

FINISAR[°]

Optical Solutions for 4G LTE Networks and Beyond

4G LTE International Conference 2017 Hanoi

Tony Pearson

Finisar Corporation

World's Largest Supplier of Fiber Optic Components and Subsystems

- Optics industry leader with \$1.4B+ in annual revenue
- Founded in 1988
- IPO in 1999 (NASDAQ: FNSR)
- 13,000+ employees
- Best-in-class broad product line
- Vertically integrated with low cost manufacturing
- Significant focus on R&D and capacity expansion
- ~30% market share

- Experienced management team
- 1300+ Issued U.S. patents



Broad Product Portfolio and Customer Base

TELECOM



DATACOM



Differentiation Through Vertical Integration



Advantages: Cost, Quality, Technical Leadership, IP Protection

FINISAR[°]

Finisar Facilities Worldwide



World's Largest Supplier of Optical Communication Components and Subsystems

FINISAR[°]

Telecom Network Segments



Datacom Network Segments



Wireless/Mobile Network High-Level Architecture



Wireless/Mobile Network High-Level Architecture

Types of Front Haul Networks

RRU: Remote Radio Unit BBU: Baseband Unit



D-RAN – Distributed Radio Access Network

- For architectures integrating BBU and RRU, in outdoor macro cells
- Optimized for small indoor cells to enhance coverage

C-RAN – Centralized Radio Access Network

- Uses a centralized BBU Pool; point to multipoint architecture
- For areas with <u>fiber constraints</u> or with longer separations between cells

Wireless Front Haul and Backhaul Optical Links



24.330

Option 10

SFP/SFP+ CPRI Optical Transceiver Modules

Complete portfolio for 3G, 4G LTE, and LTE-Advanced applications

	Data Rate (Gb/s)	300m	2Km	10Km	30-40Km
	2.458	FTLF8519P3BTL	FTLF1321P1BTL	FTLF1421P1BTL	FTLF1721P2BTL
-400	3.072	FTLF8519P3BTL	FTLF1321P1BTL	FTLF1421P1BTL	FTLF1721P2BTL
to	4.915	FTLF8526P3BNL	FTLF1326P3BTL	FTLF1426P2BTL	FWLF1625P2V51
+85C	+85C 6.144 FTLF8526P3BNL	FTLF1326P3BTL	FTLF1426P2BTL	FTLX1672D3BTL	
	9.830 (10G)	FTLX8573D3BTL	FTLX1370W3BTL	FTLX1471D3BTL FTLX2071D3xx	FTLX1672D3BTL FTLX2672D3xx



Diversity of Future Front Haul Optical Architectures



New optical technologies minimize the required fiber infrastructure and to support increasing antenna densities: DWDM, Tunable and Bidirectional ("Bidi") architectures

Bidirectional Architecture Doubles Available Fiber



Tunable DWDM Bidi Reduces Requirements by 80x



No	Architecture	Feed fiber	Mux / Demux	Termination	Transceiver Part Numbers
А	Traditional 2-fiber DWDM Ring	2	4x 40ch 100GHz	160	40x C-band Duplex SFP+ p/n
В	Bidirectional 50GHz DWDM	1	2x 40ch 50GHz cyclic AWG	80	80x C-Band Bidi SFP+ p/n
С	Tunable Bidi 50GHz DWDM	1	2x 40ch 50GHz cyclic AWG	80	1x Tunable C-Band Bidi SFP+ p/n

Finisar 10G Grey Products for 4G Applications

• They include multimode, single mode and Bidi versions.

	300m	1.4km	10km	10km Bidi	40km
Part Number	FTLX8573D3BTL	FTLX1370W4BTL	FTLX1475D3BTL	FTLX2071D3xx	FTLX1672D3BTL
Operating Temperature Range	-40 to 85°C	-40 to 85°C	-40 to 85°C	-40 to 85°C	-40 to 85°C
Availability	Production	Beta	Production	Production	Production



Finisar 10G DWDM Products for 4G Applications

- DWDM pluggable transceivers for C-RAN and backhaul applications (fixed and tunable channels).
- Tunable Bidi version under development.
- Support bit rates from 1.2Gb/s through 11.3Gb/s.

	Fixed [DWDM	T-SFP+	Tunable Bidi
Part Number	FTLX3971yTCxx	FTLX3671yTCxx	FTLX6872MNC	FTLB6811P3
Optical Link Budget	al Link 25dB 17dB		23dB	22.5dB
Operating Temp. Range	-40 to 85°C	-40 to 85°C	-5 to 85°C cold start at -40°C	-5 to 85°C cold start at -40°C
Availability Production Alpha		Alpha	Production	Alpha



Mobile Market Trends: New Applications and Drivers

4K and HDR video over mobile devices



4x pixels of HD (1080p), needs more bandwidth

- 4K and HDR (highdynamic range) video
- Spec announced at 2017 Mobile World Congress
- "Mobile HDR Premium" certification will be issued to both devices & content
- Key application for driving 5G wireless, bandwidth

Driverless Car



Industry 4.0 - smart factories



IoT - Many devices & many high speed links

- Supported by Internet of Things (IoT) / Industrial Internet / Industry 4.0
- Increasing data collection from tens of thousand of sensors from new devices
- Integration of production & manufacturing systems;
 "Big Data" to improve industrial processes

Many vehicles and need many low latency links

- No standards yet but more recent designs have acknowledged the need for wireless links
- Downloading up-to-date map data, receiving traffic information from other vehicles, allowing vehicles to maintain a constant distance

Massive connections, Higher bandwidth, Low latency links

Driving pre-5G and 5G Mobile Networks

Mobile Market Trends: Increasing Optical Data Rates

- Mobile Fronthaul (from BBU to RRU) CPRI bit rates:
 - Option 2: 1.2288 Gb/s
 - Option 4: 3.072 Gb/s
 - Option 6: 6.144 Gb/s 4G LTE Mobile
 - Option 7: 9.8304 Gb/s 4G LTE Mobile
 - Option 10: 24.33 Gb/s 5G Mobile
- Uncompressed 5G CPRI may need 100G or even 400G optics
- An emerging eCPRI (CPRI over Ethernet) standard with a 25.78Gb/s bit rate expected to be released in August 2017
- Mobile Backhaul network will need to support 25G/100G/400G
 Ethernet, 100G/200G/400G Coherent transmission

Mobile Market Trends: Optical Modules for Mobile

China is leading the global mobile market in 4G, pre-5G and 5G.



- China Mobile: 860 million subscribers (64% of China or 11% of the world).
- The rest of world is still working on 4G deployments, driving significant demand for 10Gbps optics beyond 2020.

Mobile Front Haul / CPRI Optical Module Market

- Most CPRI links will be deployed on 4G LTE networks beyond 2020.
- 5G Mobile drives new and higher CPRI data rates (25G)



Worldwide Market of CPRI Optical Transceivers

Finisar 25G/40G/100G Products for 5G Mobile Applications

100m		10km					
25G	100G	25G	25G Bidi	40G	100G		
CPRI (24.33Gb/s) and eCPRI (25.78Gb/s) capable							
FTLF8536W4BTV	FTLC9555WEPM3	FTLF1436W4BTV	FTLB2021P3Txx	FTL4C1QW2N	FTLC1155WGPLC		
5G Mobile Products Under Development Please contact Finisar							







FINISAR[°]

Thank You / Q&A

