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STAND OUT FROM THE CROWD

22nd January 2003
The Building Centre
London

- 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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Steve Strange
FIA Commercial Director

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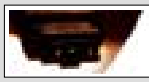

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FIA SERVICES | Steve Strange, Commercial Director

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Mike Gilmore

The Cabling Partnership

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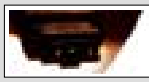

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Work Smart

Mike Gilmore

Senior Partner,
The Cabling Partnership

Managing Director
e-Ready Building

Standards Activities

Member:
ISO/IEC JTC1 SC25 WG3: Generic Cabling
ISO/IEC JTC1 SC25 Project Team: SOHO

Convenor:
ISO/IEC JTC1 SC25 WG3 IPTG: Industrial Premises Cabling

Convenor:
CENELEC TC215 WG1: IT Cabling
CENELEC TC215 WG1 PTIP: Industrial Premises Cabling

Chairman:
BSI TCT7/-/1: IT Cabling
BSI TCT7/-/3: IT Cabling Support Group

Technical and Standards Director:
Fiberoptic Industry Association

e-mail: mike.gilmore@btinternet.com

Mobile: +44 (0) 7860 110563

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The End is Nigh

EN 50173-1 (2002)	ISO/IEC 11801 Ed.2 (2002)	ANSI/TIA/EIA 568 B Series
Information technology - Generic cabling systems	Information technology - Generic cabling for customer premises	Commercial building telecommunications cabling standard
• published Q4, 2002	• published Q4, 2002	• B.1 General Requirements • published • B.2 Balanced Cabling • published • Addendum 1 • Category 6 • published • B.3 Optical Fibre Cabling • published

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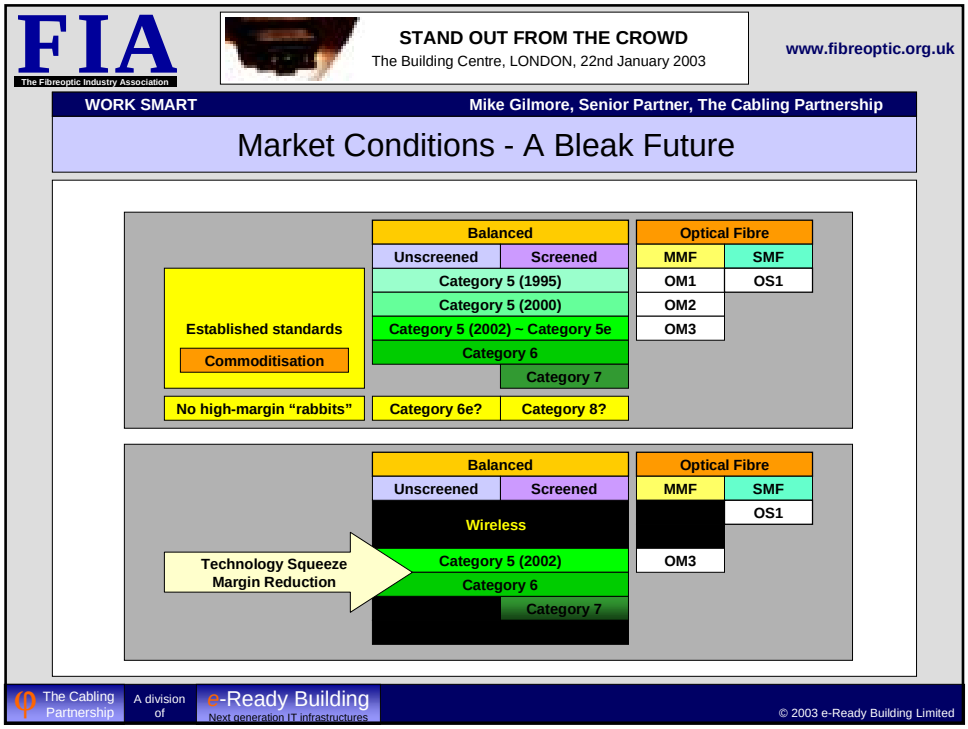

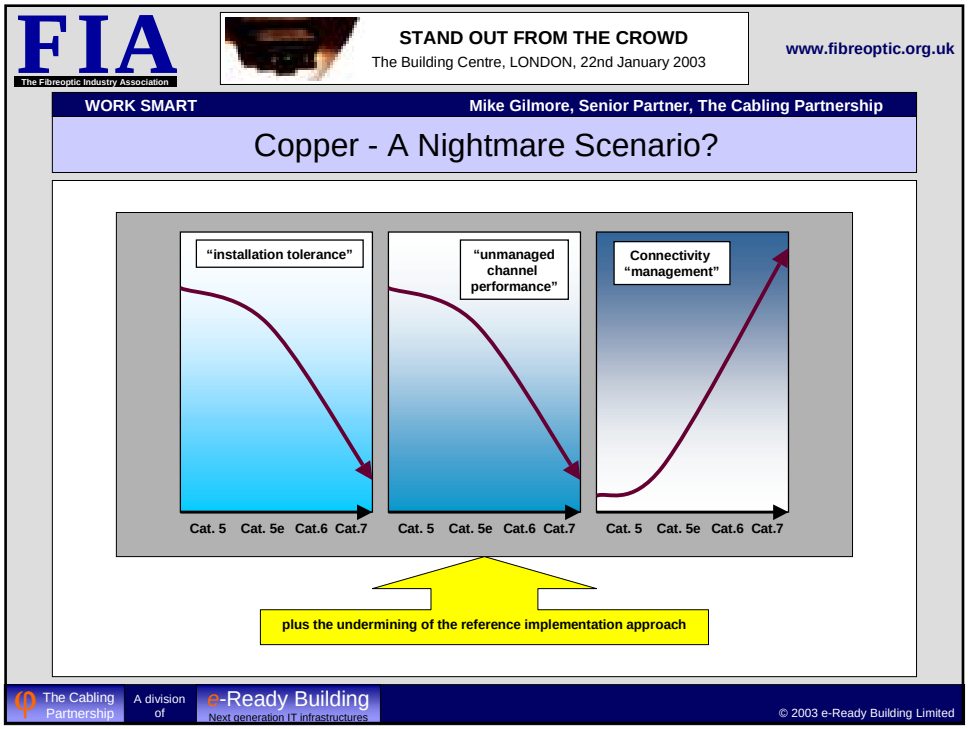

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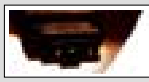

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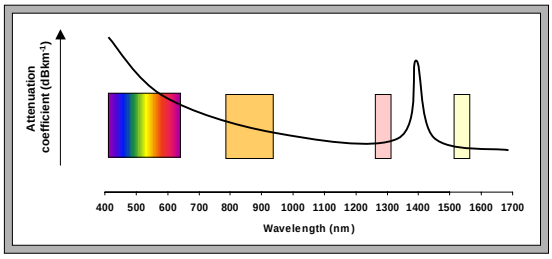
1GbE Performance Margin - What Margin?



	850nm		1300nm		1310nm
	62.5/125	50/125	62.5/125	50/125	SMF
OFL Modal Bandwidth (MHz.km)	200	500	500	500	
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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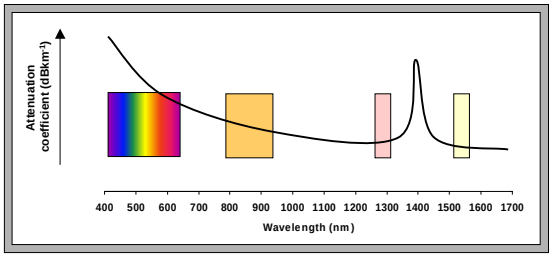
10GbE Performance Margin - What Margin?



	850nm		1300nm	1310nm		1550nm
	62.5/125	50/125	MMF	SMF		
OFL Modal Bandwidth (MHz.km)	200	500	500			
Assumed OF attenuation (dBkm-1)	3.50	3.50	1.5	0.4		0.5

10GBASE	-SR/SW		-LX4	-LR/LW	-LX4	-ER/EW
	830nm		1269-1356 nm	1270nm	1269-1356 nm	1550nm
Maximum channel length (m)	33	82	300	10000	10000	40000
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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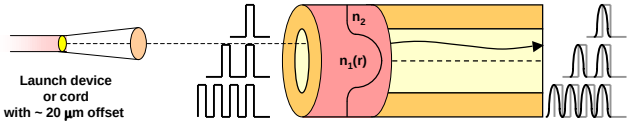
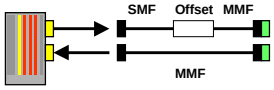
Application-specific Cordage



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



Mode conditioning cord

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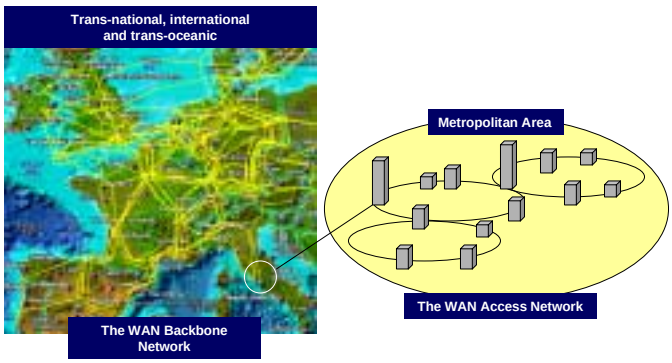
WAN Opportunities?



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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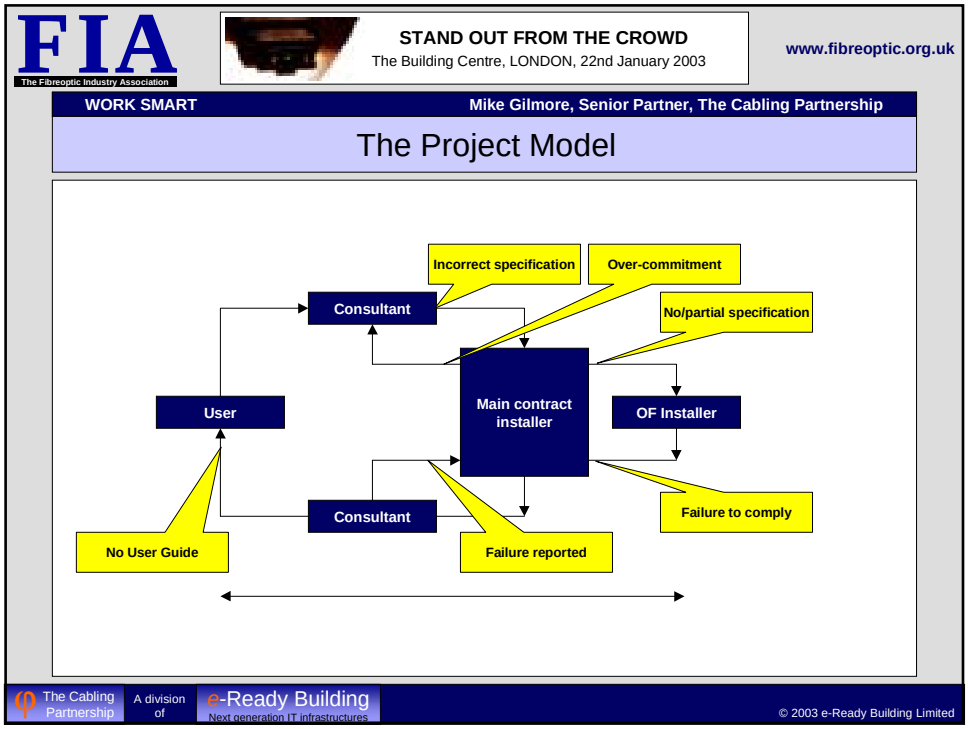

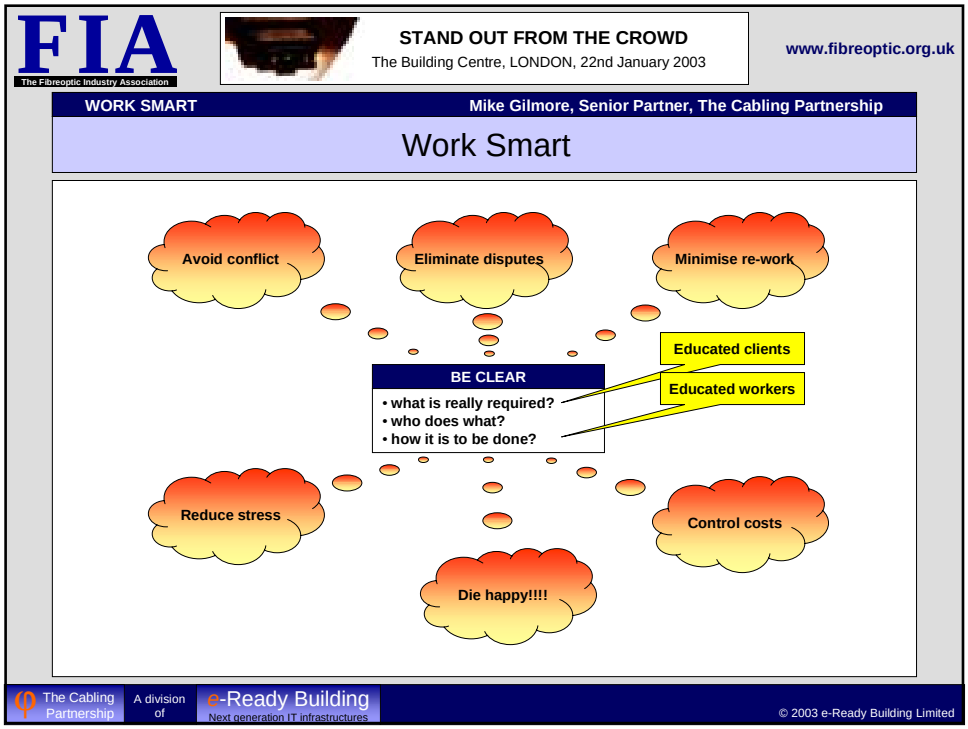

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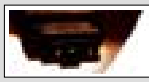

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Installation Standards - Increasing Regulation

BS EN 50174-1	Information technology - Cabling installation- Part 1: Specification and Quality Assurance
BS EN 50174-2	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 60825-2	Safety of Laser Products Part 2: Safety of optical fibre communication systems
BS 7671	Requirements for electrical installations: IEE Wiring Regulations: Sixteenth Edition

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Installation Standards - Changes Ahead

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 EN 50174-3 (2003)	Information technology - Cabling installation- Part 3: Installation planning and practices between buildings
BS 6701 (2003)	*Installation of apparatus and cabling to support telecommunications systems*

"Standard" - not Code of Practice

incorporating optical fibre

referenced from BS 7671

references EN 50174 series

IEC 60825-2	Safety of Laser Products Part 2: Safety of optical fibre communication systems
BS 7671	Requirements for electrical installations: IEE Wiring Regulations: Sixteenth Edition

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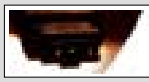

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Testing Standards - Spoilt for Choice?

BS EN 61280-4-2	Fibre optic communication subsystem basic test procedures - Part 4-2: Fibre optic cable plant - Single-mode fibre optic cable plant attenuation
BS EN 50346	Information technology - Cabling installation- Testing of installed cabling

IEC 61280-4-1 (underway)	Fibre optic communication subsystem basic test procedures - Part 4-1: Fibre optic cable plant - Multimode fibre optic cable plant attenuation
ANSI/TIA/EIA-526-14-A	OFSTP-14A Optical Power Loss Measurement of Installed Multimode Fiber Cable Plant (ANSI/TIA/EIA-526-14A-98)
ANSI/TIA/EIA-526-7	OFSTP-7 Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant (ANSI/TIA/EIA-526-7-98)

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Testing Standards - Changes Ahead

BS EN 61280-4-2	Fibre optic communication subsystem basic test procedures - Part 4-2: Fibre optic cable plant - Single-mode fibre optic cable plant attenuation
BS EN 50346	Information technology - Cabling installation- Testing of installed cabling

EN 50346 Ed.1 A.1	Information technology - Cabling installation- Testing of installed cabling

incorporating latest test methods for optical fibre cabling

IEC 61280-4-1 (underway)	Fibre optic communication subsystem basic test procedures - Part 4-1: Fibre optic cable plant - Multimode fibre optic cable plant attenuation
ANSI/TIA/EIA-526-14-A	OFSTP-14A Optical Power Loss Measurement of Installed Multimode Fiber Cable Plant (ANSI/TIA/EIA-526-14A-98)
ANSI/TIA/EIA-526-7	OFSTP-7 Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant (ANSI/TIA/EIA-526-7-98)

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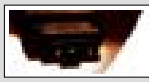

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FIA Technical Support

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

e-mail link

Installation Browser

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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e-Tools in Action

"*e*-Tools" are an integrated multi-platform documentation system

The Cabling Partnership — Project Browser

- Project Documentation
- Architects Drawings
- Cabling Schematics
- Test Results
- Connectivity Data

The Cabling Partnership — Company IntraNet

- Company Data
- Policies
- Method Statements

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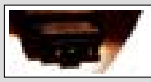

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FIA Initiatives

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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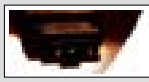

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TESTING SOLUTIONS | Paul Bateson, Optical Test and Calibration

Testing Solutions

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Optical Test and Calibration

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Fax: +44 (0) 1274 393336
Email: info@otc.co.uk
Web: www.otc.co.uk

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

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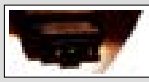

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Web: www.otc.co.uk

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

Services Offered

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	Section Two	Section Three
Fibre Optic Basics	Measurement Techniques	Understanding Measurements

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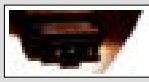

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Agenda

Section One	Section Two	Section Three
Fibre Optic Basics	Measurement Techniques	Understanding Measurements

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

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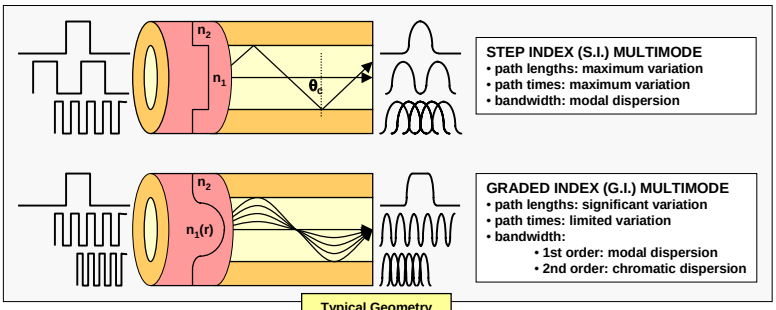
Multimode Optical Fibre



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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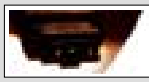

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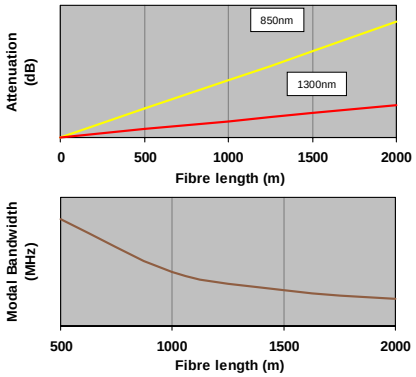
Multimode Optical Fibre

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	-



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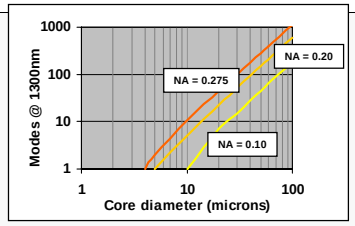
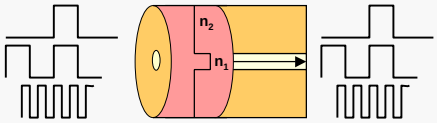
Singlemode Optical Fibre





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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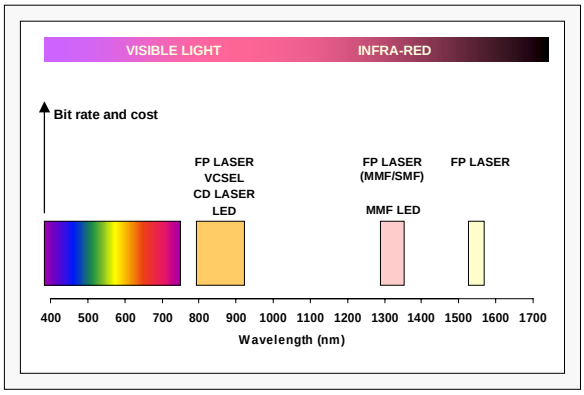
Fibre Optic Sources



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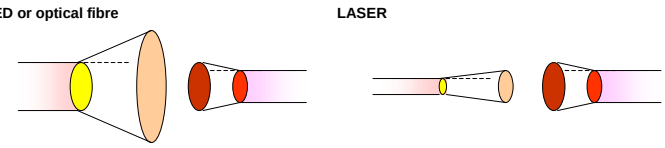
Coupling Losses



COUPLING LOSSES					
From					To
LED	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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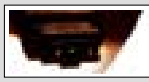

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Typical Interconnections

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 Doamin Reflectometry
Specialist Measurements

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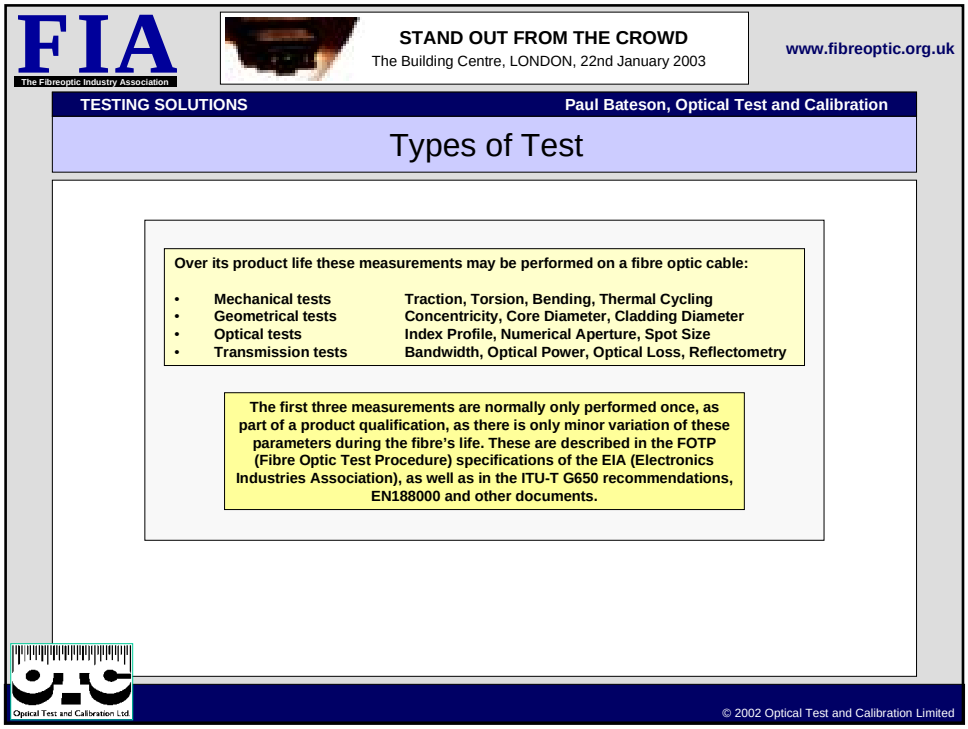

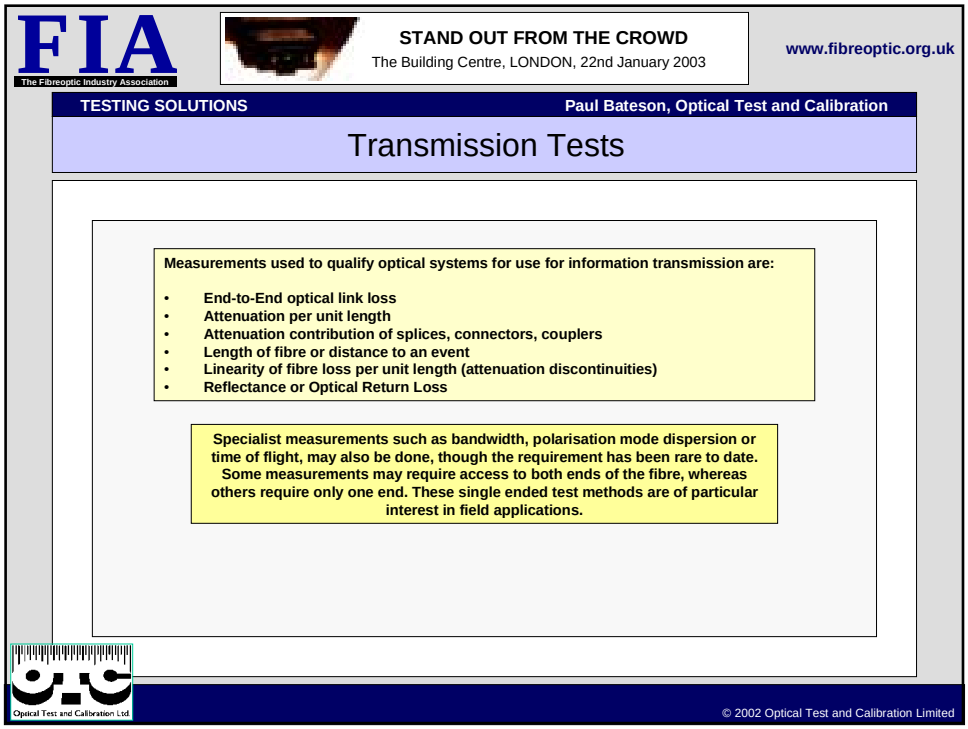

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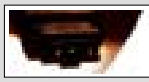

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Field Testing

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.

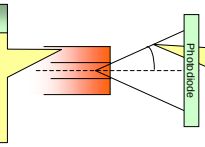
Typical Dynamic Ranges for power meters are:
- **+13 dBm to -70 dBm for telephony applications**
- **+24 dBm to -50 dBm for CATV applications**
- **-20 dBm to -60 dBm for LAN applications**

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 a 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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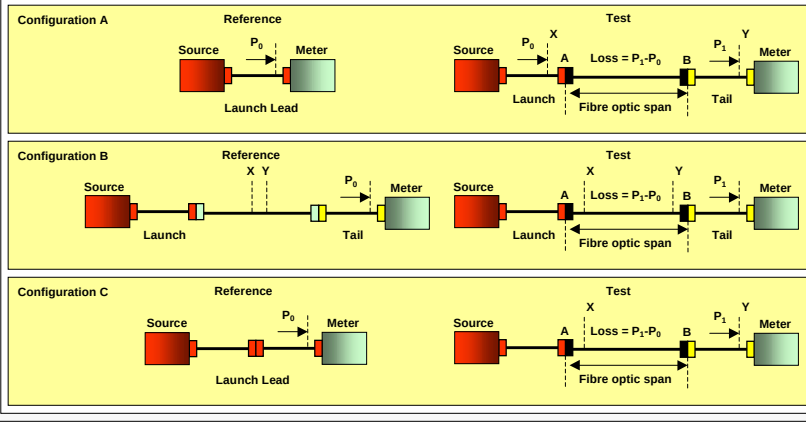
Insertion Loss Measurement



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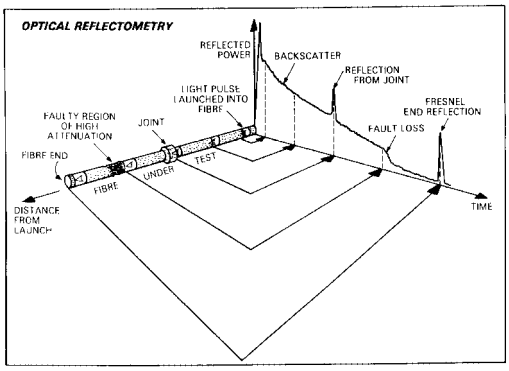
Optical Time Domain Reflectometry

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 ≤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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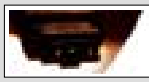

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Special Measurements

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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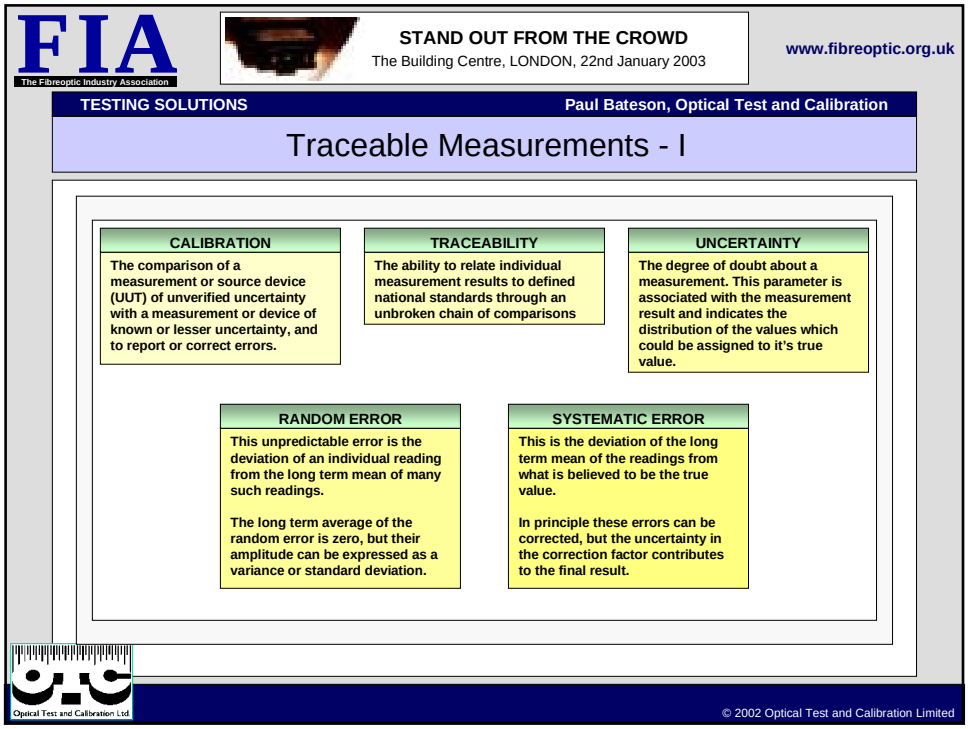

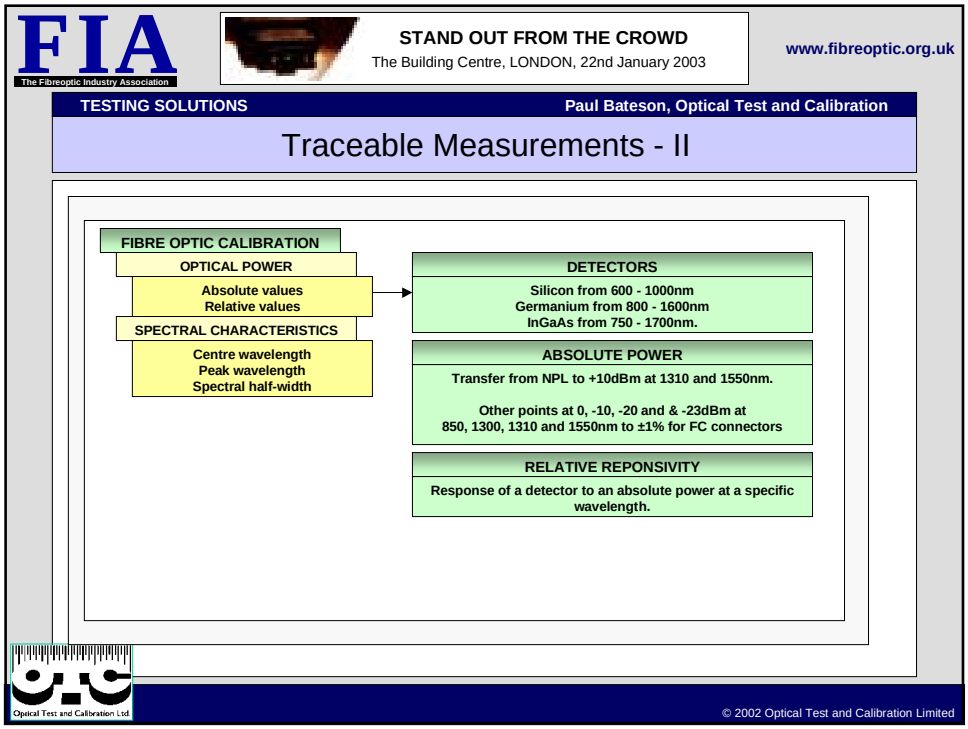

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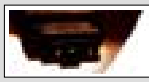

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Sources of Error

WAVELENGTH

Experimentation with Time of Flight shows errors in length of up to 2m for a change in 20nm in peak wavelength!

Nominal 3km 50/125 multimode

812nm	3084.31m
834nm	3082.91m
851nm	3081.04m

DECADE ERRORS IN METERS

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.

TEMPERATURE VARIATIONS

These affect detector responsivity and source wavelength.

OPTICAL REFLECTIONS

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.

GROUP REFRACTIVE INDEX

Many OTDR's now allow setting of Group Index to at least 4 decimals. Temperature fluctuations of only ±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.

SYSTEMATIC ERROR

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.

Look out for new Raman lasers to 3W power!

SOURCE CHARACTERISTICS

Mode structure of lasers, the laser drive current and localised laser chip heating effects all contribute to wavelength and optical power fluctuations.

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Human Factors

PEOPLE	TOOLS	PROCESS
Use personnel with direct practical experience of the work involved to conduct interviews with potential staff	Apply ergonomic as well as technical criteria when purchasing new equipment	Involve staff in the design and review of jobs.
Guard against any factors e.g. excessive time pressures which may adversely affect staff performance.	Ensure that any software purchased for measurement or documentation is 'fit for purpose'.	Design work processes to provide adequate variety and sufficient breaks.
Invest in training to ensure staff have the skills and competency to fulfil their role.	Adopt a 'user-centred' approach when developing new systems.	Allow staff to concentrate when required and minimise sources of interruption.
		Consider automating any parts of a process which may be prone to error.
		Improve checking and audit strategies where possible.
		Promote information exchange within the organisation.

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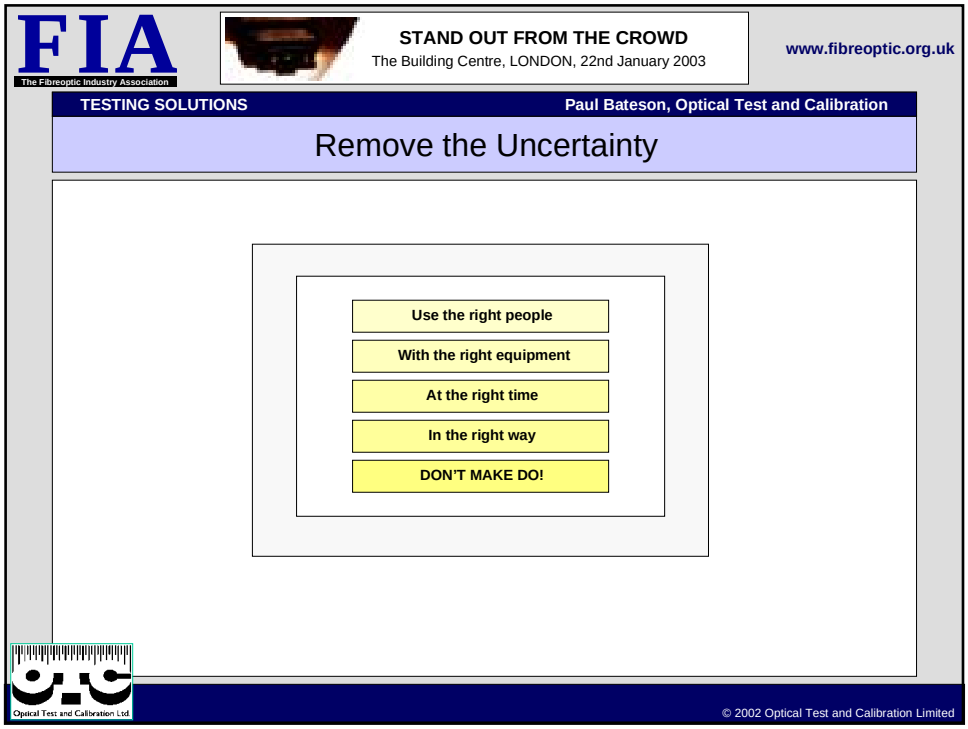

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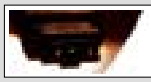

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Glossary - I

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

Absorption: in an optical fibre, loss of optical power resulting from the conversion of power into heat.
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.
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.
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.
Backscattering: portion of scattered light returned in the opposite direction to that of propagation.
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.
Bend Radius (minimum): The radius a fibre can bend before increased loss or mechanical damage occurs.
Cut-off Wavelength: in a singlemode fibre, the shortest wavelength at which a single mode can transmitted. Beyond this wavelength, several modes transmit simultaneously, and the fibre becomes multimode.

CW: abbreviation for continuous wave.
Dense WDM: Dense Wavelength Division Multiplexing is used to transmit several signals on the same fibre within a narrow wavelength band.
DFB: Distributed Feedback Laser, incorporates a Bragg reflection grating in the active region of the laser diode to enhance a single longitudinal mode.
Dispersion: The cause of bandwidth limitation in fibre. The broadening of a light pulse as it propagates along a fibre:
Modal Dispersion caused by differential optical path lengths in an optical fibre.
Chromatic Dispersion caused by differential delay of various wavelengths of light passing through a fibre.
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.
IEC/Bellcore defines this noise floor point as that containing at least 98% of all noise data points.
The RMS definition defines the noise floor point for a Signal-to-Noise ratio = 1. (Typically gives a value −1.56dB better than IEC)
EDFA: Erbium Doped Fibre Amplifier. Amplifies optical signals without using O/E and E/O conversions.

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Glossary - II

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

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 cannot be measured.
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.
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.
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.
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.
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.
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.
Multimode Fibre: An optical fibre in which light travels in multiple modes.

Multiplex: Combining two or more signals into a single bit stream that can then be individually recovered.
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.
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=-10log(Pr/Pi).
Reflectance: The ratio of reflected power to incident power of an event or connector, represented by R=10log(Pr/Pi).
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.
Scattering: A property that causes light to deflect out of the core area of the fibre, thereby contributing to attenuation.
Singlemode Fibre: An optical waveguide or fibre in which the signal travels in one mode.
Step Index Fibre: A fibre whose index of refraction changes sharply at the interfaces of its core and cladding.
WDM: Wavelength Division Multiplexer. Passive fibre optic components which combine optical channels on different wavelengths.

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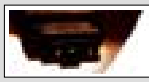

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Optical Test and Calibration Ltd

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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 USER - MAKING DEMANDS — **Mike Daly, HSBC**

The User- Making Demands

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Mike Daly
VCCTI Manager

HSBC

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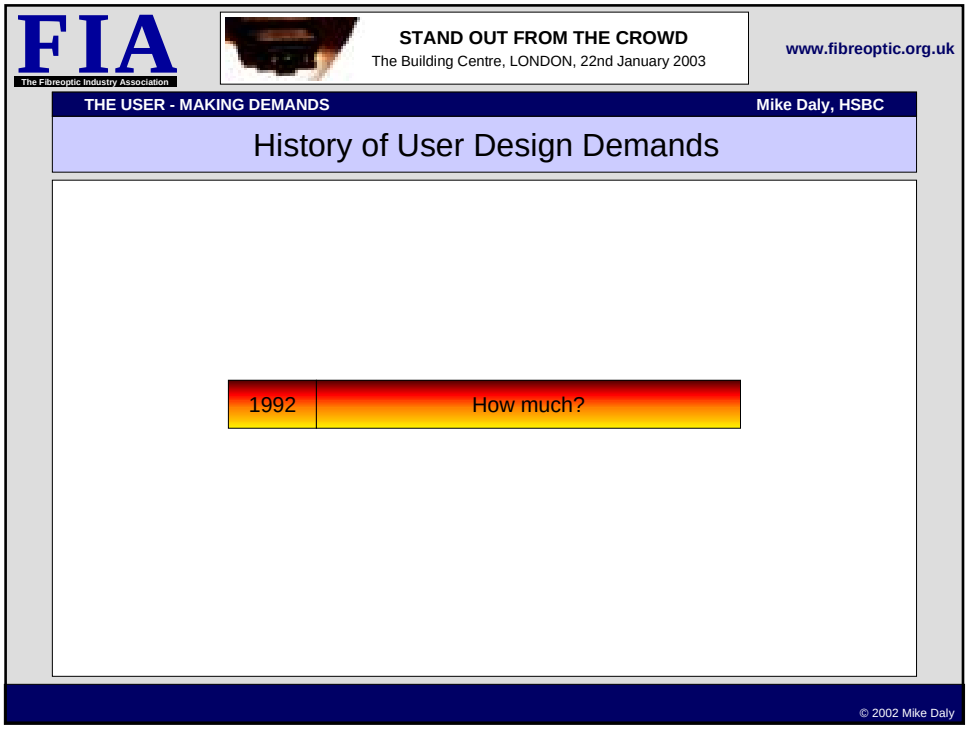

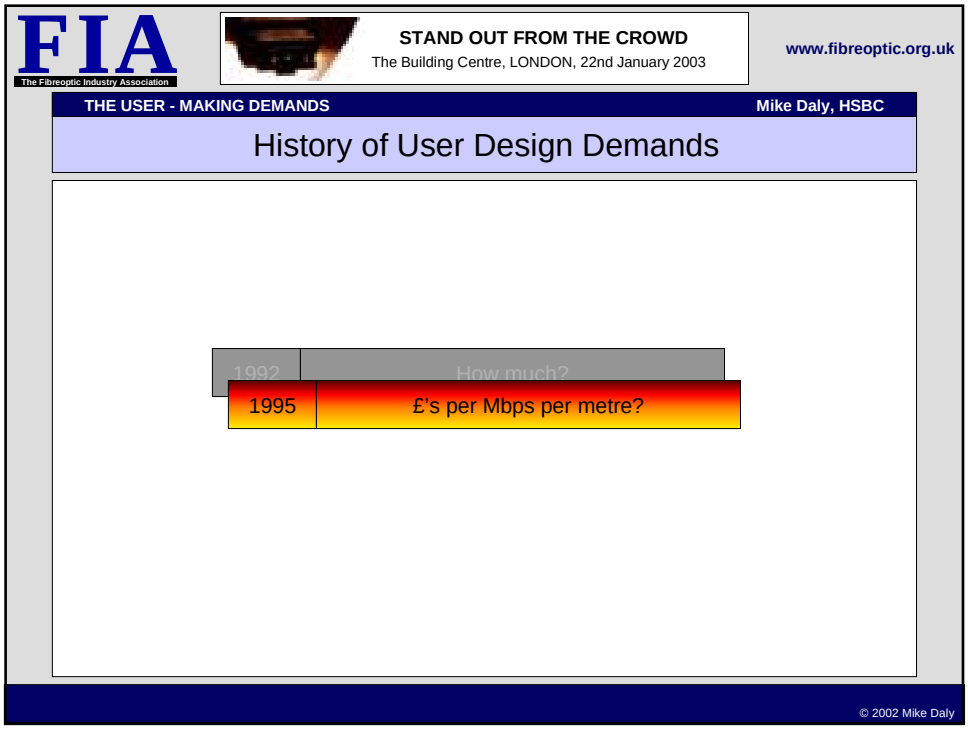

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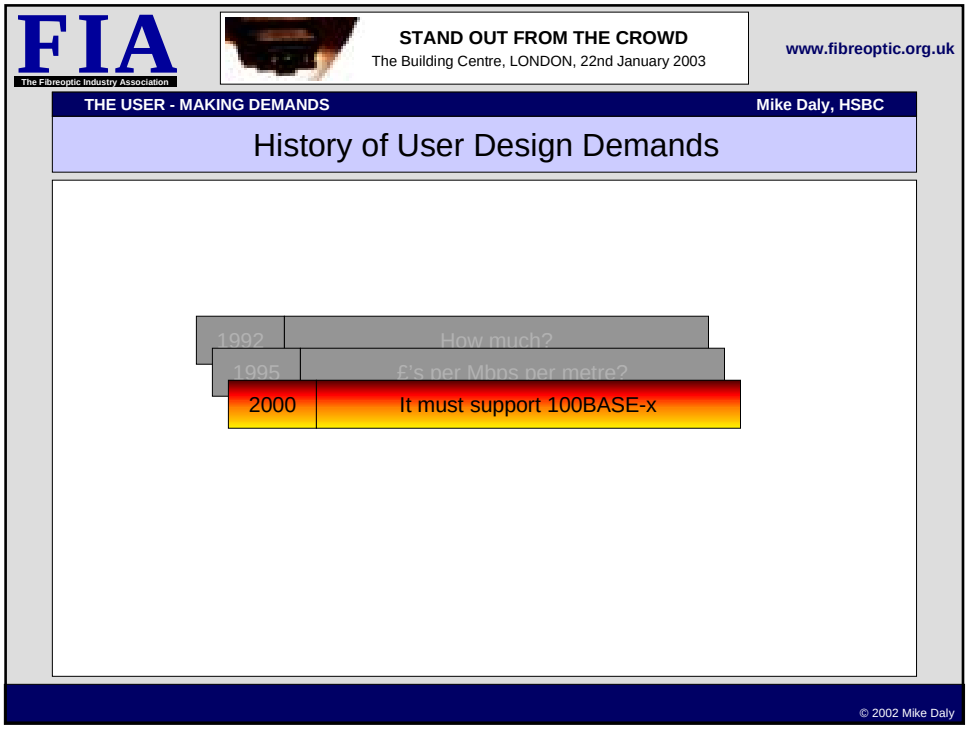

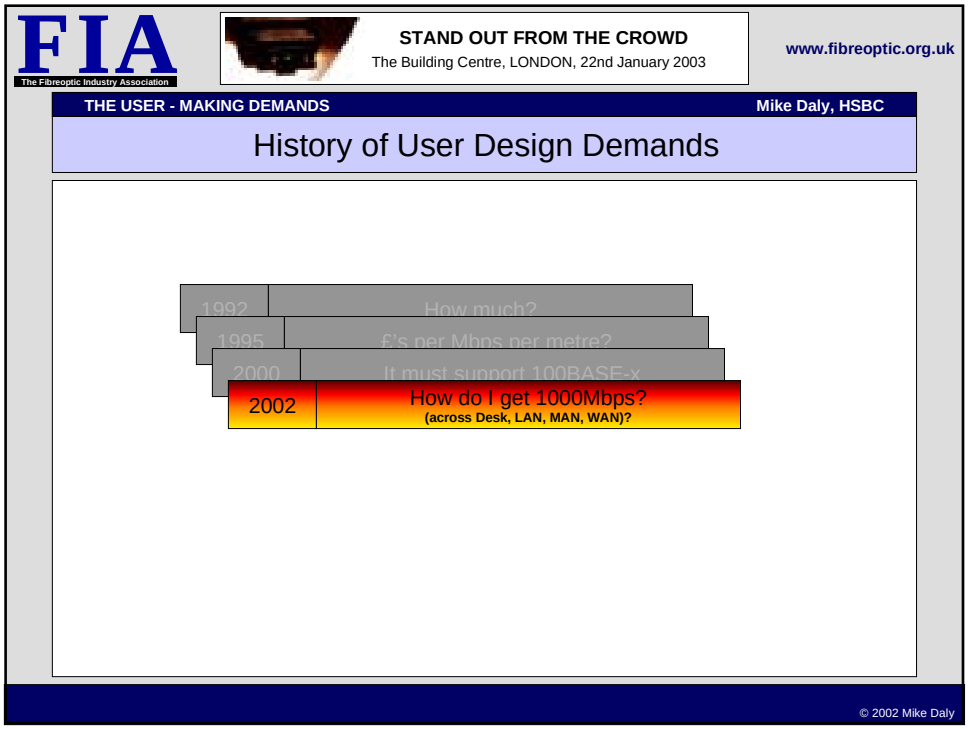

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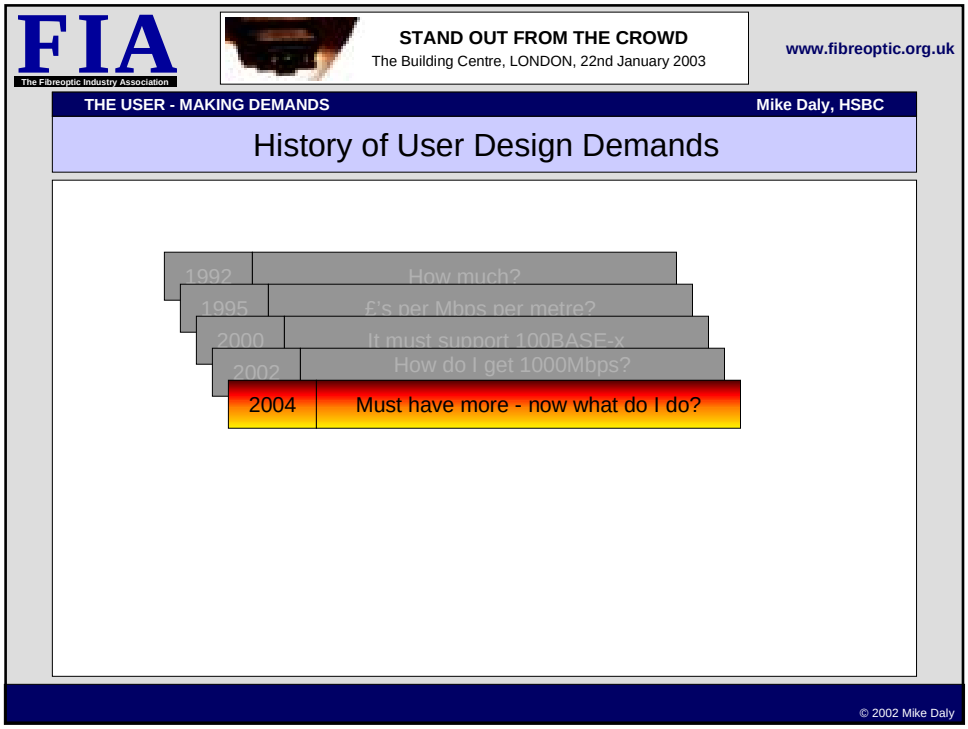

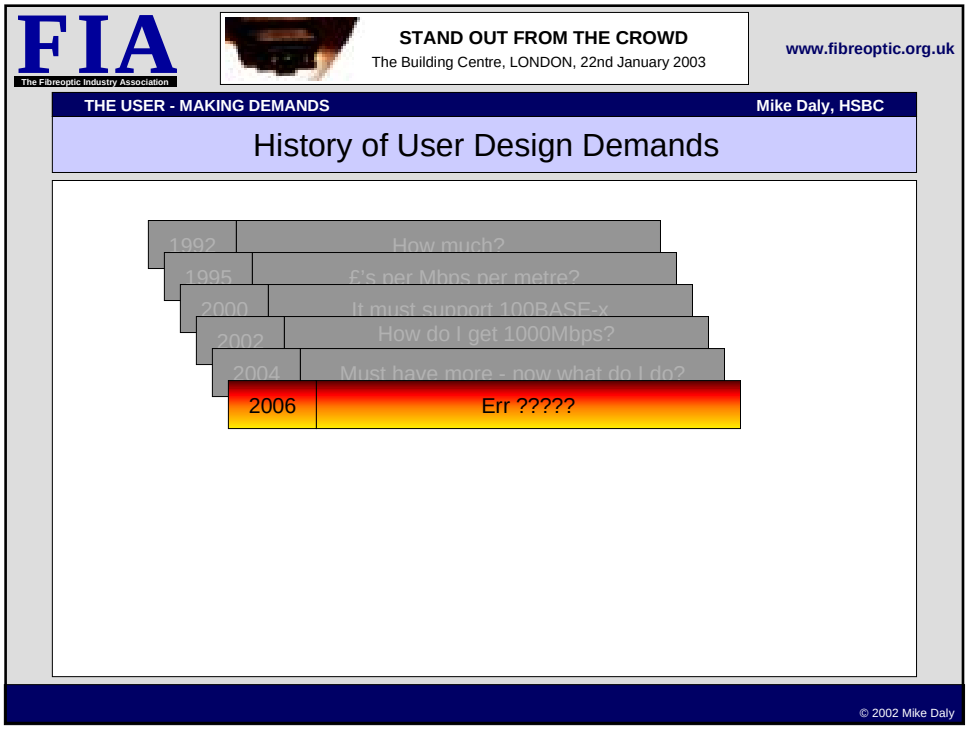

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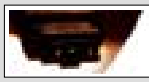

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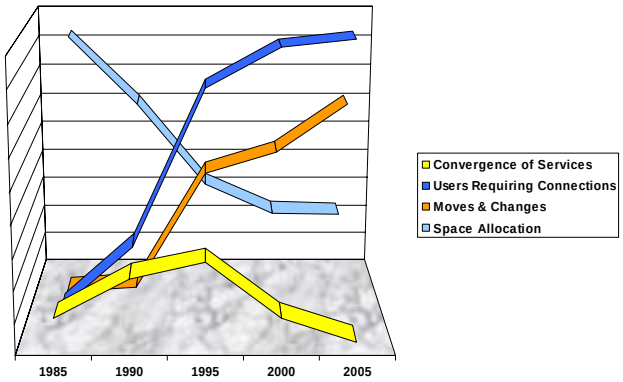
THE USER - MAKING DEMANDS — Mike Daly, HSBC

Network Evolution Trends



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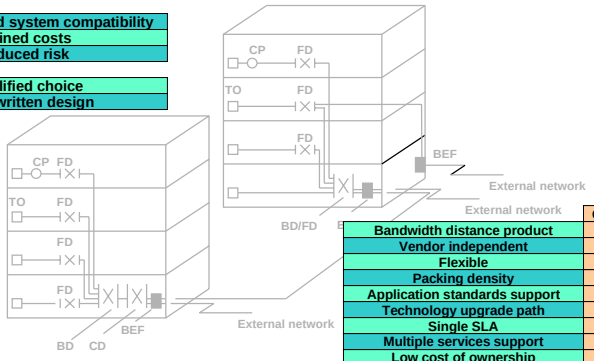
A Common Structure

- 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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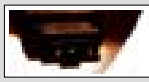

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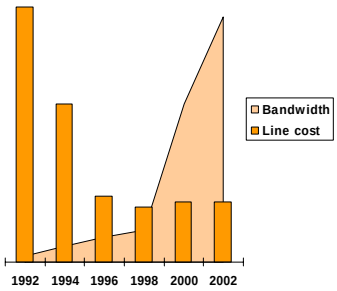
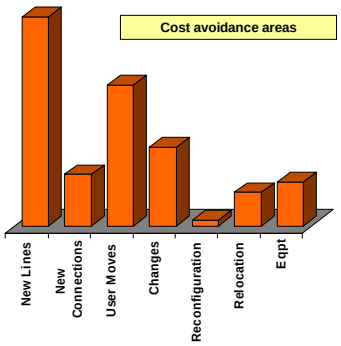
The Benefits of a Generic Template

- Improved ROI
- Reduced user risk
- Network convergence
- CHURN management

- Increased demand
- Increased industry expertise
- Knowledgeable suppliers
- Plenty of headroom





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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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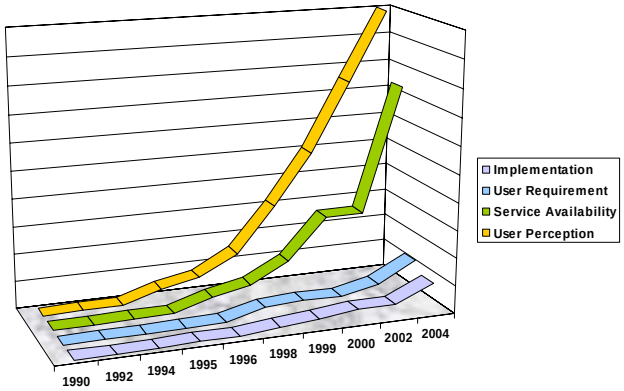
Perception Management



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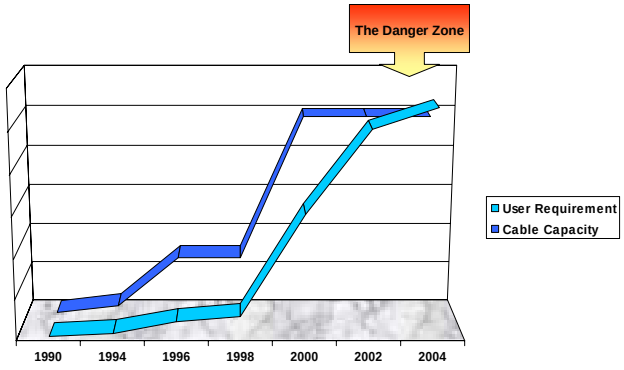
Copper “Headroom”



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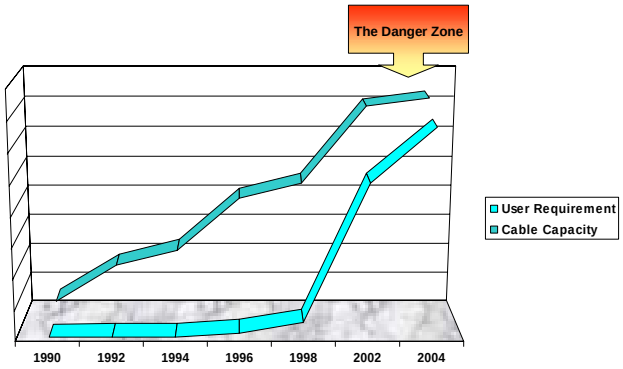
Optical Fibre "Headroom"



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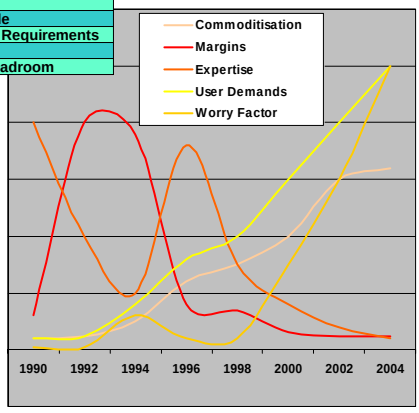
Industry Challenges

- Convergence
- Increased Commoditisation
- Reduced Margins
- Reduced Expertise Available
- Increased LAN, MAN & WAN Integration Requirements
- Increased User Demands
- Increased Quality vs. Reduced Headroom



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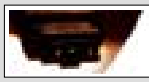

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Design Challenge vs. Changing Requirements

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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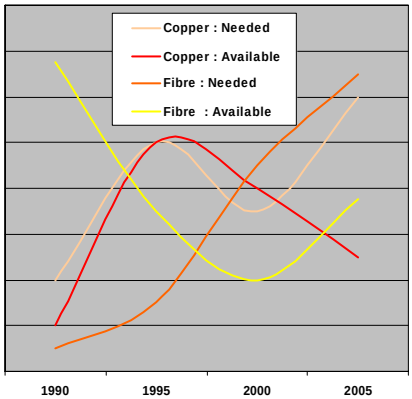
Industry Expertise vs. Demands



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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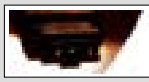

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Real User Requirements

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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Stand Out from the Crowd, Avoid Headaches and Litigation

(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

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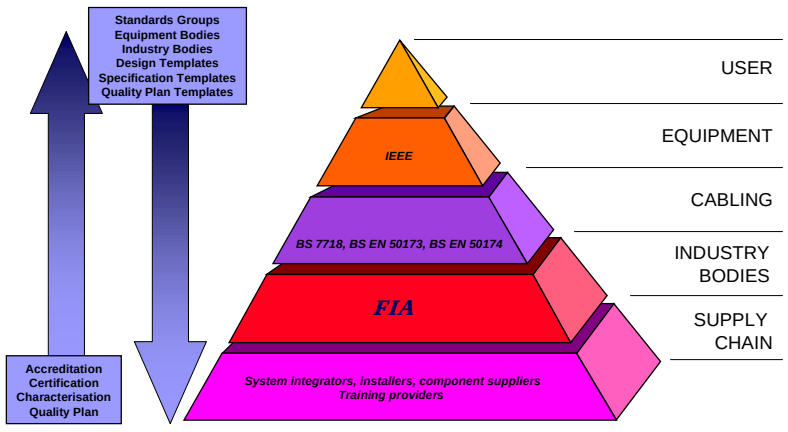
(Daly's User Guide : Part 2)



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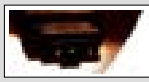

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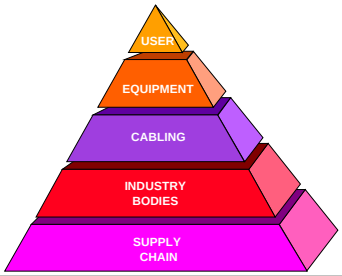

Standards and Industry Bodies

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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- **Questions and Answers**

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