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| <b>(51) International Patent Classification <sup>6</sup> :</b><br><b>G02F</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |  | <b>A2</b> | <b>(11) International Publication Number:</b> <b>WO 98/47039</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
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| <b>(30) Priority Data:</b><br>60/038,149 10 February 1997 (10.02.97) US<br>09/019,347 5 February 1998 (05.02.98) US                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |  |           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>(63) Related by Continuation (CON) or Continuation-in-part (CIP) to Earlier Applications:</b><br>US 60/038,149 (CON)<br>Filed on 10 February 1997 (10.02.97)<br>US 09/019,347 (CON)<br>Filed on 5 February 1998 (05.02.98)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |  |           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>(71) Applicant (for all designated States except US):</b> OPTICAL NETWORKS, INC. [US/US]; 3450 Hillview Avenue, Palo Alto, CA 94304 (US).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |  |           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>(72) Inventors; and</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |  |           | <b>(81) Designated States:</b> AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, GM, GW, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG). |
| <b>(75) Inventors/Applicants (for US only):</b> SHARMA, Rohit [IN/US]; 20350 Stevens Creek Boulevard #315, Cupertino, CA 95014 (US). MCADAMS, Larry, R. [US/US]; 1801 Robbin Whipple Way, Belmont, CA 94002 (US).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |  |           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>(54) Title:</b> METHOD AND APPARATUS FOR OPERATION, PROTECTION, AND RESTORATION OF HETEROGENEOUS OPTICAL COMMUNICATION NETWORKS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |  |           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>(57) Abstract</b><br><br>Techniques for providing normal operation and service restoration capability in the event of failure of terminal equipment or transmission media in a heterogeneous network, such as a hybrid network containing single- and multi-wavelength lightwave communications systems. An optical switching node or OSN (12, 120a-d) is placed at each node in the ring network (110) to provide the required connections between various fibers (55) and terminal equipment (50, 50a-d), but having switch states that allow signals on the protection fibers to bypass the terminal equipment at that node. Ring-switched signals propagate around the ring on protection fibers (55adp', 55dap') without encountering the terminal equipment at the intervening nodes. To the extent that the protection fiber links between any given pair of nodes are incapable of supporting all the relevant communication regimes, such links are modified to provide such support. |  |           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |