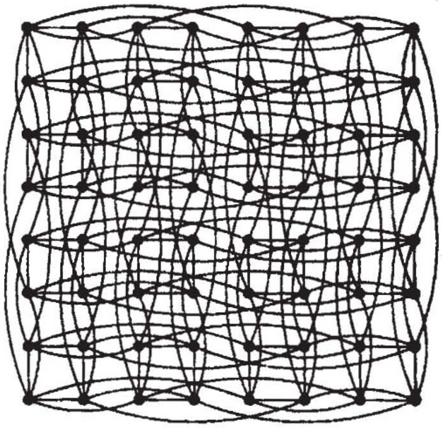
Supercomputers

Intel's hypercube architecture

Washington

INTEL, the computer-chip manufacturer, is coming out with the first of what it hopes will be a new generation of supercomputers, inexpensive machines that offer high computational power by hooking many small computers together in parallel operation. The Intel machines, which will initially be offered in configurations consisting of 32, 64 or 128 separate computers, or "nodes", are to be aimed specifically at scientific users, particularly those tackling large-scale



A hypercube connects $N = 2^n$ small computers, called nodes, through point-to-point communication channels in the Cosmic Cube. Shown here is a two-dimensional projection of a six-dimensional hypercube, or binary 6-cube, which corresponds to a 64-node machine.

modelling problems in areas such as fluid dynamics and circuit simulation.

The chief attraction of the Intel computers is certain to be their price, which will range from $150,000 for the 32-node model to $520,000 for the 128-node. The largest has a peak capacity of 10 million floating-point operations per second (MFLOPS), or about 25 times that of Digital Equipment Corporation's VAX 11/780, which costs about $225,000. Perhaps the most familiar supercomputer, the Cray-1, costs $5-10 million. Intel has announced that its computers will be available this summer.

Unlike the other parallel-processing supercomputers on the market, the Intel machines break totally with the conventional computer architecture based on executing a series of instructions in sequence. Each node consists of a separate central processor, floating-point processor and 512-kbyte random-access memory. Memory is not shared between the separate nodes. Each node can communicate with those adjacent to it in a hypercube layout (see diagram). In essence, the idea is to increase performance by stringing together many cheap processors, taking advantage of the recent advances in Very Large Scale Integration technology that have sent prices plummeting, rather than spending more and more on ultimately diminishing returns in attempting to improve performance of individual processors.

Intel's problem with this, its first entry into the marketing of complete computer systems, is that people do not know how to program highly-parallel processors. Although the company says it is encouraging third parties to develop applications software, it is offering only an operating system initially. Conventional supercomputers, such as the Cray, allow users to write their programs in the ordinary sequential manner; smart Fortran compilers (for example) are then employed to pick out the steps that can be executed simultaneously. The Cray-type parallel processor operates most efficiently when tackling, for example, vector arithmetic operations; its parallel processors can simultaneously perform the requested operation on each element of the vector. The inherent disadvantage of this approach, however, is that the overall execution is still sequential, and the high speed gained in vector operations inevitably runs into a "bottleneck" when single scalar operations are reached during the program.

To program the Intel-type machine successfully, the problem has to be split into independent pieces that each node can tackle simultaneously. In fluid dynamics problems, for example, each node can be assigned one sector of coordinate space; since the underlying physical laws involve only nearest-neighbour interactions of particles, each sector can be computed independently; the only communication between nodes that is necessary is the result at the edge of each node's sector.

In dealing with such problems, each node is used to its fullest, unlike the Cray-type machine which operates in practice only at 5-20 per cent of its peak capacity. (The Cray-1 has a peak capacity of about 160 MFLOPS.)

In justifying its somewhat daring move, Intel points to a potential market for such "near supercomputers" of $100 million now, reaching ten times that in 1990. Supercomputers now account for $300 million of the scientific computing market, estimated to be at least $2,000 million. Intel clearly also has its eyes on the National Science Foundation's plans to support the establishment of supercomputer centres and to purchase time on existing machines in response to a considerable perceived demand for scientific supercomputing.

The Intel machines are based on the design developed by Charles Seitz, a researcher at California Institute of Technology. Intel is licensing the design from Caltech. **Stephen Budiansky**

Correction

THE article "Corporate plans all the rage" (*Nature* News 31 January, p.341) incorrectly states that the Ordnance Survey is the responsibility of the Ministry of Defence rather than the Department of the Environment. □

Japan Prize

First awards go overseas

Tokyo

JAPAN'S answer to the Nobel prize was launched on 15 February with the announcement of the first two Japan Prize laureates. Honoured by the Science and Technology Foundation of Japan were Ephraim Katchalski-Katzir of the Weizmann Institute of Science, Israel, and John Robinson Pierce, professor emeritus of Stanford University in the United States.

The Science and Technology Foundation is itself the creation of its president, Konosuke Matsushita, founder of the vast Matsushita Electrical Industries, Japan's fifth biggest company. Matsushita is well known as a philanthropist and even philosopher; he established the spiritual and educational PHP (peace and happiness through prosperity) movement that has gained enormous popularity in Japan. Although Matsushita donated 3,000 million yen ($12 million) to establish the Prize, he has stayed very much behind the scenes since — the foundation is officially a non-profit foundation endorsed by the Cabinet for the awarding of medals of honour. The foundation's funds have, however, made it possible to give a prize of Y50 million ($200,000) with the medal. The Japan Prize thus rivals the Nobel prize financially; the intention is that with the passage of time it will also rival it in prestige.

The Japan Prize's aim is a little different from that of the Nobel prizes: it is intended for those who have achieved breakthroughs that can clearly be put to work in new ways that will "contribute to world peace and prosperity", rather than at discoveries in basic science. Perhaps the prize will help in some way to overcome Japan's inferiority complex that the development of original new technology is in some sense a less creative endeavour than research in pure science.

For this first year, three target areas — biotechnology, medical engineering, and information and communication — were selected and nominations of scientists in these fields sought from well-known academics around the world. Some 432 recommendations for 291 candidates were received, roughly two-thirds of them from outside Japan. A 24-member committee, split into sub-groups for the three areas, then chose just two laureates.

Considerable surprise was expressed (by members of the Japanese press, at least) that no Japanese was chosen for the prize even though Japan has made a considerable contribution in the three areas. The simplest explanation, other than plain modesty, seems to be that the principal Japanese workers in these areas were all members of the selection committee.

In the biotechnology category, Ephraim Katchalski-Katzir was awarded the prize for the development of the immobilized enzyme systems now in widespread use in bioreactors and bioanalysers, which have done much to trigger the present biotechnology boom. He showed in the 1960s (see for example *Nature* **188**, 856; 1960) how the charge distribution and the hydrophobic and hydrophilic properties of enzymes affect their interaction with a carrier agent and their catalytic activity, thus making it possible to define criteria for selection of proper enzyme carrier materials. Japanese companies now lead the world in immobilized enzyme technology and the prize may thus partly acknowledge a debt to his pioneering work.

Professor Katchalski-Katzir is now 69 and a professor at the Weizmann Institute. He also served as Israel's president from 1973 to 1978, continuing a tradition which began with Chaim Weizmann himself that prominent scholars should hold the presidency.

In the information and communication category, John R. Pierce received the prize for a number of studies, among them his leading role in the development of pulse code modulation theory which has made possible the digital communications technology now coming into use everywhere. His other key discoveries include the Pierce gun, the key to the design of practical travelling wave tubes and now in use in microwave communications systems, and the Pierce loop, which has made possible the rational design of Local Area Networks. Professor Pierce, now 75, has been guest professor at the Stanford University's Center for Computer Research on Music and Acoustics since his retirement as head of research at Bell Laboratories.

Alun Anderson

Chinese reactors

China plans for independence

CHINA'S nuclear industry must switch from military to civilian aims , Li Pong, vice premier of the State Council, urged last month. Addressing a "work conference" of the Ministry of the Nuclear Industry, he called for the ministry to direct its main efforts to nuclear power generation, while at the same time to diversify by providing services on a contract basis to other branches of industry. This could entail a major change from the defence-orientated stance in which good economic returns were desirable but not the prime necessity to a more cost-effective approach.

Li Peng's remarks have been widely publicized in the Chinese media, and contrast oddly with the last major coverage of nuclear matters — the twentieth anniversary, last October, of the first Chinese nuclear bomb. (Among more overtly political issues, it was noted, on that occasion, that the Lop Nor test site has made a good ecological recovery, with burgeoning grass and gazelles.) Much of his speech, however, related rather to the reform of the Chinese economy; the need to develop "horizontally" and the role of technology transfer in achieving the "four modernizations". As an example, he urged that the technology for exploiting uranium mines developed by the Ministry of the Nuclear Insdustry could be transferred to the coal and non-ferrous ore sectors. He also took the opportunity of annoucing the government's decision on the vexed question of ministerial responsibility in nuclear power development. Responsibility for the construction of large-scale nuclear power stations, Li Peng said, would rest with the Ministry of Water Resources and Electric Power, while the construction of the "nuclear island" would be borne by the Ministry of the Nuclear Industry.

Nuclear power in China, Li Ping suggested, must gradually become a completely Chinese matter. The Ministry of the Nuclear Industry already possessed, he said, a complete system for processing nuclear materials "from the exploration and exploitation of uranium mines to the post-processing of irradiated fuel". This expertise must be used so that nuclear fuel can be supplied to the power stations by Chinese enterprises, and so that a complete nuclear fuel cycle can be established.

The publication of Li Peng's speech was delayed for three weeks to coincide, on 24 January, with the start of construction of what was officially described as the first nuclear power plant designed and built exclusively by China. This is the 300 MW pressurized-water station at Qinshan, which will serve the east China industrial network centered on Shanghai. The Qinshan station is expected to provide a "complete range of experience for building power plants", and hence will have a key role in Chinese plans to contruct a total nuclear capacity of 10 GW by the end of the century.

Following Li Peng's lead, Chinese spokesmen have stressed the indigenous nature of the project, and rumours that China planned to purchase two nuclear-powered generating facilities from the Soviet Union under the 1986-1990 Sino-Soviet economic and trade agreement have been strenuously denied by the Chinese Foreign Trade Ministry.

But the Qinshan project may be less than exclusively Chinese. The reactor presssure vessel and reactor main coolant pump will be built by West German and Japanese companies to Chinese designs, and the design of all major equipment has been checked by consultants from the United States and Italy. Moreover, according to Zhou Ping, vice minister of the Nuclear Industry, the experience gained at Qinshan will enhance China's capacity to absorb imported nuclear power technology, paving the way for the import of large complete generating sets.

Vera Rich

French reactors

Problems only of plenty

FRENCH nuclear power strides on — even though the major nuclear constructor, Framatome, is tottering and the first commercial-scale fast breeder, Superphénix, is suffering problems that could delay its start-up by one or two years.

First, the good news. Last year, French 900-MW pressurized water reactors (PWRs, the bulk of the stations now operating) achieved an availability (energy delivered over energy theoretically available) of 79 per cent. These would seem to be extraordinary figures in relation to the results of only a couple of years ago, when availablity was in the sixties, and again confirm the claims of Electricité de France (EDF), the national utility, that these were only "teething problems" in reactors which were mostly very new. The first two 1,300-MW PWRs, Paluel 1 and Paluel 2, also came on line last year and reached full power in late December bringing — with the other reactors — some 178 TWh of nuclear energy into the French grid in 1984 (compared with British nuclear power production in the same year of 34 TWh).

The trouble now is that with many more PWRs under construction, France really needs no more electricity, and Framatome is in dire need of diversification. The problem can be solved only by finding new industrial partners (or products), by selling reactors abroad or by exporting electricity.

All options are open. On electricity exports, EDF nearly doubled to 25 TWh the amount of electrical energy exported from France in 1984, and plans to do better in 1985 with the establishment of a high-power cross-Channel link with the British grid. On the export of reactors, Framatome is bidding hard for contracts in Egypt and in Israel. France, it is believed, is prepared to let Israel buy its reactors without demanding that Israel sign the non-proliferation treaty — the stumbling block for a deal with the US company Westinghouse in the 1970s.

Meanwhile, Superphénix, the great white hope for European nuclear power in the next century, has been troubled by vibrations in certain components in the sodium cooling circuit, now under test before what was to be the fuelling of the reactor this summer. The elements are baffles in the stainless-steel "cauldron" in which the fuel elements sit, and they appear to vibrate, when the sodium is introduced and pumped. The problem is whether to rebuild the baffles, which could cause a lengthy delay in the operation of the reactor, or to load the fuel and hope the problem goes away when the reactor reaches its working temperature of 425°C, some 75°C above the temperature at which preliminary tests have been conducted.

Robert Walgate