Technical feasibility of DMT for 400GbE SMF transmission

IEEE802.3 Indian Wells Interim, January, 2014

Tomoo Takahara, Toshiki Tanaka, Masato Nishihara,
Jens C. Rasmussen

Fujitsu Limited / Fujitsu Laboratories Ltd.

Supporters

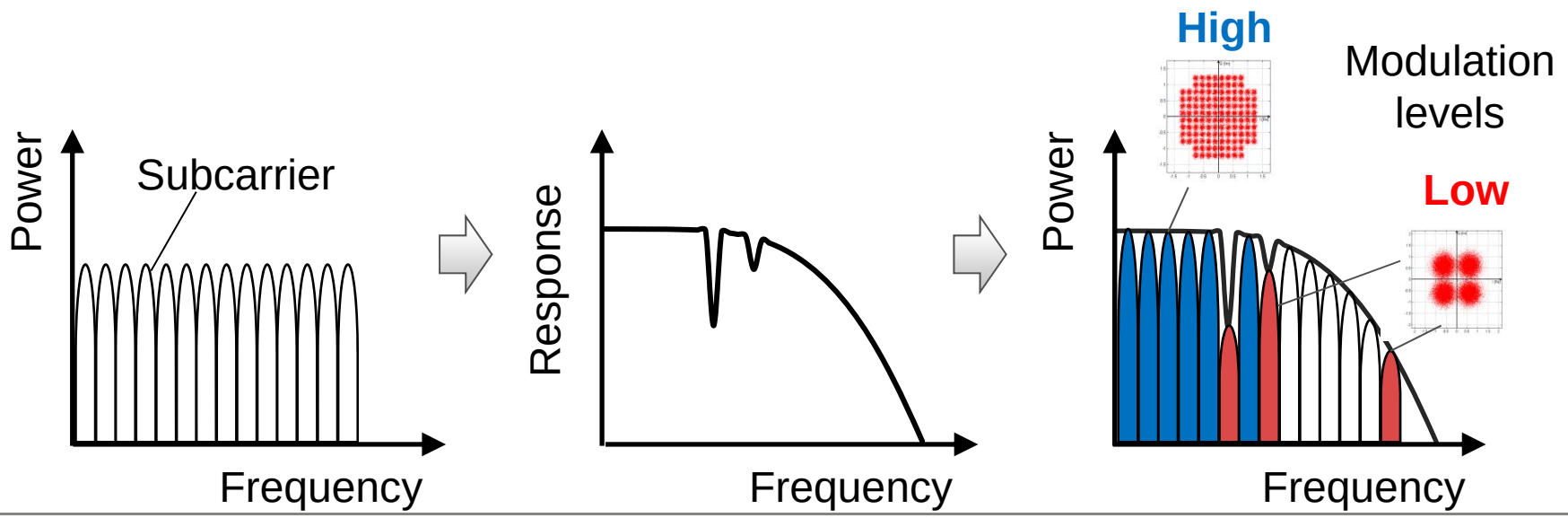
Hideki Isono	Fujitsu Optical Components
Ian Dedic	Fujitsu Semiconductor
Patricia Bower	Fujitsu Semiconductor
Tomas McDermott	Fujitsu Network Communications
Bouda Martin	Fujitsu Laboratories of America
Yasuaki Kawatsu	Hitachi Metals

Outline

- Discrete Multi-Tone (DMT) technology
- Previous experimental data on optical DMT transmission
- Experimental results of optical 400G DMT transmission

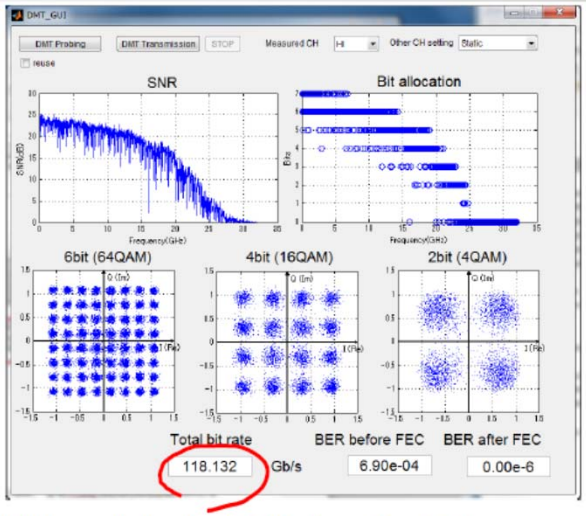
Discrete Multi-Tone (DMT) technology

- Widely used in xDSL system (ADSL, HDSL….)
  - Widely used in xDSL system for almost two decades
  - High spectral efficiency and cost effectiveness
- Adaptive bit and power allocation for each subcarrier depending on transmission characteristics
  - SNR is measured by probing signal
  - Modulation format of all subcarriers of probing signal is QPSK
  - Waterfilling algorithm based on the calculated SNR is used



Previous 100GbE experimental data

Experimental Results



Channel bandwidth was limited to 10GHz due to long PCB traces on DAC & ADC evaluation boards.

takahara_01_0513_optx.pdf

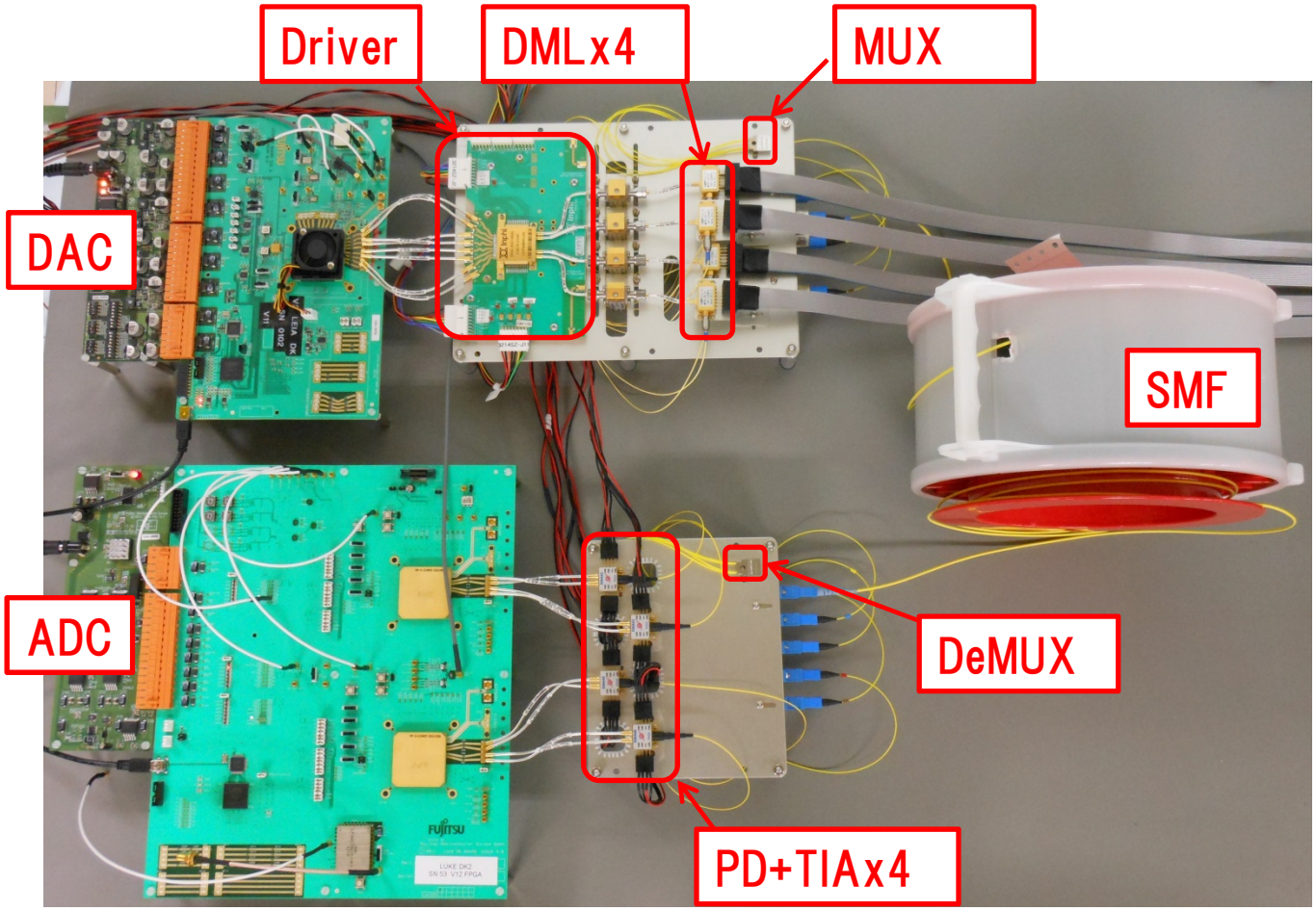
IEEE802.3 Victoria Interim meeting, May, 2013 6 IEEE802.3bm 40 Gb/s and 100 Gb/s Fiber Optic Task Force

We have repeatedly shown 100 Gbps+ transmission experimental results.

There are some other presentations about DMT viability.

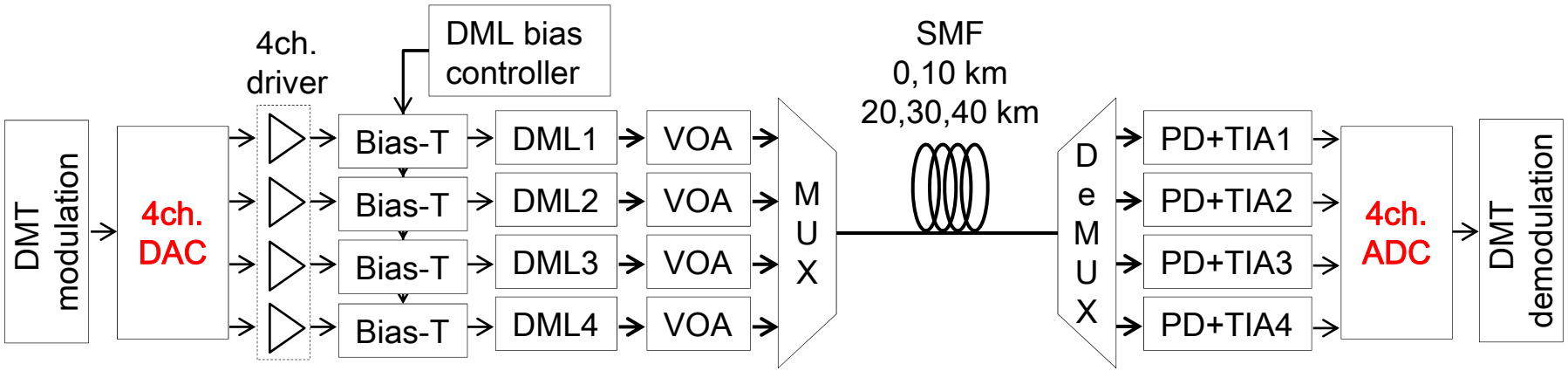
lyubomirsky_01_0313_optx.pdf

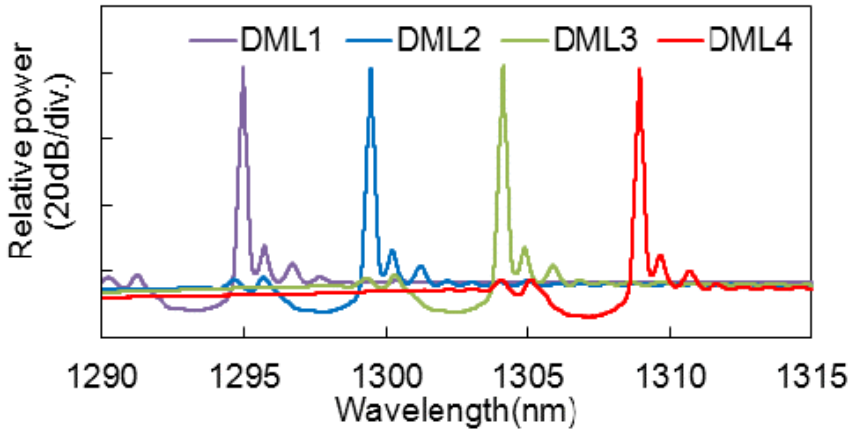
Optical 400G DMT transmission set-up

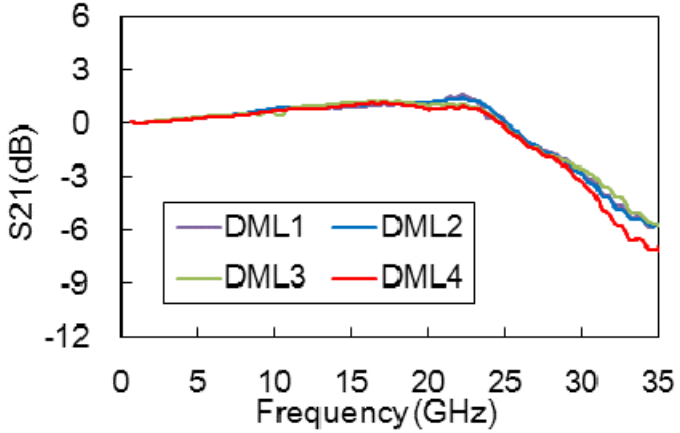


All devices are real device.

Experimental demonstration of 4-ch optical DMT transmission

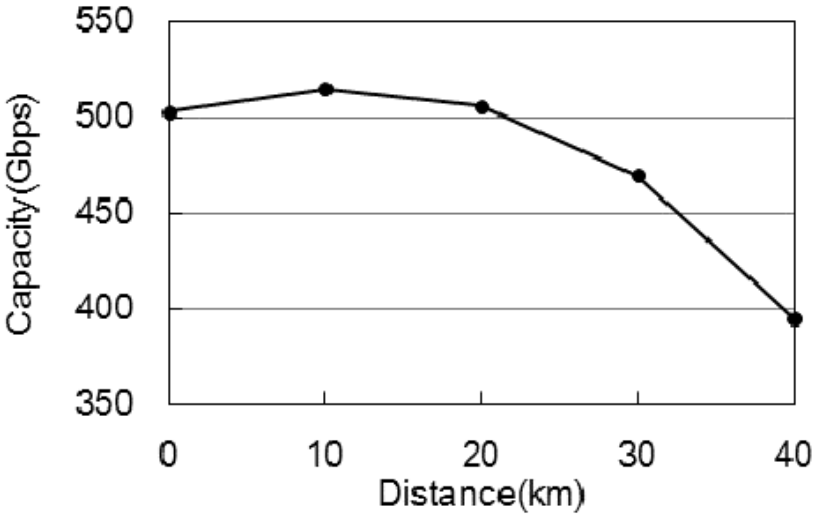


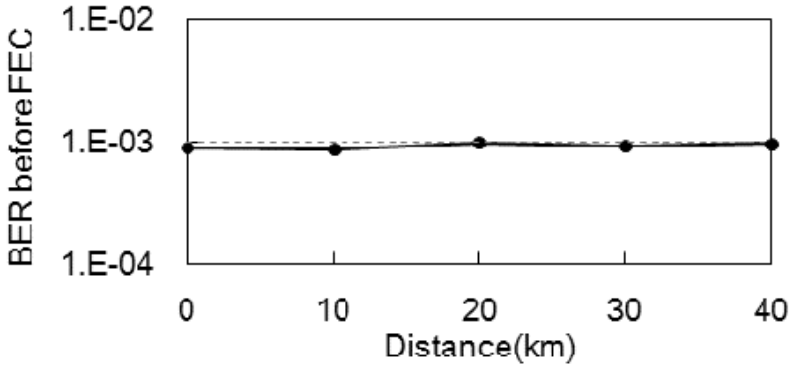




- 4-ch 40 nm CMOS ADC & DAC test chips and PCBs
- LAN-WDM configuration using commercial 4-ch transmitters
- No optical compensation for power and dispersion

Experimental demonstration of 4-ch optical DMT transmission





- **Up to 20 km, 500 Gbps** was achieved giving extra margin for CMOS implementation and for optical non-linearities
- **Up to 30 km, 450 Gbps** was achieved
- For 40 km, around 400 Gbps was achieved **without compensation**
- DMT can cover transmission range in SG PMD objectives (500 m to 10 km)
- With simple re-configurations, DMT could potentially cover a wide range of transmission distances (up to 40 km)
- Details of this experiment will be presented at OFC2014

Summary

- DMT is proposed as a candidate for 400G SG SMF PMD objectives
  - DMT is mature and proven technology, widely deployed in high volumes for decades
- 400 Gbps+ transmission has been achieved with hardware used in deployed optical transmission systems today
  - We achieve 500 Gbps over 20 km SM
  - 40 nm CMOS ADC & DAC test chips/PCBs
  - Drivers, DML & TIA
- Optical DMT is a realistic and cost-effective foundation for a broad range of 400GbE applications