# Fortran at AWE, Aldermaston

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# Fortran: A personal view

- The last decent thing written in C was Schubert's 5th Symphony

- Performance tuning a Fortran program is difficult and tedious and requires highly skilled effort to do it successfully.

- Performance tuning a program in any other language is much simpler:-

**Re-code it in Fortran**

# AWE Aldermaston

- AWE is the Atomic Weapons Establishment
  - Sites at Aldermaston and Burghfield
- Was AWRE until 1987
- AWE Mission
  - To deliver the UK's requirements for nuclear warheads and support for national security
- AWE Vision
  - To be internationally recognised for delivering scientific, engineering, manufacturing and business excellence in national defence

# UK Nuclear Weapons Timeline

- 1940 Frisch-Peierls Memorandum
- 1941 Maud Committee – bomb is possible
- 1943 Britain partners US in Manhattan Project
- 1945 Atomic bomb used against Japan
- 1947 UK decides to develop nuclear weapon
- 1950 Aldermaston airfield taken over
- 1951 First scientific staff arrive
- 1952 Aldermaston site named Atomic Weapons Research Establishment
- 1952 First UK nuclear device successfully detonated
- 1954 First computer at AWRE: Ferranti Mark 1
- 1955 UK decision to develop hydrogen bomb
- 1958 US/UK Mutual Defence Agreement
- 1958 Moratorium on atmospheric nuclear tests
- 1961 H-bomb enters service
- 1962 First UK underground test
- 1962 IBM Stretch computer installed at AWRE – AWRE standardises on FORTRAN
- 1968 Polaris operational
- 1979 First Cray supercomputer at AWE
- 1987 AWRE becomes AWE
- 1994 Trident operational
- 1998 UK ratifies Comprehensive Test Ban Treaty
- 2000 AWE 50th anniversary

# AW(R)E Supercomputing timeline

- 1954 1st AWRE computer: Ferranti Mark 1
  - 1.9 kBytes memory
  - 80 kBytes drum storage
  - Programmed in machine code via paper tape
- 1956 English Electric Deuce
- 1957 IBM 704
- 1959 IBM 709
- 1960 IBM 7090
- 1962 IBM Stretch (7030)
- 1964 ICT Atlas 2 – running alongside Stretch
- 1971 IBM 360/75
- 1972 IBM 360/165
- 1974 IBM 360/168
- 1979 Cray 1A
- 1983 Cray XMP
- 1990 Cray YMP
- 1995 Cray C98D
- 1996 IBM RS/6000 SP
- 2000 IBM RS/6000 SP Nighthawk
- 2006 Cray XT3

# AW(R)E scientific programming

- 1952 Alick Glennie develops first precursor to FORTRAN
  - Lecture at Cambridge University
- Machine code on early machines
- Assembly language on IBM 704/709/7090 – moving to early FORTRAN
- 1962 AWRE standardised on FORTRAN for Stretch
  - Stretch delivered with no FORTRAN compiler
  - AWRE's Alick Glennie and IBM (UK) wrote S1 compiler
  - Alick Glennie wrote S2 compiler – 20 times faster
    - Dynamic memory allocation at run-time was key feature

**AWE is still standardised on FORTRAN in 2007**
**-Very happy with that position**
**-Pleased we didn't follow some US Labs to C++ and C**
**(Note: Only for Design Physics. Engineers and Material Scientists use 3rd party codes.)**

# AW(R)E scientific programming (contd)

- 1979 Cray supercomputing demanded VECTORISATION
  - And, later, AUTOTASKING
  - Cray extensions for dynamic memory management
- 1996 IBM SP – new era of MPP programming using MPI
  - Vectorisation abandoned
  - OpenMP (autotasking equivalent) never really taken up
  - FORTRAN 90 adopted enthusiastically
  - Dynamic memory management in Fortran standard at last!
  - **Programming paradigm unchanged with Cray XT3**
- THE FUTURE
  - Will SIMD floating point accelerators usher in a new era of “vectorisation”?

**But it will still be Fortran!**

# Fortran as a language - view from AWE

- Simplicity = Good Performance important
- Lack of Dynamic memory management was a big deficiency
  - Coded by AWRE into S2 compiler for Stretch
  - Cray language extensions for Cray machines
  - Not fixed until Fortran 90 with IBM SP in 1996
- “Fortran 90 saved Fortran as a scientific language’”
  - Dynamic memory management vital
    - ALLOCATABLE arrays
    - … but don’t like implementation of POINTER arrays
    - MODULEs and Free Format useful
    - Derived Types useful – but need to watch performance