

List of Figures

1.1	The three generations of networks.	2
1.2	A broadcast-and-select network using passive stars.	3
1.3	An optical wavelength-routed network.	4
1.4	Wavelength continuity constraint in a wavelength-routed network.	7
2.1	Block diagram of a WDM transmission system.	9
2.2	Transmitter and receiver structures.	10
2.3	The low-attenuation regions of an optical fiber.	11
2.4	Splitter, combiner and coupler.	13
2.5	A 16x16 passive-star coupler.	14
2.6	A semiconductor optical amplifier.	17
2.7	Erbium-doped fiber amplifier.	18
2.8	The gain spectrum of an erbium-doped fiber amplifier with input power = -40 dBm.	18
2.9	2×2 crossconnect elements in the cross state and bar state.	20
2.10	A 4×4 non-reconfigurable wavelength-router.	22
2.11	The waveguide grating router (WGR).	23
2.12	A $P \times P$ reconfigurable wavelength-routing switch with M wavelengths.	24
2.13	Broadcast-and-select WDM local optical network.	27
2.14	Lightpath routing in a WDM WAN.	30
3.1	Example of a passive-star-based optical metropolitan area network.	36
3.2	Original amplifier gain model approximations used in previous studies.	40
3.3	More-accurate amplifier gain model used here.	40
3.4	Modules.	42
3.5	Link between stars.	45

3.6	Link from a station to a star.	45
3.7	Link from a star to a station.	46
3.8	A pair of adjacent stars in the network.	50
3.9	Sample Network 2.	55
3.10	Sample Network 3.	56
3.11	Amplifier placements for Sample Network 1 using the link-by-link method.	56
3.12	Amplifier placements for Sample Network 1 using the global optimum method (this work).	57
4.1	Two examples of powers on three wavelengths passing through a fiber.	62
4.2	Simple two-star network that needs no amplifiers to operate.	63
4.3	Amplifier placement using the As Soon As Possible (ASAP) method.	72
4.4	Amplifier placement using the As Late As Possible (ALAP) method.	73
4.5	Mid-sized tree-based network needing no amplifiers to function.	76
4.6	A possible MAN network.	76
4.7	Scaled-up version of the MAN network.	78
4.8	Scaled-down version of the MAN network.	79
4.9	A denser version of the MAN network.	80
5.1	An all-optical wavelength-routed network.	86
5.2	Wavelength continuity constraint in a wavelength-routed network.	87
5.3	Organization of this study.	88
5.4	Functionality of a wavelength converter.	89
5.5	An opto-electronic wavelength converter.	90
5.6	A wavelength converter based on nonlinear wave mixing effects.	91
5.7	A wavelength converter based on XGM in an SOA.	92
5.8	An interferometric wavelength converter based on XPM in SOAs.	93
5.9	A switch which has dedicated converters at each output port for each wavelength (WC denotes a wavelength converter).	95
5.10	Switches which allow sharing of converters.	96
5.11	The share-with-local wavelength-convertible switch architecture.	97
5.12	Architecture which supports electronic wavelength conversion.	97

5.13	Wavelength conversion for distributed network management.	100
6.1	Network components along a lightpath.	117
6.2	Components and their loss/gain parameters in a wavelength-routing node (WRN).	117
6.3	Architecture of a $N \times N$ nonblocking space switch used in our model.	118
6.4	Hybrid simulation technique.	119
6.5	Calls at the instant of our simulation snapshot in a bidirectional ring network.	125
6.6	Progress of a tagged call from node 10 to node 6 in the bidirectional ring network. The figure shows the signal, noise and crosstalk powers and the BER values at the receivers of the intermediate nodes (9, 8 and 7) and the destination node (6) on wavelength λ_2 for this call.	126
6.7	A mesh network.	127
6.8	Blocking probability vs. load for the mesh network.	128
A.1	Illustration of a directional coupler in the bar state.	136
A.2	Crosstalk in a 2×2 switch.	137
A.3	Crosstalk in a 4×4 switch. Existing calls from input port 3 to output port 4 and from input port 1 to output port 2 both interfere with the new call from input port 2 to output port 3.	138
B.1	Calculated gain saturation curves for input and output power variation.	148