Facebook: The Drive Towards Flexible Optical Networking

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Facebook
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Facebook by the Numbers

>1.86 Billion Users
>1.2 Billion Daily Users
82% of users outside US
3+ Billion Photos daily
60 Billion Messages daily
100+ Million hours of video
Watched per day
Facebook Global Data Centers

- Prineville, OR (PRN)
- Altoona, IA (ATN)
- Clonee, Ireland (CLN)
- Ashburn, VA (ASH)
- Los Lunas NM (VLL)
- Forest City, NC (FRC)
- Santa Clara, CA (SNC)
- Luleå, Sweden (LLA)
- Odense, Denmark (ODN)
- Singapore (SGP1)

Legend:
- Owned & Constructed
- Under Construction
- Leased Sites
Facebook Global Optical Network

Links shown are schematic only and do not represent the extensiveness of the Facebook Global Network.
MAREA Submarine Cable

6,600 km
20 Tb/s per fiber 1
8 fps, 160 Tb/s Total Capacity

First Open Cable System
Provides diverse Trans-Atlantic routing
PLCN Submarine Cable

- 12,871 km - longest submarine DLS
- First C+L band Submarine System - 80 nm BW
  - Increasing BW in addition to fighting log term of Shannon
  - Now 24 Tb/s per fiber pair
- New Capacity-Distance Record
- We plan on installing Undersea WSS ROADMs!
Optical Technology Directions - driving to highest capacity per fiber while maintaining flexibility

- Expanded Bandwidth- L-band
  - In submarine links now

- Higher Order Modulation Formats- 64 QAM and above.. Flexible channel spacing/width- Superchannels
  - Hybrid Raman used extensively to keep high OSNR, new fiber builds

- Advanced Coherent Modulation Techniques
  - Flexible Coherent: format, baud rates, granular capacity, spacing
  - Nonlinear Compensation- next area to mine dBs
  - Probabilistic Constellation Shaping (PCS) – can drive very close to the Shannon limit
Trans-Atlantic Trial with Nokia Bell Labs

Probabilistic Constellation Shaped (PCS) 64 QAM
New spectral efficiency records set
Also 200G 8-QAM and 250G 16-QAM demonstration with commercial product

Facebook wants to promote challenging submarine field trials to advance optical technology!
#NETWORKS TODAY:
Closed system with multiple vendors
...with increasing transiting traffic

VENDOR1
(TL1, GUI)

VENDOR2
(TL1, GUI)

TRANSPONDER

NMS1

NMS2

2xLine Cards
2xNMSs
2xOptics
2xSupport
#NETWORKS TOMORROW:

Open System with many vendors

...with subsea DC-DC traffic

- Always Best Tech
- Automated provisioning
- Automated testing
- Alarms correlations
- 1 NMS for NOC
# NETWORKS TOMORROW:

Terrestrial-Subsea ROADM interop.

...with subsea DC-DC traffic

Terrestrial and Subsea ROADMs:
- Gridless, 6.25GHz pixel
- Open power control at WSS for pre-emphasis and Q-based equalization
- Move to CDC

VENDOR1

VENDOR2

SUBSEA
Facebook Optical Technology Goals

• **Capacity – Spectral Efficiency- want to drive to highest values**
  - Higher capacity needs to also translate to low cost and power per bit, high density

• **Flexibility**
  - Flex modulation, Flexgrid, Flex clients (FlexEthernet), near continuous tuning of all parameters

• **ROADM Requirements for Facebook**
  - Submarine and Terrestrial, Open, Gridless, 6.25 GHz granularity, move towards CDC