of a research pattern which is made up of the inclinations of several agencies, and which in Washington must be the responsibility of the Office of Science and Technology, is bound to be imperfect. Much depends on the historical accident of whether the President is in the mood to listen to his science adviser. The democratic processes with which, within the NSF or the National Institutes of Health, the scientific community shares out the funds available apply to small decisions but not to big ones.

What is the solution? There is no reason why Congress should not consider seriously proposals to transfer from other agencies to the NSF and NIH responsibility for certain kinds of basic research. To be sure, this will fly in the face of what has become the American equivalent of the British Haldane doctrine—the belief that agencies of government with missions to accomplish can only do their job effectively if they are able to support the basic research on which their future will depend. As a general principle, this sounds well, but is there really a good reason why the Department of Defense, with this rubric to guide it, should be providing direct institutional support for universities under the label of Project Themis? By the same test, is it proper, let alone wise, that NASA should be the chief source of funds for the kind of basic research that has in the past ten years demonstrated the intricacy of the relationship between the Sun and the Earth? Is it sensible that support for oceanography should come from a host of agencies, ranging from the US Navy to the NSF? The advantages of a more tidy pattern would be not merely that the strategy would be better coordinated but that the quality of the work supported would often be improved. To be sure, it would make no sense to ask that the NSF should promptly become the custodian of all the basic research at present supported by other agencies. Obviously it would be better that obligations already undertaken should stay with the agencies concerned. But there is the strongest possible case for asking that new spending on basic research, even at the instance of a mission oriented agency, should be channelled through the NSF.

But will not this incur the opposition of the powerful committees of Congress? Certainly it is hard to think that the Joint Committee on Atomic Energy would willingly give up its long association with the support for high energy physics. Moreover, the AEC has proved to be an efficient and liberal protector of this cause. But is there any reason why these links should not be preserved if high energy physics became a pensioner of the NSF? The Congressional committees and the agencies at present responsible for large slices of basic research like this could surely continue to have a say in the long-term planning of these projects without being involved in providing money for them. Indeed, they would under such a system usually find that detailed questions about the rightness or wrongness of particular proposals would be answered in advance by the internal processes of assessment for which the research agencies have won confidence in the

past few years. It follows that in what seems almost certain to be a prolonged period without growth in the scientific budget, Dr L. DuBridge's most useful role would be not so much that of a cheerleader on behalf of the principle that all research is worthwhile as that of a tactician concerned to create the mechanism for support that will function best when times are more favourable for spending.

SATELLITE ASTRONOMY

Orbiting 120-inch Urged

from our Astronomy Correspondent

THE Space Science Board of the National Academy of Sciences and the National Research Council has come out strongly if belatedly for a 120-inch optical telescope in Earth orbit in its latest report, *Scientific Uses of the Large Space Telescope*, published last week. The report is the work of an *ad hoc* committee set up as a continuation of the board's working group on optical astronomy, which put forward the case for a 120-inch space telescope in a 1965 study of priorities in space research (*Space Research, Directions for the Future*, National Academy of Sciences; 1966). Since then, the committee has organized three meetings during 1966 and 1967 devoted to astronomical questions which would benefit from the telescope, and the present report is a distillation of what was said. Although the last of the meetings was in March 1967, no explanation is given for the delay in publication. One likely possibility is that the Space Science Board has been prompted to broadcast the committee's recommendations now to coincide with the discussions going on in the United States on the future of the space programme. Only two months ago the board staked a powerful claim on behalf of the scientific community for greater participation in the space programme with the report *The Outer Solar System, a Program for Exploration* (see *Nature*, **223**, 661; 1969).

The 120-inch telescope which the board would like to see would be able to observe objects down to visual magnitude 29, a hundred times fainter than anything which can be seen from the ground, producing images less than 0.1 seconds of arc in diameter compared with about 0.5 seconds of arc for the 200-inch telescope on Palomar Mountain. By choosing the right kind of coating for the mirror, it ought to be possible to operate at wavelengths from 900 Å to about 1 mm, while from the Earth anything between 10,000 Å and 1 mm, and less than 3000 Å, is inaccessible. To obtain the maximum benefit from the resolution of the telescope, it will have to be held steady during exposures to better than 0.004 seconds of arc, but, according to the report, experience with balloon-borne telescopes suggests that this ought to be feasible.

The bulk of the report is devoted to a discussion of the areas in astronomy where such a telescope would be most useful. The authors are particularly taken with the impact which the telescope would have on cosmology. For example, detailed studies of the structure of galaxies which the high resolution would make possible should throw light on the way galaxies evolve. And the observation of really distant galaxies should provide values for the scale and curvature of the universe.

The report emphasizes that a range of supporting facilities would be needed to get the best out of the space telescope. Smaller orbiting instruments with mirrors between 30 and 60 inches, as well as rocket-borne telescopes, would not only make good test-beds before the 120-inch telescope is launched, but would also carry out programmes where the full 120 inches is not necessary. Like astronomers everywhere, the authors of the report cannot help asking for more ground-based instruments, which they say are necessary if time on the space telescope is not to be wasted on research which could equally well be done from the ground if only the telescopes were available. It seems, for example, that if the 120-inch telescope were orbiting at present, astronomers would be using it to make up for the dearth of southern hemisphere telescopes. Of course, by the time the orbiting telescope could be launched—and four years ago the date was put at 1979, based on an immediate start—the situation in the southern hemisphere will be much improved.

The report makes the orbiting telescope seem a suitable project for US space funds, because it combines a fair amount of scientific merit with the necessity for some prestigious manned space flight. There are three reasons why an astronaut would be necessary: to check the telescope once it has been launched, to carry out repairs and to modify the system as the programme progresses. Otherwise there is no reason for permanent manning and the telescope could be controlled from the ground.

COMMUNICATIONS

Satellite Manoeuvres

SOME action is to be expected on the dusty question of a domestic communications satellite system in the United States. For several years, the Federal Communications Commission has been labouring to decide which organization under what circumstances would be allowed to have the profitable licence to operate such a system. Two Presidents have stayed the commission's hand, apparently realizing the size of the empire at stake. Now the last delaying tactic seems to be ending; Mr Nixon's own communications study group has been looking at the proposals framed by the various hopefuls for several months, and with Canada far ahead of the United States in the eminently sensible plan to link far-flung regions by satellite, Americans feel the pressure of competition from the north. Somebody is going to get the American licence soon.

This is why the recent moves by the Columbia Broadcasting System and the American Telephone and Telegraph Company should not be taken at face value. CBS, the largest American television network, has proposed that it and the other two networks combine and put up their own satellites so as to transmit their own programmes. In this way, the networks would between them save the \$45 million a year they now pay AT&T to transmit television programmes over its land lines—not to mention the \$20 million more they would be paying if the AT&T is allowed to raise its rates, as it wants to do.

If the past were any guide, AT&T should have greeted this proposal with horror, reminding all concerned of its own plan, on the FCC's desk, to incor-

porate a domestic satellite system into the national communications network which it already offers most of the United States. Instead, the big telephone company had put out a disarming statement to say that wise public policy might be to permit any organization to apply for a satellite licence. AT&T did not claim any monopoly for itself.

Both manoeuvres play into the hands of Comsat, the half-public, half-commercial corporation that runs American interests in the international communications satellite network. Comsat has been begging the FCC for years to be allowed to put up a domestic network, at least on a demonstration basis. But every time the FCC has seemed on the verge of giving permission, another applicant has intervened. AT&T has, so far, been a strong opponent of Comsat (even though it is also the largest shareholder) out of obvious fear of the day when much of its transcontinental business would be shunted to the newer corporation, with its equipment in the sky. But AT&T, like many others, is now wiser about communications economics than it was a few years ago. Satellites are certain to be a headache and AT&T is having a hard enough time meeting the growing demand for telephones and for the transmission of computer data to fight very hard for an entirely new business. And both AT&T and the television networks seem to agree that it will be better if Comsat runs an American satellite system than some total outsider.

Who would be left out? The Ford Foundation, for example, or the General Electric Company? GE has put forth a plan which would devote a national satellite network entirely to the transmission of computer data and business mail. There is no point, GE's engineers argue, putting up satellites and receiving stations only to save 20 or 30 per cent of the cost of transmitting messages over the ground. Satellites must offer really big reductions—something like 90 per cent—and the way to do this is to let them offer radical new services: instantaneous delivery of business mail (defined as that which does not require a personal handwritten signature) to offices by teleprinter, for example. That is the kind of use of satellite which could shatter the whole rigid structure of American communications, and one that presumably the television networks and AT&T hope to avoid.

The same could be said of the Ford Foundation's plan, put out several years ago, to have a national satellite network publicly owned, with the fees charged to the commercial television companies being used to provide free transmission for a national educational television service. (Both Comsat and CBS now have incorporated similar philanthropic offers in their satellite plans. Although these would give non-commercial television a free ride, they would not allow its governors much voice in the running of the system.)

The latest manoeuvres by CBS and AT&T, therefore, strengthen Comsat's bid and rule out the possibility that any further novelties will be suggested for an American domestic satellite system. It is probably just as well—so long as the FCC lets Comsat have a go on a purely temporary basis. Action has been postponed ridiculously long. Places like Alaska, with little in the way of land-line communication, need satellites. It is positively un-American to leave a new technology mouldering on the shelf while musing about the many possible uses to which it might be put.