text{Tbps} <\text{受信}>$$

さらにもう1本 Elephant Flow(150Gbps)を追加

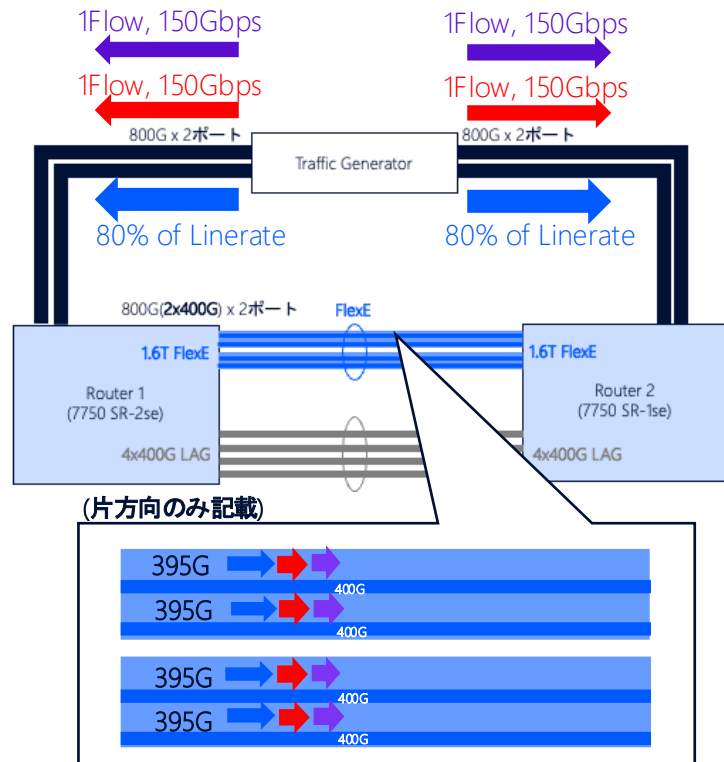
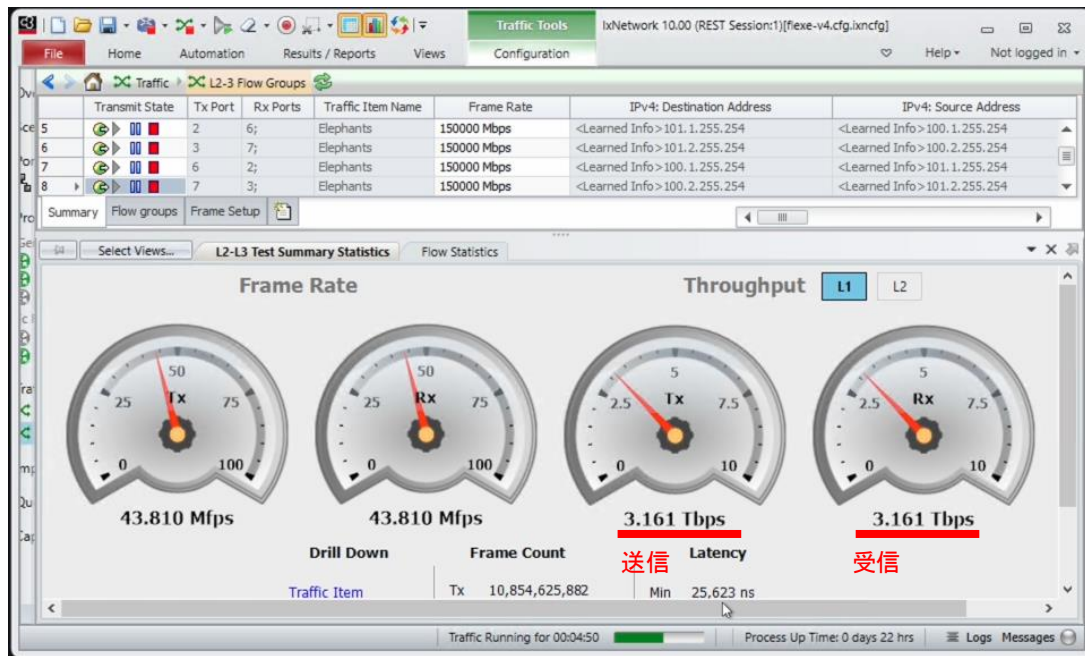


800Gbps x 2port x 80% x 2(双方向) = 2.56Tbps
 + 150Gbps x 2 x 2(双方向) = 3.16Tbps <送信>

400G LAG 1portあたり320Gbps(片方向)
 + 150Gbpsが1リンクに片寄りDrop発生
 + 150Gbpsが別のリンクに片寄りDrop発生

(320Gbps * 2 + 400Gbps * 2) * 2 = 2.88 Tbps <受信>

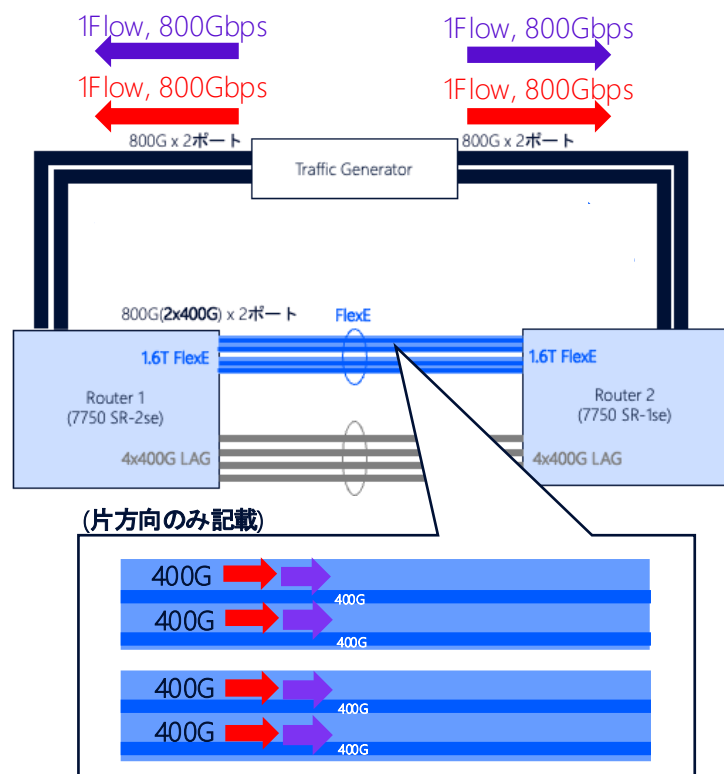
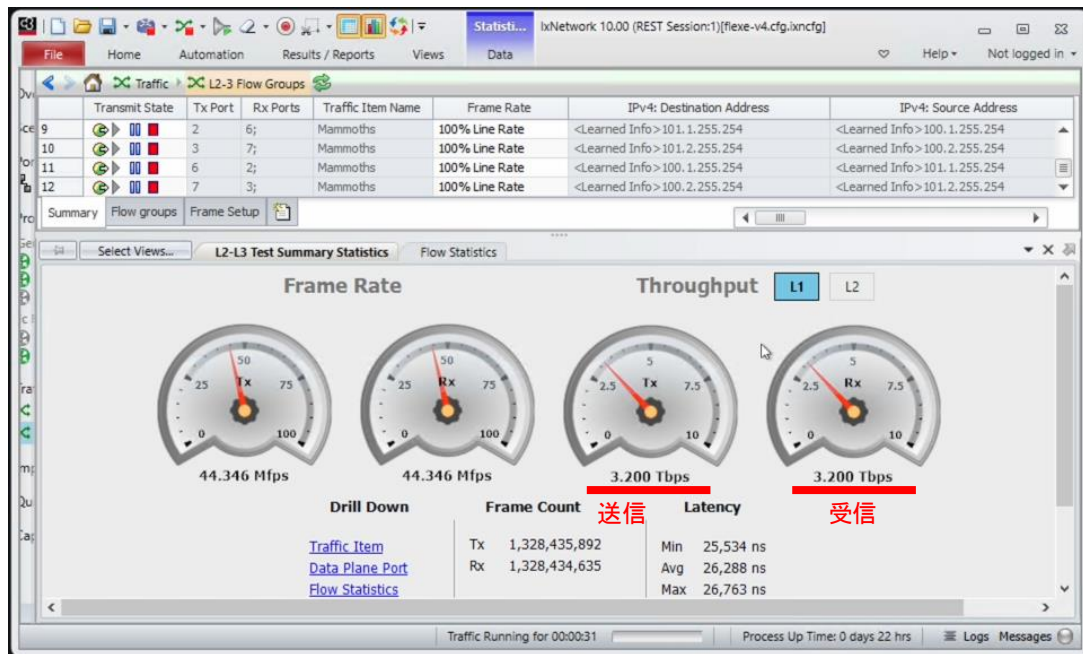
Routingを変更してFlexEリンクに 経路を切り替える



$800\text{Gbps} \times 2\text{port} \times 80\% \times 2(\text{双方向}) = 2.56\text{Tbps}$
 $+ 150\text{Gbps} \times 2 \times 2(\text{双方向}) = 3.16\text{Tbps}$ <送信>

受信 3.16 Tbps, Drop無し

巨大なフローでLinerate流してみる



800Gbps x 4 = 3.2 Tbps <送信>

受信 3.2 Tbps, Drop無し

まとめ

- FlexEで偏りの無いTraffic分散が可能に。Elephant Flowも分散可能となり、Drop無く転送可能
- FlexE2.0で400GE/800GポートでもFlexE使用可能に。
- ZR/ZR+の長距離向けPluggableも使用可能=>WAN回線への適用可

NOKIA