

ACOPTIC®

Characteristics of single-mode fibres

Single-mode fibres

An expert in the field of fibre drawing, ACOME presents its range of single-mode optical fibres.

ACOME single-mode optical fibres meet the most stringent transmission requirements for all network applications (WAN, MAN, FTTx, etc.). Their high quality of production allows them to be used for C-WDM and D-WDM applications.

ACOME optical fibres fully comply with the current ITU standards G652, G652C, G655, and IEC 560793-2-50.

The fibres manufactured by ACOME are produced on the site at Mortain (France). The preforms are made using the Advanced Plasma and Vapour Deposition (APVD) process, which guarantees optical fibres of a very high level of purity.

The secondary coating of the ACOME range of single-mode fibres is directly coloured in the mass during the fibre drawing process (COLORLOCK™ process)

ACOME optical fibres can be used in loose tube, compact tube, tight buffer and semi-tight buffer cable structures, as well as the new microstructures for blowing/carrying or micro civil engineering applications

Whatever the application, the ACOME range of single-mode optical fibres has the product to suit:

ACSM2: ACOME G652 fibres

These fibres exceed the requirements of the current standards and are ideal for all medium-and long-distance applications.

Optimised for very high speed applications and compatible with wavelength division multiplexed (D-WDM) signals, ACSM2 fibres meet the telecom operators' most stringent requirements.

ACSM2 fibres are very low PMD fibres guaranteeing their continued ability to cope with the very high bit rates of tomorrow. The low value of PMD is proof of ACOME's fibre drawing expertise.

ACSM2-C: ACOME G652C fibres

Optical fibres providing a wider spectrum by using band E (1 350 nm – 1 450 nm), allowing the available number of transmission channels to be increased.

ACSM5: ACOME G655 fibres

G655 (NZDSF) single-mode optical fibres for very high speed applications over very long distances

G653 type fibres

Cables can be produced using fibres complying with IEC standards 60793-2-50-B2 upon request

| Characteristics of ACOME fibres | Advantages |
|---|--|
| Low PMD optical fibres | Increased transmission distances at 40 Gbit/s |
| Low attenuation per unit length (including under extreme conditions) | Improved performance in all types of network (Access, MAN, WAN) |
| Fibres characterised in band L (1 625 nm) | Increase in spectrum available for future applications |
| Colouring of secondary coating in the mass | Colour stability, reduced diameter |
| Ease of stripping (mechanical and thermal) | Reduction of network installation and maintenance times |
| Compatibility with fibres on the market | ACOME fibres are compatible with all fibres available on the market* |

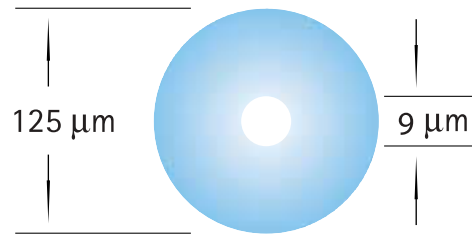
* Tests performed in certified laboratories

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Characteristics of single-mode fibres

9/125, G652 single-mode fibre

This is an optical fibre in which a light beam travels at a given wavelength. The diameter of the jacket is 125 μm and that of the core of the fibre is small (typically 9 μm)



Transmission characteristics



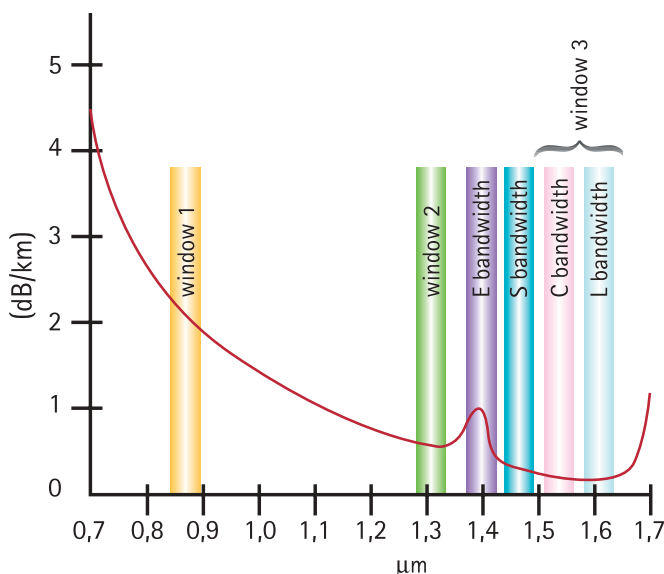
Applications

The most widely used fibre in telecommunications remains the G652. Other types of fibre have been developed, based on the G652 but seeking, in particular, to improve the chromatic dispersion or the polarisation mode dispersion (PMD), while at the same time seeking to limit the other non-linear effects.

Propagation window

Three propagation windows are defined for silica fibres:

- the first window at 850 nm for multimode fibres
- the second window at 1310 nm for multimode and single-mode fibres
- the third window at 1550 nm for single-mode fibres



Spectral attenuation of ACOMÉ fibres

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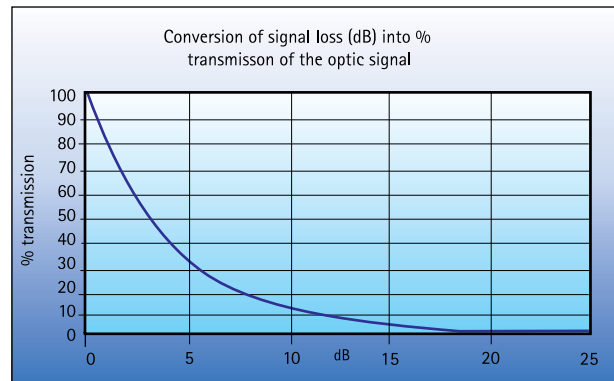
Characteristics of single-mode fibres

The attenuation measures the loss of power of the light signal between two points of the fibre. This loss is due to impurities and residual defects in the fibre. Attenuation is expressed in decibels per kilometre (dB/km) at a given wavelength.

Standards

These are established by international bodies such as the ITU, CENELEC and the IEC. Our fibres comply with these standards.

| Type of fibre | Corresponding standard |
|--------------------|------------------------|
| Single-mode fibres | CEI and EN 60793 |
| | ITU G652 |
| | ITU G652C |
| | ITU G653 |
| | ITU G655 |



Our cables comply with the following standards

| | International | American | European |
|--------------------------|--------------------------------|-------------|---|
| Cable standards | IEC 60 794 | | EN 60794 and EN 187 |
| Cabling system standards | ISO/IEC 11801 | EIA/TIA 568 | EN 50173 |
| Application standards | Token Ring | IEEE 802-5 | |
| | Ethernet (10 to 10,000 Mbit/s) | IEEE 802-3 | |
| | FDDI | | ANSI X3T9-5 |
| | ATM and SDH | | SONNET / SDH / STMx SONNET / SDH / Ocy |
| | Fiber Channel | | CD 14465-1 |

PMD

Since the mid 1980's, telecommunications operators have been constantly seeking to increase optical fibre transmission rates and offer an increasing range of services, all requiring more spectral bandwidth. This desire to transmit greater amounts of data at higher speed has brought to light a new dispersion phenomenon: PMD or polarisation mode dispersion. This dispersion effect is small and consequently only affects high bit rate transmissions.

Definition

PMD is a stochastic* phenomenon of dispersion of the light pulse along the length of a fibre caused by the interaction of the light with the material forming the optical fibre. It results in a loss of power and a broadening of the pulse, leading to transmission errors. Its measurement is therefore based on a statistical approach. The PMD is expressed in ps or ps/√km

Aware that each step of the cable manufacturing process can adversely affect the PMD of the fibre, ACOME has implemented manufacturing processes that preserve the transmission qualities of the optical fibres.

When ACOME develops new cable structures, it takes account of the transmission requirements and investigates the PMD performance of these new structures. It is a matter of preventing any alteration of the local birefringence of the fibres:

- during fibre production,
- during cable laying,
- in service.

The PMD is thus an important criterion to be taken into account when combining increased speeds with increased distances. The PMD values of ACOME fibres are well below those specified in international standards ITU G652 and IEC 60793.

ACOME has the necessary skills to control and measure the PMD of fibres and cables, which enables it to guarantee PMD levels that are among the best available on the market.

* of a random nature

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Characteristics of single-mode fibres

ACSM2 range

G652 COLORLOCK™ single-mode optical fibre

| Geometric characteristics | |
|---------------------------|------------------|
| Cladding diameter | 125.0 +/- 1.0 µm |
| Coloured coating diameter | 245 +/- 7 µm |
| Cladding non-circularity | ≤ 1 % |
| Core non-circularity | ≤ 6 % |
| Coating non-circularity | ≤ 6 % |
| Concentricity error | |
| - core/cladding | ≤ 0.6 µm |
| - cladding/coating | ≤ 12 µm |
| CURL | ≥ 4 metres |

| Mechanical tests | |
|---|---|
| Macrobend attenuation (100 turns on a 60 mm mandrel) | ≤ 0.05 dB at 1550 nm |
| Continuous tension test | Elongation > 1 % during 1 s (0.69 Gpa) |
| Tensile strength test | ≥ 45 N |
| Dynamic stress corrosion factor (nd) | ≥ 20 |
| Stripping test | 1.2 < Fav < 3 N & Fmax < 5 N |

| Environmental tests | |
|---|----------------------------|
| Temperature induced variation [-60 to 85 °C] | ≤ 0.05 dB/km at 1550 nm |
| Dry heat ageing (85 °C for 30 days) | ≤ 0.05 dB/km at 1550 nm |
| Damp heat ageing (85 °C and 85 % HR for 30 days) | ≤ 0.05 dB/km at 1550 nm |

| Environmental tests | |
|---|----------------|
| Cable cut-off wavelength (λ_{cc}) | ≤ 1260 nm |
| Mode field diameter at 1310 nm | 9.1 +/- 0.5 µm |
| Mode field diameter at 1550 nm | 10.2 +/- 1 µm |

| Cabled fibre attenuation per unit length | |
|--|-----------------------------|
| $\lambda = 1310$ nm | from ≤ 0.34 to ≤ 0.38 dB/km |
| $\lambda = 1383$ nm | from ≤ 1 to ≤ 2 dB/km |
| $\lambda = 1550$ nm | from ≤ 0.21 to ≤ 0.24 dB/km |
| $\lambda = 1625$ nm | from ≤ 0.25 to ≤ 0.31 dB/km |
| Maximum attenuation difference | |
| 1,285 < λ < 1310 nm | ≤ 0.035 dB/km |
| 1310 < λ < 1330 nm | ≤ 0.03 dB/km |
| 1525 < λ < 1550 nm | ≤ 0.03 dB/km |
| 1550 < λ < 1625 nm | ≤ 0.03 dB/km |
| Back-scatter curve irregularity | ≤ 0.05 dB |

| Chromatic dispersion | |
|---|----------------------------------|
| Zero dispersion wavelength λ_0 | 1300-1320 nm |
| Typical λ_0 | 1309 nm |
| Slope at λ_0 : So | ≤ 0.092 ps/(nm ² .km) |
| Typical value of So | 0.086 ps/(nm ² .km) |
| Chromatic dispersion @ 1550 nm | ≤ 18 ps/(nm.km) |
| Typical CD @ 1550 nm | 17 ps/(nm.km) |
| Chromatic dispersion @ 1,285-1330 nm | ≤ 3.5 ps/(nm.km) |

| Group index | |
|-------------|--------|
| @ 1310 nm | 1.4640 |
| @ 1550 nm | 1.4645 |

| Polarisation mode dispersion | |
|------------------------------|-----------------------------|
| PMD of cabled fibre | ≤ 0.2 ps.km ^{1/2} |
| PMD Q (concatenated link) | ≤ 0.1 ps.km ^{-1/2} |

Optical fibres in accordance with ITU G652, IEC/EN 60793-1 & IEC/EN 60793-2



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Characteristics of single-mode fibres

ACSM2C range

G652C COLORLOCK™ single-mode optical fibre

| Geometric characteristics | |
|---------------------------|------------------|
| Cladding diameter | 125.0 +/- 1.0 µm |
| Coloured coating diameter | 245 +/- 7 µm |
| Cladding non-circularity | ≤ 1 % |
| Concentricity error | |
| - core/cladding | ≤ 0.6 µm |
| - cladding/coating | ≤ 12 µm |
| CURL | ≥ 4 metres |

| Mechanical tests | |
|---|--|
| Macrobend attenuation (100 turns on a 60 mm mandrel) | ≤ 0.05 dB at 1550 nm |
| Continuous tension test | Elongation > 1 % during 1s (0.69 Gpa) |
| Tensile strength test | ≥ 45 N |
| Dynamic stress corrosion factor (nd) | ≥ 20 |
| Stripping test | 1.3 N < Fav < 8.<9 N |

| Environmental tests | |
|---|----------------------------|
| Temperature induced variation [-60 to 85 °C] | ≤ 0.05 dB/km at 1550 nm |
| Dry heat ageing (85 °C for 30 days) | ≤ 0.05 dB/km at 1550 nm |
| Damp heat ageing (85 °C and 85 % HR for 30 days) | ≤ 0.05 dB/km at 1550 nm |

| Environmental tests | |
|---|----------------|
| Cable cut-off wavelength (λ_{cc}) | ≤ 1260 nm |
| Mode field diameter at 1310 nm | 9.0 +/- 0.4 µm |
| Mode field diameter at 1550 nm | 10.2 +/- 1 µm |

| Cabled fibre attenuation per unit length | |
|--|---------------|
| $\lambda = 1310$ nm | ≤ 0.35 dB/km |
| $\lambda = 1383$ nm | ≤ 0.33 dB/km |
| $\lambda = 1450$ nm | ≤ 0.26 dB/km |
| $\lambda = 1550$ nm | ≤ 0.22 dB/km |
| $\lambda = 1625$ nm | ≤ 0.25 dB/km |
| Maximum attenuation difference | |
| 1.285 < λ < 1.310 nm | ≤ 0.035 dB/km |
| 1.310 < λ < 1.330 nm | ≤ 0.03 dB/km |
| 1.525 < λ < 1.550 nm | ≤ 0.03 dB/km |
| 1.575 < λ < 1.550 nm | ≤ 0.03 dB/km |
| Back-scattering curve irregularity | ≤ 0.01 dB |

| Chromatic dispersion | |
|---|----------------------------------|
| Zero dispersion wavelength λ_0 | 1300-1320 nm |
| Typical λ_0 | 1310 nm |
| Slope at λ_0 : S_0 | ≤ 0.090 ps/(nm ² .km) |
| Typical value of S_0 | 0.086 ps/(nm ² .km) |
| Typical chromatic dispersion @ 1550 nm | 17 ps/(nm.km) |
| @ 1285-1330 nm | 2.8 ps/(nm.km) |

| Group index | |
|-------------|--------|
| @ 1310 nm | 1.4640 |
| @ 1550 nm | 1.4645 |

| Polarisation mode dispersion | |
|------------------------------|-----------------------------|
| PMD of cabled fibre | ≤ 0.2 ps.km ^{-1/2} |
| PMD Q (concatenated link) | ≤ 0.08 ps.km ^{1/2} |

* Ageing in an atmosphere containing 1% hydrogen
Optical fibres in accordance with ITU G652, IEC/EN 60793-1 & IEC/EN 60793-2

ACOPTIC®

Characteristics of single-mode fibres

ACSM5 range

G655 COLORLOCK™ single-mode optical fibre

| Geometric characteristics | |
|---------------------------|------------------|
| Cladding diameter | 125.0 +/- 1.0 µm |
| Coloured coating diameter | 245 +/- 7 µm |
| Cladding non-circularity | ≤ 1 % |
| Concentricity error | |
| - core/cladding | ≤ 0.6 µm |
| - cladding/coating | ≤ 12 µm |
| CURL | ≥ 4 metres |
| Typical effective surface | 63 µm |

| Mechanical tests | |
|--|---------------------------------------|
| Macrobend attenuation (100 turns on a 60 mm mandrel) | ≤ 0.05 dB at 1550 nm |
| Continuous tension test | Elongation > 1% during 1 s (0.69 Gpa) |
| Tensile strength test | ≥ 3.8 GN/m ² |
| Dynamic stress corrosion factor (nd) | ≥ 20 |
| Stripping test | 1.3 N < Fav < 8.9 N |

| Environmental tests | |
|---|-------------------------|
| Temperature induced variation [-60 à 85 °C] | ≤ 0.05 dB/km at 1550 nm |
| Dry heat ageing (85 °C for 30 days) | ≤ 0.05 dB/km at 1550 nm |
| Damp heat ageing (85 °C and 85 % RH for 30days) | ≤ 0.05 dB/km at 1550 nm |

| Environmental tests | |
|---|----------------|
| Cable cut-off wavelength (λ _{cc}) | ≤ 1260 nm |
| Mode field diameter at 1550 nm | 9.2 +/- 0.5 µm |

| Cabled fibre attenuation per unit length | |
|--|--------------|
| λ = 1310 nm | ≤ 0.40 dB/km |
| λ = 1383 nm | ≤ 1 dB/km |
| λ = 1550 nm | ≤ 0.25 dB/km |
| λ = 1625 nm | ≤ 0.28 dB/km |
| Maximum attenuation difference | |
| 1525 < λ < 1550 nm | ≤ 0.03 dB/km |
| 1550 < λ < 1575 nm | ≤ 0.03 dB/km |
| 1550 < λ < 1625 nm | ≤ 0.05 dB/km |
| 1,285 < λ < 1310 nm | ≤ 0.05 dB/km |
| 1310 < λ < 1330 nm | ≤ 0.05 dB/km |
| Back-scattering curve irregularity | ≤ 0.1 dB |

| Chromatic dispersion | |
|---|--------------------------------|
| Zero dispersion wavelength λ ₀ | ≤ 1440 nm |
| Chromatic dispersion @ 1550 nm | > 0,1 ps/(nm.km) |
| Chromatic dispersion @ 1530-1565 nm | 5.5:10.0 ps/(nm.km) |
| Chromatic dispersion @ 1565-1625 nm | 7.5:13.8 ps/(nm.km) |
| Chromatic dispersion @ 1,285-1330 nm | -10.0:-3 ps/(nm.km) |
| Typical value of slope at 1550 nm | 0.052 ps/(nm ² .km) |
| Typical value of CD @ 1550 nm | 8 ps/(nm.km) |
| Typical value of CD @ 1625 nm | 12 ps/(nm.km) |
| Typical value of CD @ 1310 nm | - 6 ps/(nm.km) |
| Typical value of CD @ 1440 nm | 2 ps/(nm.km) |

| Group index | |
|-------------|--------|
| @ 1310 nm | 1.4690 |
| @ 1550 nm | 1.4692 |

| Polarisation mode dispersion | |
|------------------------------|-----------------------------|
| PMDQ (concatenated link) | ≤ 0.08 ps.km ^{1/2} |

Optical fibres in accordance with ITU G652, IEC/EN 60793-1 & IEC/EN 60793-2



ACOPTIC®

Characteristics of multimode fibres

Multimode fibres

A leading producer of transmission media for local networks, ACOME, offers a range of latest generation multimode optical fibres that are optimised to meet the economic and technical requirements of current cabling systems.

The ACOME range of multimode optical fibres fully complies with the requirements of the most recent versions of IEC 60793-2-10, ISO 11801 and EN50173 ...

The ACOME multimode optical fibre range is centred around graded index 50/125 and 62.5/125 fibres operating within the 850 nm and 1 300 nm windows.

All of the ACOME range of fibres are able to transmit the latest protocols such as ATM, FDDI, 1 Giga and 10 Giga ETHERNET.

The ACMM 62.5, GIGA, ACMM50 GIGA and ACMM 50 OM3 fibres include all the latest technological innovations, and their optimised index profile provides excellent results at high transmission rates.

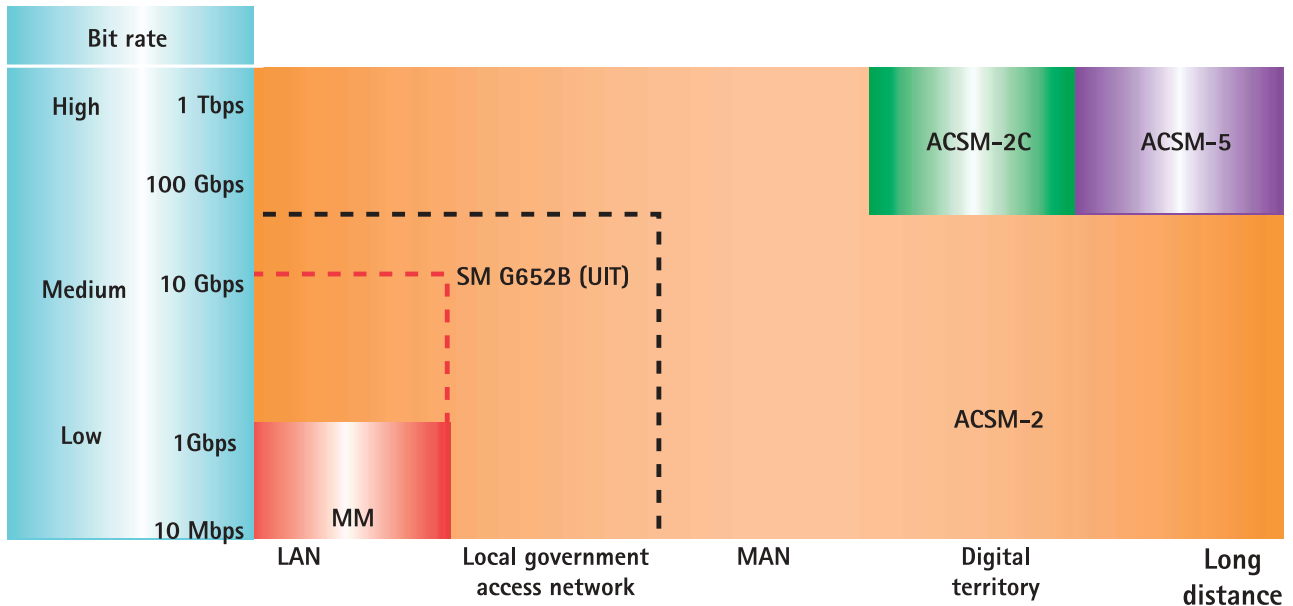
The ACOME range of optical fibres is compatible with existing networks and meets the needs of very high speed Local Area Networks (see ACOLAN® catalogue).



| ACOME multimode fibre | Areas of application |
|-----------------------|---|
| ACMM62.5 OM1 | Able to transmit at bit rates of 10 Mbits over 3 km (850 nm) to 100 Mbits over 5 km (1 300 nm), this fibre is ideal for use with low-cost LED-based optoelectronic interfaces. The ACMM62.5 OM1 is OM1 compatible and can also handle bit rates of 1 Gigabit over 550 m |
| ACMM62.5 GIGA | Compatible with all existing networks, this fibre with its optimised index profile is ideal for use with VCSEL transmitters. Optimised for high speed networks, this fibre can transmit at 1 Gbit/s over distances of 600 m to 1 200 m |
| ACMM50 ENHANCED | 50/125 type fibre supporting LAN applications of 10 Mbit over 2 km (850 nm) to 100 Mbit over 5 km (1 300 nm). This fibre exceeds class OM2 and is able to transmit 1 Gigabit over 600 m using the 850 nm window. |
| ACMM50 GIGA | Compatible with existing networks, this optimised index profile fibre is specially designed for transmitting bit rates of 1 Gigabit over distances of 1 000 to 2 000 m |
| ACMM50 OM3 | The only fibre capable of transmitting 10 Gbit/s over 300 m in the 850 nm window |

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Selecting a fibre



G652 fibres are suitable for most applications, G655 fibres are reserved for very high speed transmissions over very long distances.

G652 fibres have the advantage of having very good interoperability, i.e., they are compatible with one another regardless of origin.

ACSM-2 fibres (G652 B and B optimised for attenuation and PMD)

These fibres are suitable for all low and medium bit rate applications over distances of up to a few hundred kilometres. They also allow wavelength division multiplexing (WDM).

ACSM-2C fibres (G652-C)

These fibres have the same advantages as class B fibres, while at the same time being able to operate over a wider range of wavelengths, allowing the use of multiplexing techniques over all transmission windows.

ACSM-5 fibres (G655)

These fibres are reserved for very high speed networks over very long distances. They allow the use of ultra-dense multiplexing (UDWDM) techniques, but their limited interoperability imposes certain network upgrade and maintenance restrictions.