

FIA
The Fibreoptic Industry Association

STAND OUT FROM THE CROWD

14th May 2002, Bisham Abbey

- Introduction
- FIA Services
- Work "Smart"
- Testing Solutions
- The Consultant - Friend or Foe?
- The User - Making Demands

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INTRODUCTION

Welcome

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Paul Bateson
FIA Industry Sector Director
Optical Test and Calibration

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FIA SERVICES Paul Bateson, Industry Sector Director

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INTRODUCTION

Work Smart



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Work Smart

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Mike Gilmore, Senior Partner

	Secretary: ISO/IEC JTC1 SC25 WG3: Generic Cabling Member: ISO/IEC JTC1 SC25 Project Team: SOHO
	Convenor (1994-2002): CENELEC TC215 WG1: IT Cabling
	Chairman: BSI TCT7/-1: IT Cabling Chairman: BSI TCT7/-3: IT Cabling Support Group Technical and Standards Director, Fibreoptic Industry Association

mike.gilmore@btinternet.com

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The End is Nigh

To be published as
EN 50173-1

EN 50173 Ed.2 (2002)

Information technology
-
Generic cabling systems

• SE	Completed
• 6MP begins	July, 2001
• 3MV begins	Q2, 2002
• publication	Q4, 2002

ISO/IEC 11801 Ed.2 (2002)

Information technology
-
Generic cabling for customer premises

• 2nd CD	Completed
• FCD	Completed
• FDIS	Q2, 2002
• publication	Q4, 2002

ANSI/TIA/EIA 568 B Series

Commercial building
telecommunications cabling
standard

- B.1 General Requirements
 - published
- B.2 Balanced Cabling
 - published
 - Addendum 1
 - Category 6
 - Draft 11
- B.3 Optical Fibre Cabling
 - published

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Market Conditions - A Bleak Future

Balanced		Optical Fibre	
Unscreened	Screened	MMF	SMF
Category 5 (1995)		OM1	OS1
Category 5 (2000)		OM2	
Category 5e		OM3	
Category 6			
Category 7			
Category 6e?	Category 8?		

Balanced		Optical Fibre	
Unscreened	Screened	MMF	SMF
Wireless			OS1
Category 5e			
Category 6		OM3	
Category 7			

Established standards

Commoditisation

No high-margin "rabbits"

Technology Squeeze
Margin Reduction

➔

Wireless

Category 5e

Category 6

Category 7

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Copper - A Nightmare Scenario?


"installation tolerance"

"unmanaged channel performance"

Connectivity "management"

plus the undermining of the reference implementation approach

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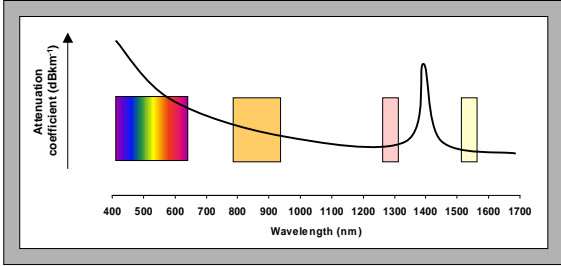


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1GbE Performance Margin - What Margin?



	850nm		1300nm		1310nm
	62.5/125	50/125	62.5/125	50/125	SMF
OFL Modal Bandwidth (MHz.km)	200	500	500	500	500
Assumed OF attenuation (dBkm ⁻¹)	3.75	3.50	1.5	1.5	0.5
1000BASE	-SX		-LX		
	830nm		1270nm	1270nm	
Maximum channel length (m)	275	550	550	550	5000
Max. OF cable attenuation (dB)	1.1	2.06	0.85	0.85	2.57
Connecting hardware allowance (dB)	1.5	1.5	1.5	1.5	2.0
Maximum Channel Insertion Loss (dB)	2.60	3.56	2.35	2.35	4.57




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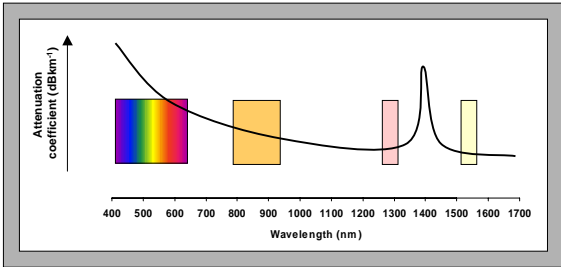


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10GbE Performance Margin - What Margin?



	850nm		1300nm	1310nm	1550nm
	62.5/125	50/125	MMF	SMF	
OFL Modal Bandwidth (MHz.km)	200	500	500	500	
Assumed OF attenuation (dBkm ⁻¹)	3.50	3.50	1.5	0.4	0.5
10GBASE	-SR/SW		-LX4	-LR/LW	-LX4
	830nm		1269-1356 nm	1270nm	1269-1356 nm
Maximum channel length (m)	33	82	300	10000	10000
Max. OF cable attenuation (dB)	0.12	0.30	0.46	4.20	4.20
Connecting hardware allowance (dB)	1.5	1.5	1.5	2	2
Maximum Channel Insertion Loss (dB)	1.62	1.80	2.46	6.20	6.20
					10.9




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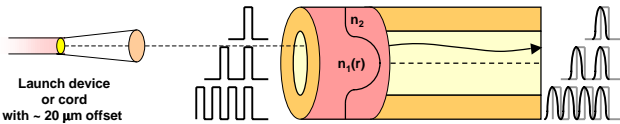
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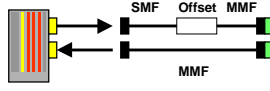
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Application-specific Cordage




Launch device or cord with ~ 20 μ m offset

1000BASE				
-SX		-LX		
62.5/125	50/125	62.5/125	50/125	SMF
830nm		1270nm	1270nm	1270nm
Internal to eqmt		Cord required		NA




Mode conditioning cord




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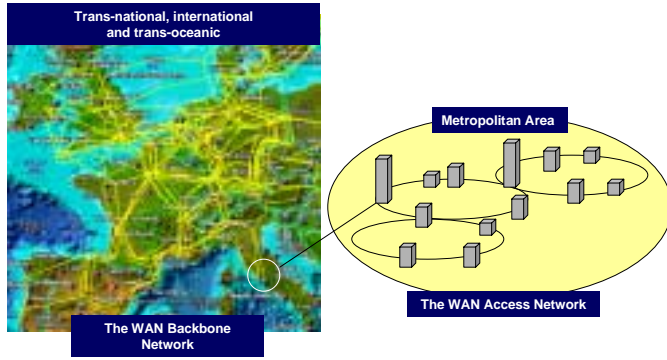
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WAN Opportunities?




Trans-national, international and trans-oceanic

Metropolitan Area

The WAN Backbone Network

The WAN Access Network

G.652 - Characteristics of a single-mode optical fibre cable
 G.653 - Characteristics of a dispersion-shifted single-mode optical fibre cable
 G.654 - Characteristics of a cut-off shifted single-mode optical fibre cable
 G.655 - Characteristics of a non-zero dispersion shifted single-mode optical fibre cable



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The Project Model

The diagram illustrates the 'Project Model' with the following components and interactions:

- User** provides a **No User Guide**.
- Consultant** provides **Incorrect specification** and **Over-commitment** to the **Main contract installer**.
- Main contract installer** provides **No/partial specification** to the **OF Installer**.
- Main contract installer** reports a **Failure reported** to the **User**.
- OF Installer** results in a **Failure to comply**.

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Work Smart

The 'Work Smart' diagram features a central goal: **GET BETTER BUSINESS AT BETTER MARGINS**. This goal is supported by six key objectives:

- Minimise re-work
- Control costs
- Eliminate disputes
- Reduce stress
- Die happy!!!!
- Avoid conflict

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The Installation Standards

	BS EN 50174-1 (2001)	Information technology - Cabling installation- Part 1: Specification and Quality Assurance
	BS EN 50174-2 (2001)	Information technology - Cabling installation- Part 2: Installation planning and practices inside buildings
	BS 6701	Code of Practice for the installation of apparatus intended for connection to certain telecommunications systems
	BS 7718	Code of Practice for the installation of fibre optic cabling
	IEC 60825-1 A.1 (2001)	Safety of Laser Products Part 1: Equipment classification, requirements and users guide
	IEC 60825-2	Safety of Laser Products Part 2: Safety of optical fibre communication systems

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FIA Technical Support

The FIA Technical Support Documents

- providing interpretation
- delivering guidance
- "fast-track" standardisation

TSD	DESIGN
2000-1-1	OPTICAL FIBRE CABLING: LAN APPLICATION SUPPORT GUIDE
2000-1-3	OPTICAL FIBRE CABLING: DARK FIBRE SUPPORT GUIDE
TSD	OPERATION
2000-3-3	POLARITY MAINTENANCE
TSD	INSTALLATION
2000-4-2-1	TESTING OF INSTALLED CABLING: ATTENUATION USING LSPM EQUIPMENT
2000-4-2-2	TESTING OF INSTALLED CABLING: ATTENUATION USING OTDR EQUIPMENT
TSD	SAFETY
2000-5-1	OPTICAL POWER: SAFETY LEVELS
2000-5-2	OPTICAL FIBRE: HANDLING OF PROCESSING CHEMICALS
2000-5-3	OPTICAL FIBRE: DISPOSAL OF WASTE
MODELLING TOOLS	
CABLING STRUCTURES COST MODEL	

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Smart Spade Work

BE PRO-ACTIVE, NOT REACTIVE

- read the standards
- obtain expert advice
- produce statements of compliance
- develop a specification checklist
- produce accurate method statements for all aspects of the installation process
 - define the in-feed requirement
 - dictate the alternative
- produce the foundations for the generic User Guide

MANAGE YOUR RESOURCE

- identify the true leaders
- identify an office-based project coordinator
- train each person appropriately in your procedures

INVEST IN SOFTWARE

- web-browser production
- pdf creation
- CD production
- test result readers

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Integration

Fibreoptics Anonymous
Installation Browser

e-mail link

User logo
User details
Consultant details
Main Contract Installer details

Quality Assurance

- Specifications
 - User
 - Checklist
 - In-house
- Quality Plan
- Method Statements
 - Installation
 - Documentation
 - Test Methods
 - Test Result Administration
- Component specifications

As-built Documentation

- Connectivity spreadsheets
- Schematics
- User Guide
- Channel Manager

Test Results

- OTDR
- LSPM
- OTDR Reader
- LSPM Reader

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FIA Initiatives

WorkSmart Programme

INSTALLERS

- Quality Assurance
- Specifications
- User Checklist
- In-house
- Quality Plan
- Method Statements
- Installation Documentation
- Test Methods
- Test Result Administration
- Component specifications

CONSULTANTS

- As-built Documentation
- Connectivity spreadsheets
- Schematics
- User Guide
- Channel Manager

USERS

- Test Results
- OTDR
- LSPM
- OTDR Reader
- LSPM Reader

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Break
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Testing Solutions



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- Fibre Optic Services
- Photometric/Radiometric Services
- Electrical/Electronic Calibration
- Environmental Test Services
- Maintenance & Repair Services
- Other Support Services



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 Web: www.otc.co.uk

Services Offered

Fibre Optic Services

Photometric/Radiometric Services

Electrical/Electronic Calibration

Environmental Test Services

Maintenance & Repair Services

Other Support Services

Fibre Optic Services

- Calibration Traceable or UKAS, service & repair
- Hire & Sales OTDR's, OPM's, sources

Photometric/Radiometric Services

- Calibration Traceable or UKAS, service & repair
- Sales New instruments

Electrical/Electronic Calibration

- Calibration Traceable or UKAS, service & repair
- Hire & Sales Cable testers etc

Environmental Test Services

- Testing Vibration, shock, temperature, humidity

Maintenance & Repair Services - European Support

- Agilent Technologies (WireScope Products)
- ILX Lightwave
- Noyes Fibre Optics
- STC/FTT/Biccotest Fibre Optic products
- Beale/BIT/First Fibre fusion splicers

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Agenda

Section One

Fibre Optic Basics

Section Two

Measurement Techniques

Section Three

Understanding Measurements

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Section One

Section Two

Section Three

Fibre Optic Basics

Multimode Optical Fibre
 Singlemode Optical Fibre
 Fibre Optic Sources
 Coupling Losses
 Typical Interconnections

Measurement Techniques

Understanding Measurements

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Multimode Optical Fibre

STEP INDEX (S.I.) MULTIMODE

- path lengths: maximum variation
- path times: maximum variation
- bandwidth: modal dispersion

GRADED INDEX (G.I.) MULTIMODE

- path lengths: significant variation
- path times: limited variation
- bandwidth:
 - 1st order: modal dispersion
 - 2nd order: chromatic dispersion

Typical Geometry	
d/D (µm)	NA
50/125	0.20
62.5/125	0.275
100/140	0.29
200/230	0.24

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Multimode Optical Fibre

Typical Optical Fibre Geometry			
	50/125	62.5/125	
Core diameter (m)	50 ± 3	62.5 ± 3	
Cladding diameter (µm)	125 ± 3	125 ± 3	
NA	0.20 ± 0.015	0.275 ± 0.015	

Typical Optical Fibre Performance Parameters				
Fibre Type (µm)	Attenuation coefficient (dBkm ⁻¹ max)		Modal bandwidth (MHz.km min)	
	850nm	1300nm	850nm	1300nm
50/125	3.5	1.0	200	500
62.5/125	3.75	1.5	160	500
100/140	5.0	2.0	100	200
200/300	6.0	-	18	-

Attenuation (dB)

Fibre length (m)

Modal Bandwidth (MHz)

Fibre length (m)

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Singlemode Optical Fibre

Modes @ 1300nm

Core diameter (microns)

STEP INDEX (S.I.) SINGLEMODE

- path lengths: no variation
- path times: no variation
- bandwidth:
 - 1st order: chromatic dispersion
 - 2nd order: pulse shape dispersion

Typical Geometry	
d/D (µm)	NA
8-10/125	0.10

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Fibre Optic Sources

Bit rate and cost

Wavelength (nm)

LED, VCSEL, FP LASER, MMF LED

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Coupling Losses

LED or optical fibre LASER

COUPLING LOSSES					
LED	From				To
	62.5	50	LASER	SMF	
0 dB	0 dB	0 dB	0 dB	0 dB	62.5
-4.7 dB	-4.7dB	0 dB	0 dB	0 dB	50
--26 dB	--26 dB	--22 dB	0 dB	0 dB	SMF

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Typical Interconnections

SPliced JOINTS		Insertion loss	Return loss
Multimode		<0.05 dB	N/A
Singlemode		<0.2 dB	N/A

DEMOUNTABLE CONNECTORS		Insertion loss	Return loss
Early Multimode	SMA905, SMA906, OFP101, Biconic, Stratos	0.6 dB	N/A
Later Multimode	Diamond HFS-3, FC, FC/PC, ST, ESCON, FDDI	0.3 dB	N/A
Singlemode	D4, FC/PC, Diamond HMS-0, HMS-10, DIN	0.2 dB	<-30 dB
Advanced Singlemode	HRL-10, FC/UPC, FC/APC, SC/APC, E2000, EC	0.25 dB	<-60 dB
Small Form Factor	LC, MT-RJ, SG (3M Volition™)	0.2 dB	-

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Agenda

Section One

Section Two

Section Three

Fibre Optic Basics

Measurement Techniques

Understanding Measurements

Types of Tests
 Transmission Tests
 Field Testing
 Power Measurement
 Insertion Loss Measurement
 Optical Time Domain Reflectometry
 Specialist Measurements

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Types of Test

Over its product life these measurements may be performed on a fibre optic cable:

- Mechanical tests Traction, Torsion, Bending, Thermal Cycling
- Geometrical tests Concentricity, Core Diameter, Cladding Diameter
- Optical tests Index Profile, Numerical Aperture, Spot Size
- Transmission tests Bandwidth, Optical Power, Optical Loss, Reflectometry

The first three measurements are normally only performed once, as part of a product qualification, as there is only minor variation of these parameters during the fibre's life. These are described in the FOTP (Fibre Optic Test Procedure) specifications of the EIA (Electronics Industries Association), as well as in the ITU-T G650 recommendations, EN188000 and other documents.

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Transmission Tests


Measurements used to qualify optical systems for use for information transmission are:

- End-to-End optical link loss
- Attenuation per unit length
- Attenuation contribution of splices, connectors, couplers
- Length of fibre or distance to an event
- Linearity of fibre loss per unit length (attenuation discontinuities)
- Reflectance or Optical Return Loss


Specialist measurements such as bandwidth, polarisation mode dispersion or time of flight, may also be done, though the requirement has been rare to date. Some measurements may require access to both ends of the fibre, whereas others require only one end. These single ended test methods are of particular interest in field applications.

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Field Testing


Installation, Maintenance and Restoration are the main themes for field tests:

- **Installation** testing to ensure quality of received cables (transit damage), damage during cable placement, cable splices, cable terminations (attenuation, location, reflectance), overall system characteristics (end-to-end loss, system optical return loss) and to provide completion documentation.
- **Maintenance** testing to assess periodic degradation of cable, splices and connections (cable attenuation, attenuation and reflection of splices and terminations). In high capacity and critical systems automated testing devices may be employed.
- **Restoration** usually begins with testing to ascertain the cause of a problem (system transmitter, system receiver, cable integrity, splice failures, connector faults). Once faults are identified and rectified, testing will then be used to assess the quality of the repaired system, similar to testing performed at the conclusion or hand-over of a cable installation.




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Power Measurement

THE POWER METER

The standard instrument for fibre testing and displays the incident power on the integral photodiode. Choice of the meter depends on the application and should have enough dynamic range to measure the transmitter output, but be sensitive enough to measure the received power at the remote end of the system.

Typical Dynamic Ranges for power meters are:

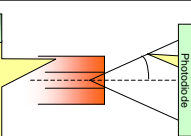
- +13 dBm to -70 dBm for telephony applications
- +24 dBm to -50 dBm for CATV applications
- -20 dBm to -60 dBm for LAN applications

Features on more sophisticated meters may include temperature stabilisation, ability to calibrate to different wavelengths, display power 'relative' to a 'reference' input, to introduce additional attenuation etc.

Optical fibre under test

Normally terminated with an optical connector.


Bare fibre adapters can be used for unterminated fibres, but accuracy and repeatability may be impaired.



Acceptance angle or NA

Generally accepted that optimal power measurement made with 75% fill of the photodiode.

Note: large area photodiodes will provide more repeatable results.



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Insertion Loss Measurement

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Optical Time Domain Reflectometry

Dynamic Range defines the maximum observable length of fibre and therefore the OTDR's suitability for analysing a particular network.

The higher the dynamic range, the higher the signal to noise ratio, the cleaner the trace will be with better event detection. It is defined as the difference between the extrapolated point of the backscatter trace at its interception with the power axis and the upper level of the noise floor.

IEC 61746 & Bellcore define this limit as the point that contains $\leq 98\%$ of all the noise data points. The RMS definition takes the noise at an SNR = 1 which gives a value 1.56dB bigger than IEC/Bellcore.

Others include N=0.1dB, End Detection, 4% Fresnel and Peak Level Plus 0.3dB.

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Special Measurements

RETURN LOSS

Two methods:

- single-ended with an OTDR and read direct from the display has the advantage of locating the reflection.
- single-ended with a return loss test set, but needs access to the far end to dump and remove spurious reflections.

BANDWIDTH

Two possible methods:

- The CW method which involves the direct measurement of the frequency response of the link.
- The Pulse method which is indirect and measures pulse broadening in the time domain.
 - these are then converted to the frequency domain using FFT techniques and a computer.

Needed for measurement of 'legacy' systems.
Requires access to both ends.
Equipment is cumbersome.
Developments are in hand.

POLARISATION MODE DISPERSION

This is becoming important in long haul singlemode EDFA systems and in DWDM systems. Single ended access is possible and many OTDR's now offer an optional plug-in module, but kit is expensive and measurement repeatability is poor due to environmental factors.

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Agenda

Section One Section Two Section Three

Fibre Optic Basics Measurement Techniques Understanding Measurements

Traceable Measurements
Sources of Error
Human Factors
Removing the Uncertainty

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Traceable Measurements - I

CALIBRATION

The comparison of a measurement or source device (UUT) of unverified uncertainty with a measurement or device of known or lesser uncertainty, and to report or correct errors.

TRACEABILITY

The ability to relate individual measurement results to defined national standards through an unbroken chain of comparisons

UNCERTAINTY

The degree of doubt about a measurement. This parameter is associated with the measurement result and indicates the distribution of the values which could be assigned to its true value.

RANDOM ERROR

This unpredictable error is the deviation of an individual reading from the long term mean of many such readings.

The long term average of the random error is zero, but their amplitude can be expressed as a variance or standard deviation.

SYSTEMATIC ERROR

This is the deviation of the long term mean of the readings from what is believed to be the true value.

In principle these errors can be corrected, but the uncertainty in the correction factor contributes to the final result.

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Traceable Measurements - II

FIBRE OPTIC CALIBRATION

OPTICAL POWER

Absolute values
Relative values

SPECTRAL CHARACTERISTICS

Centre wavelength
Peak wavelength
Spectral half-width

DETECTORS

Silicon from 600 - 1000nm
Germanium from 800 - 1600nm
InGaAs from 750 - 1700nm.

ABSOLUTE POWER

Transfer from NPL to +10dBm at 1310 and 1550nm.

Other points at 0, -10, -20 and & -23dBm at 850, 1300, 1310 and 1550nm to ±1% for FC connectors

RELATIVE REPONSIVITY

Response of a detector to an absolute power at a specific wavelength.

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Sources of Error

<div style="background-color: #e0ffe0; padding: 2px; text-align: center; font-weight: bold; font-size: small;">WAVELENGTH</div> <p style="font-size: x-small;">Experimentation with Time of Flight shows errors in length of up to 2m for a change in 20nm in peak wavelength!</p> <table border="1" style="width: 100%; border-collapse: collapse; font-size: x-small;"> <tr> <td>Nominal 3km 50/125 multimode</td> <td></td> </tr> <tr> <td>812nm</td> <td>3084.31m</td> </tr> <tr> <td>834nm</td> <td>3082.91m</td> </tr> <tr> <td>851nm</td> <td>3081.04m</td> </tr> </table>	Nominal 3km 50/125 multimode		812nm	3084.31m	834nm	3082.91m	851nm	3081.04m	<div style="background-color: #e0ffe0; padding: 2px; text-align: center; font-weight: bold; font-size: small;">DECADE ERRORS IN METERS</div> <p style="font-size: x-small;">Many calibration houses and some manufacturer's data only give calibration results at the decade points. Experience has shown errors up to 2dB in optical power measurement between these points due to log-amp non-linearities.</p>	<div style="background-color: #e0ffe0; padding: 2px; text-align: center; font-weight: bold; font-size: small;">TEMPERATURE VARIATIONS</div> <p style="font-size: x-small;">These affect detector responsivity and source wavelength.</p>
Nominal 3km 50/125 multimode										
812nm	3084.31m									
834nm	3082.91m									
851nm	3081.04m									
<div style="background-color: #e0ffe0; padding: 2px; text-align: center; font-weight: bold; font-size: small;">GROUP REFRACTIVE INDEX</div> <p style="font-size: x-small;">Many OTDR's now allow setting of Group Index to at least 4 decimals. Temperature fluctuations of only $\pm 1C$ around the fibre will affect the refractive index, and hence the Group Index, at the 3rd decimal place, giving length measurement errors of up to 4m.</p>	<div style="background-color: #e0ffe0; padding: 2px; text-align: center; font-weight: bold; font-size: small;">SYSTEMATIC ERROR</div> <p style="font-size: x-small;">A high power transfer standard has been developed in 2001 by an NPL/Anritsu collaboration. However, field kits may not yet benefit, with results showing up to 10% uncertainty due to detector saturation and the unquantified, non-linear effects at high power in passive devices.</p>	<div style="background-color: #e0ffe0; padding: 2px; text-align: center; font-weight: bold; font-size: small;">OPTICAL REFLECTIONS</div> <p style="font-size: x-small;">Variations in power of several percent can be caused by reflections from fibre ends, lenses, detector windows etc. Coherence effects also cause instability by generation of an external laser cavity in the optical fibre.</p>								
<div style="background-color: #e0ffe0; padding: 2px; text-align: center; font-weight: bold; font-size: small;">SOURCE CHARACTERISTICS</div> <p style="font-size: x-small;">Mode structure of lasers, the laser drive current and localised laser chip heating effects all contribute to wavelength and optical power fluctuations.</p>										

Look out for new Raman lasers to 3W power!

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Human Factors

<div style="background-color: #e0ffe0; padding: 2px; text-align: center; font-weight: bold; font-size: small;">PEOPLE</div> <p style="font-size: x-small;">Use personnel with direct practical experience of the work involved to conduct interviews with potential staff</p> <p style="font-size: x-small;">Guard against any factors e.g. excessive time pressures which may adversely affect staff performance.</p> <p style="font-size: x-small;">Invest in training to ensure staff have the skills and competency to fulfil their role.</p>	<div style="background-color: #e0ffe0; padding: 2px; text-align: center; font-weight: bold; font-size: small;">TOOLS</div> <p style="font-size: x-small;">Apply ergonomic as well as technical criteria when purchasing new equipment</p> <p style="font-size: x-small;">Ensure that any software purchased for measurement or documentation is 'fit for purpose'.</p> <p style="font-size: x-small;">Adopt a 'user-centred' approach when developing new systems.</p>	<div style="background-color: #e0ffe0; padding: 2px; text-align: center; font-weight: bold; font-size: small;">PROCESS</div> <p style="font-size: x-small;">Involve staff in the design and review of jobs.</p> <p style="font-size: x-small;">Design work processes to provide adequate variety and sufficient breaks.</p> <p style="font-size: x-small;">Allow staff to concentrate when required and minimise sources of interruption.</p> <p style="font-size: x-small;">Consider automating any parts of a process which may be prone to error.</p> <p style="font-size: x-small;">Improve checking and audit strategies where possible.</p> <p style="font-size: x-small;">Promote information exchange within the organisation.</p>
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Remove the Uncertainty

- Use the right people
- With the right equipment
- At the right time
- In the right way
- DON'T MAKE DO!**

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Standards

International Standards

- IEC60793-1 and IEC60793-2: Optical Fibers.
- IEC60794-1, IEC60794-2 and IEC60794-3: Optical Fiber Cables.
- ITU-T G650: Definition and Test Methods for the relevant Parameters of Singlemode Fibers.
- ITU-T G651: Characteristics of 50/125µm Multimode Graded Index Optical Fiber.
- ITU-T G652: Characteristics of Singlemode Optical Fiber Cable.
- ITU-T G653: Characteristics of Dispersion Shifted Optical Fiber Cable
- ITU-T G654: Characteristics of 1550nm Loss Minimized Singlemode Optical Fibre Cable.

National Standards

- EN186000: Optical Fibre Connectors.
- EN187000: Optical Fibres.
- EN188000: Optical Fibre Cables.
- IEC62350: Power Meter Calibration
- IEC61746: OTDR Calibration.
- BS7718: Code of Practice for Installation of Fibre Optic Cabling.

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Glossary - I

Based on IEC50, chapter 731, EIA-440-B and other documents

<p>Absorption: in an optical fibre, loss of optical power resulting from the conversion of power into heat.</p> <p>Attenuation Dead Zone: region after an event where the trace deviates from the undisturbed backscatter trace by e.g. more than 0.1dB at a reflectance of -30dB (Bellcore definition). This dead zone depends on pulse width, reflectance, loss, displayed power level and location and indicates the minimum distance after an event where the backscatter trace can be measured.</p> <p>Attenuation: in optical fibres, loss of average optical power due to absorption, scattering and other radiation losses. Normally expressed as dB without the negative sign.</p> <p>Attenuation Coefficient: rate of optical power loss with respect to distance, usually expressed as dB/km. Attenuation for a fibre is normally specified over a temperature range of -60C to +85C.</p> <p>Backscattering: portion of scattered light returned in the opposite direction to that of propagation.</p> <p>Bandwidth: difference, expressed in Hertz (Hz), between the highest and lowest frequencies passed through a fibre. Often used to specify the bandwidth (MHz.km) of a multimode fibre.</p> <p>Bend Radius (minimum): The radius a fibre can bend before increased loss or mechanical damage occurs.</p> <p>Cut-off Wavelength: in a singlemode fibre, the shortest wavelength at which a single mode can be transmitted. Beyond this wavelength, several modes transmit simultaneously, and the fibre becomes multimode.</p>	<p>CW: abbreviation for continuous wave.</p> <p>Dense WDM: Dense Wavelength Division Multiplexing is used to transmit several signals on the same fibre within a narrow wavelength band.</p> <p>DFB: Distributed Feedback Laser, incorporates a Bragg reflection grating in the active region of the laser diode to enhance a single longitudinal mode.</p> <p>Dispersion: The cause of bandwidth limitation in fibre. The broadening of a light pulse as it propagates along a fibre: <i>Modal Dispersion</i> caused by differential optical path lengths in an optical fibre. <i>Chromatic Dispersion</i> caused by differential delay of various wavelengths of light passing through a fibre.</p> <p>Dynamic Range: The difference between the extrapolated point on the backscatter trace at the near end of the fibre (at the intersection with the power axis) and the upper level of the noise floor (see below). The dynamic range is expressed in dB. The value is measured after 180s usually with the largest OTDR pulse width. <i>IEC/Bellcore</i> defines this noise floor point as that containing at least 98% of all noise data points. <i>The RMS definition</i> defines the noise floor point for a Signal-to-Noise ratio = 1. (Typically gives a value -1.56dB better than IEC)</p> <p>EDFA: Erbium Doped Fibre Amplifier. Amplifies optical signals without using O/E and E/O conversions.</p>
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Glossary - II

Based on IEC50, chapter 731, EIA-440-B and other documents

<p>Event Dead Zone: Minimum distance on a trace, where two separate events can be distinguished. The distance to each event can be measured but the separate loss <u>cannot</u> be measured.</p> <p>Reflective Event is the distance between two opposite points on a reflection that are 1.5dB down from the peak. Bellcore defines a reflectance of -30dB.</p> <p>Non-Reflective Event is the distance between the points where the beginning and ending levels at a splice or feature (≤ 1dB) are within ± 0.1dB of their initial and final values.</p> <p>Graded Index Fibre: The refractive index of the core gradually increases from the outside of the core towards a peak at the core centreline. This multimode fibre reduces the time difference between the arrival of different modes, minimising the modal dispersion and maximising bandwidth.</p> <p>Group Index: The factor by which the speed of light in vacuum has to be divided to give a propagation velocity of light pulses in fibre.</p> <p>Micro-bend: Small distortion of a fibre caused by external factors such as cabling. Particularly important in singlemode fibre systems at longer wavelengths, e.g. 1550nm.</p> <p>Mode Field Diameter (MFD): A term that expresses the diameter (cross section) of the majority of the optical energy in a fibre. This is normally larger than the geometrical core diameter, so MFD effectively replaces core diameter.</p> <p>Multimode Fibre: An optical fibre in which light travels in multiple modes.</p>	<p>Multiplex: Combining two or more signals into a single bit stream that can then be individually recovered.</p> <p>Numerical Aperture: The number ratio that expresses the light gathering capacity of a fibre related to the acceptance angle. The sine of an angle representing 5% of the optical power (corresponds to -13dB) is used to measure the Numerical Aperture.</p> <p>Optical Return Loss (ORL): The ratio, expressed in dB, of the reflected power to the incident power from a fibre optic system represented by the formula $ORL = -10 \log(P_r/P_i)$.</p> <p>Reflectance: The ratio of reflected power to incident power of an event or connector, represented by $R = 10 \log(P_r/P_i)$.</p> <p>Refractive Index: A property of light transmitting materials defined as the ratio of the velocity of light in a vacuum (c) to its velocity in a given transmission medium (v), i.e. $n = c/v$.</p> <p>Scattering: A property that causes light to deflect out of the core area of the fibre, thereby contributing to attenuation.</p> <p>Singlemode Fibre: An optical waveguide or fibre in which the signal travels in one mode.</p> <p>Step Index Fibre: A fibre whose index of refraction changes sharply at the interfaces of its core and cladding.</p> <p>WDM: Wavelength Division Multiplexer. Passive fibre optic components which combine optical channels on different wavelengths.</p>
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Acknowledgements

- "High Bit Rate Optical Fibre Networks" - FIA Breakfast Seminar by Mike Gilmore, The Cabling Partnership - 22nd March 2000
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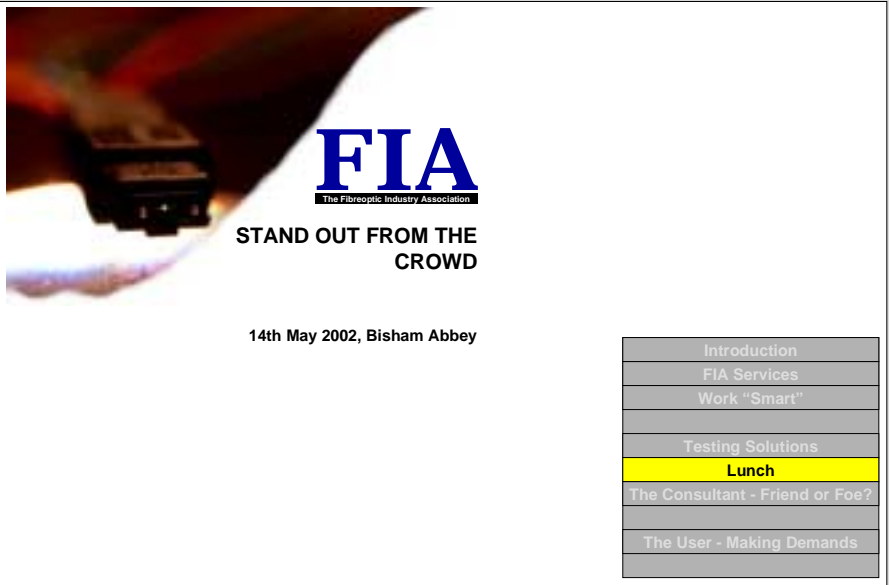
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STAND OUT FROM THE CROWD

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Introduction
FIA Services
Work "Smart"
Testing Solutions
Questions and Answers
The Consultant - Friend or Foe?
The User - Making Demands

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Introduction
FIA Services
Work "Smart"
Testing Solutions
Lunch
The Consultant - Friend or Foe?
The User - Making Demands

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THE CONSULTANT - FRIEND OR FOE? Eddie Power, Director, Improcom

The Consultant - Friend or Foe?

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Eddie Power
Director
Improcom

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The slide features a background image of a hand holding a fiber optic connector. The FIA logo is prominently displayed in the center. Below the logo, the title 'STAND OUT FROM THE CROWD' is written in bold. The date and location '14th May 2002, Bisham Abbey' are listed below the title. On the right side, there is a vertical menu of topics: Introduction, FIA Services, Work "Smart", Testing Solutions, The Consultant - Friend or Foe?, Break (highlighted in yellow), and The User - Making Demands. The copyright notice '© 2002 Fibreoptic Industry Association' is located at the bottom right of the slide.

This slide is a title slide for a presentation. It features the FIA logo in the top left corner. The main title 'THE USER - MAKING DEMANDS' is centered at the top in a blue bar, with the speaker's name 'Mike Daly, HSBC' to its right. Below this, a larger blue bar contains the subtitle 'The User- Making Demands'. The background image is the same as the first slide, showing a hand holding a fiber optic connector. The FIA logo and the title 'STAND OUT FROM THE CROWD' are repeated in the center. Below the title, the date and location '14th May 2002, Bisham Abbey' are listed. On the right side, a box contains the speaker's name and affiliation: 'Mike Daly, ITO Project Manager, HSBC'. The copyright notice '© 2002 Fibreoptic Industry Association' is at the bottom right.

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THE USER - MAKING DEMANDS Mike Daly, HSBC

History of User Design Demands

Year	Design Demand
1992	How much?

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History of User Design Demands

Year	Design Demand
1992	How much?
1995	£'s per Mbps per metre?

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History of User Design Demands

Year	Design Demand
1992	How much?
1995	£'s per Mbps per metre?
2000	It must support 100BASE-x

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History of User Design Demands

Year	Design Demand
1992	How much?
1995	£'s per Mbps per metre?
2000	It must support 100BASE-x
2002	How do I get 1000Mbps? (across Desk, LAN, MAN, WAN)?

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History of User Design Demands

Year	Design Demand
1992	How much?
1995	£'s per Mbps per metre?
2000	It must support 100BASE-x
2002	How do I get 1000Mbps?
2004	Must have more - now what do I do?

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History of User Design Demands

Year	Design Demand
1992	How much?
1995	£'s per Mbps per metre?
2000	It must support 100BASE-x
2002	How do I get 1000Mbps?
2004	Must have more - now what do I do?
2006	Err ?????

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Network Evolution Trends

Legend:

- Convergence of Services
- Users Requiring Connections
- Moves & Changes
- Space Allocation

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A Common Structure

- Standard template
- Application mapping
- Defined performance

- Component and system compatibility
- Defined costs
- Reduced risk

- Simplified choice
- Underwritten design

	Copper	OF
Bandwidth distance product	✓	✓
Vendor independent	✓	✓
Flexible	✓	✓
Packing density	✓	✓
Application standards support	✓	✓
Technology upgrade path	✓	✓
Single SLA	✓	✓
Multiple services support	✓	✓
Low cost of ownership	✓	
No incremental costs	✓	
No additional interface equipment	✓	
Standards support	✓	✓

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The Benefits of a Generic Template

Improved ROI
 Reduced user risk
 Network convergence
 CHURN management

Increased demand
 Increased industry expertise
 Knowledgeable suppliers
 Plenty of headroom

Cost avoidance areas

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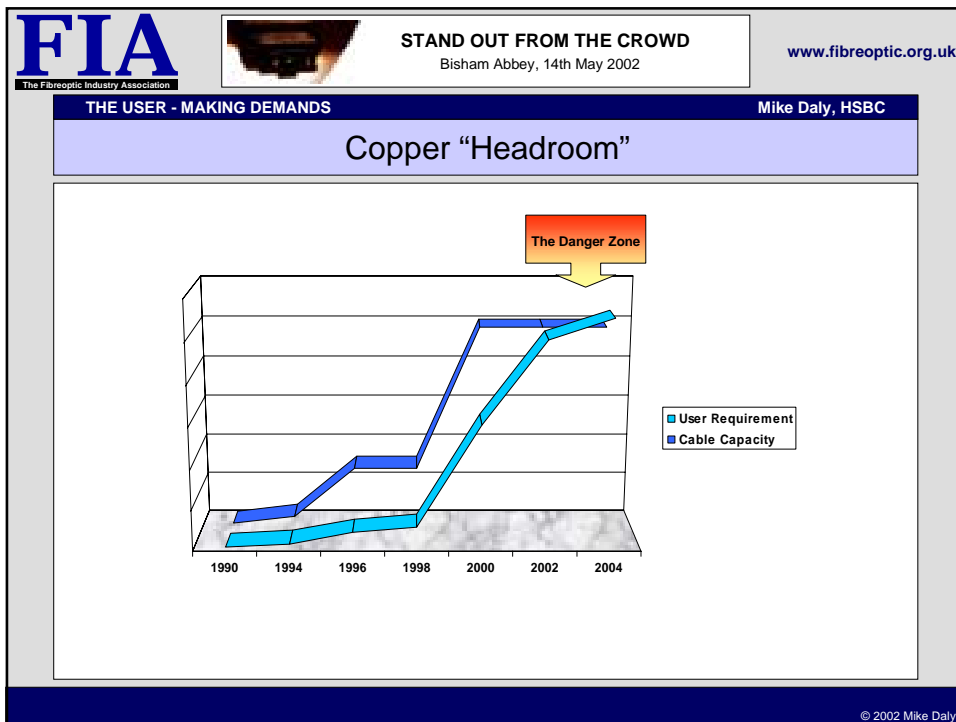
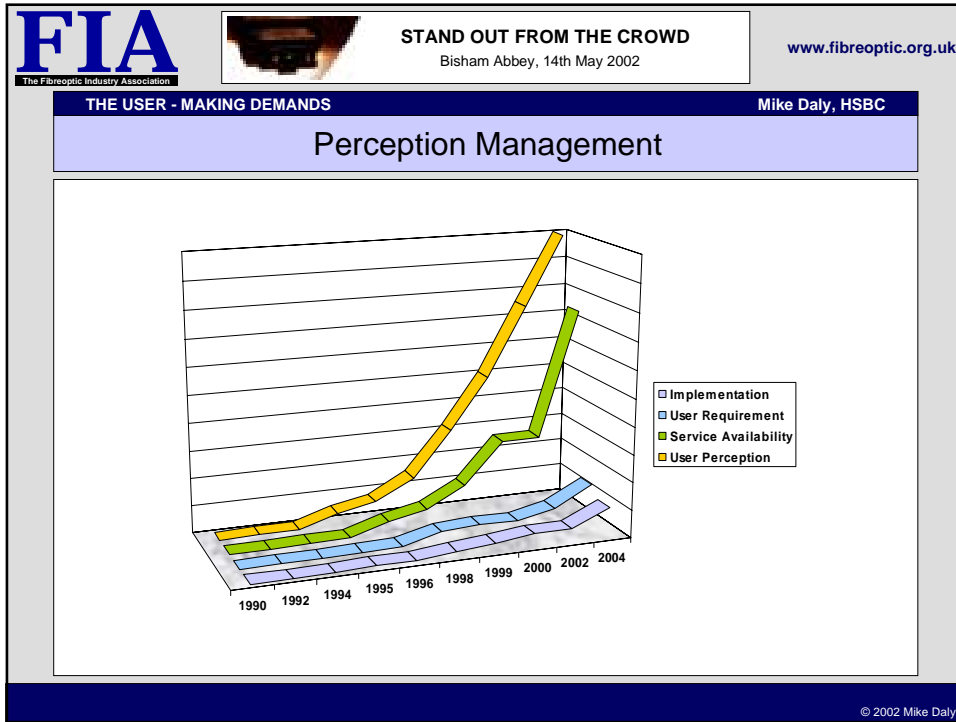
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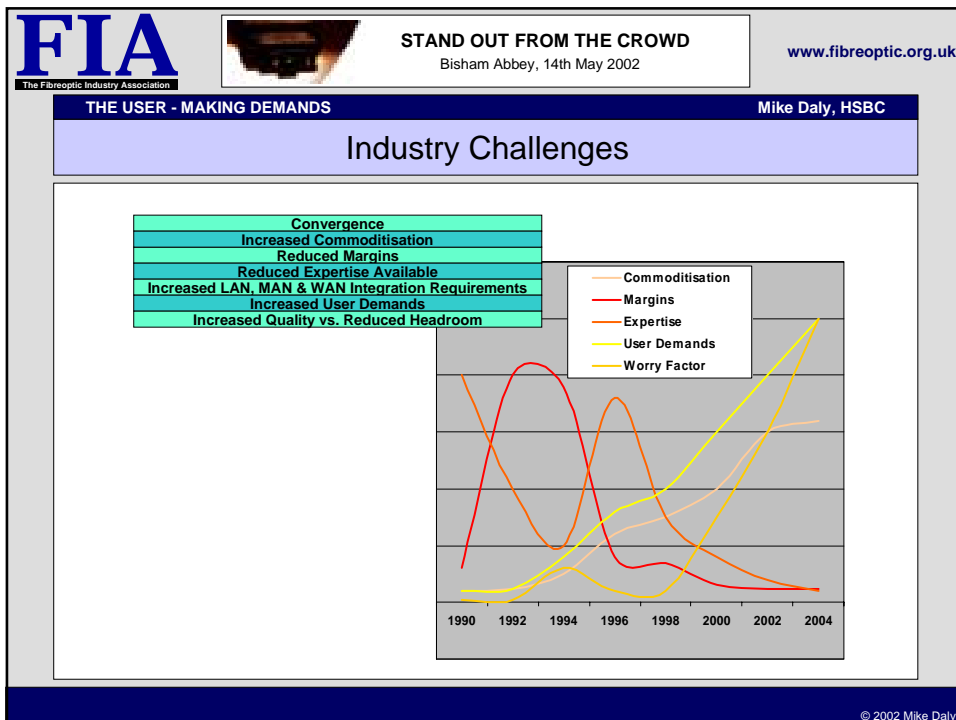
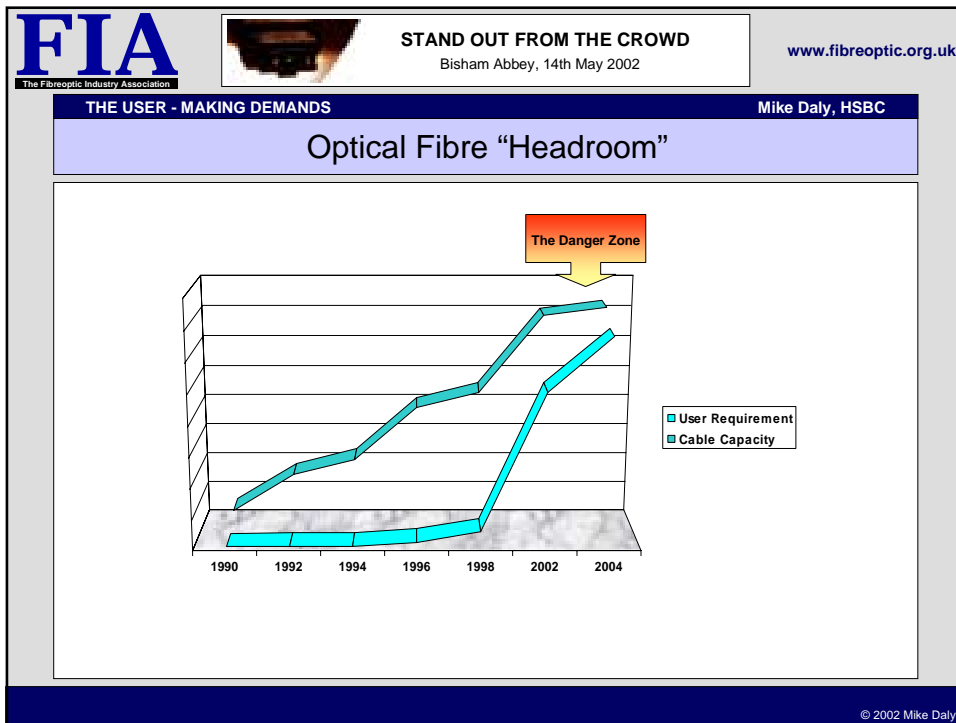
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User ~~Understanding~~ Misconceptions

I don't need to know how to "spec" it to get a working system	WRONG
Standards provide all the information I need	WRONG
Of course the equipment will work with it	WRONG
It'll be alright on the night	WRONG
It must cost nothing	WRONG
Lifetime guarantee	WRONG
I can do what I like and it will still work	WRONG
The installer and the equipment supplier will sort it out with the consultant	WRONG

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Design Challenge vs. Changing Requirements

CABLING

- diminishing headroom and tighter specifications
- optical fibre: link and DWDM
- LAN, MAN and WAN requirements

EQUIPMENT

- tighter optical power budgets
- optical fibre: link and DWDM interfaces
- LAN, MAN and WAN requirements

DESIGN AND SUPPLY
 (building, campus and external service provision)

- multiple building and line plant
- multiple optical fibre types and specifications
- LAN, MAN and WAN requirements

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Industry Expertise vs. Demands

Legend:

- Copper : Needed
- Copper : Available
- Fibre : Needed
- Fibre : Available

1990 1995 2000 2005

The current position

- increased user demand
- reduced expertise available

Immediate action

- industry training:
 - power budgets
 - maximum channel insertion loss
 - headroom
 - network capacity
 - network performance
 - component compatibility
- industry training
 - specification of the requirement
- industry training
 - design
 - installation
 - testing

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Real User Requirements

USERS REQUIRE

- No Bovine Excrement
- People who know what they are talking about
- A reality check
- People who make things happen
- People who can resolve problems

VENDORS NEED TO PROVIDE

- Delivery and action, not words
- No "Voyages of Discovery"
- No surprises
- Honesty
- Agreed design requirements and system specification
- Trust in design and supply ability
- Trust in installation quality and test results
- Trust in resolving technical and compatibility issues

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(Daly's User Guide : Part 1)

SUPPLIER

Be reliable and honest about capabilities

Understand what you are talking about
 Understand how to link cable plant and equipment across network boundaries
 Understand the user requirements and define them if not available
 Understand the limits of the system and agree EXACTLY that what you deliver will do and what it won't do
 Resource correctly : design, Q.A. and implementation
 Delivery to time and cost - no excuses
 Don't under-deliver: only one chance to make an impression
 Deliver NO surprises.
 Communicate throughout

USER

Understand what you are asking for
 Understand the complete network requirements and define them clearly
 Don't ask for the impossible
 Understand the impact of changing your requirements (time, cost, performance)
 Confirm backwards and forwards compatibility before you complain that it doesn't work
 Understand what you will get for your money
 Understand how you expect to validate, accept, support, change and expand the network at the time of negotiation & ordering.
 Check supplier capabilities and history

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The Delivery Specification

FIA Background Information Slide



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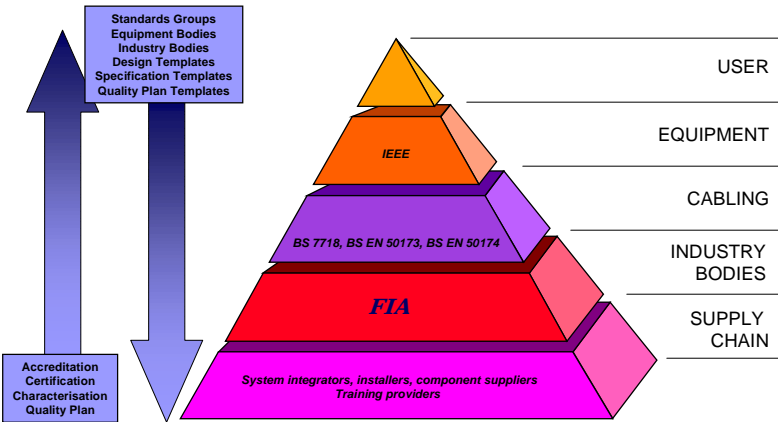
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Standards Groups
Equipment Bodies
Industry Bodies
Design Templates
Specification Templates
Quality Plan Templates

Accreditation
Certification
Characterisation
Quality Plan

USER

EQUIPMENT

CABLING

INDUSTRY BODIES

SUPPLY CHAIN

System integrators, installers, component suppliers
Training providers

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Standards and Industry Bodies

- User training
- Supplier training
- Design Guides

Codes of Practice
for installation, testing and quality assurance

DWDM specification, design & implementation guides

JOINED UP Interoperability specifications
for cable, equipment and PTT products

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Introduction
FIA Services
Work "Smart"
Testing Solutions
The Consultant - Friend or Foe?
The User - Making Demands
Questions and Answers

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- Introduction
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- Close**

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