IBM

The APL2 Family of Products

APL2

┌─ **Executive Summary** ─────────────────┐

IBM* APL2* products enable you to solve problems, create applications, and analyze data. APL2 is an open system, providing access to databases, other languages, dialog managers, and graphics facilities.

APL2 is useful to professional programmers, scientists, engineers, technical users (such as statisticians, analysts, and actuaries), and to casual users with little or no programming experience.
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What Is APL2?

It is a programming *language* ...and a whole lot more! APL2 is:

- A gateway to portable applications across systems

- An interactive programming language

- A code development environment *and* an application runtime environment

- A set of interfaces to system facilities

    - File I/O
    - Graphics
    - Network communications
    - Relational databases
    - GUI (Graphical User Interface)
    - and more

- A collection of distributed functions:

    - Sample APL programs
    - Demonstrations
    - Tools and utilities
    - and more

Unlike most computer programming languages, APL2's orientation is as an executable notation for solving problems, rather than a high-level representation of the machine architecture. Therefore, APL2 provides a problem-solving environment that significantly reduces the time to generate solutions to problems in areas as varied as finance, insurance, physics, medical imaging, scheduling, design of computers and computer chips, quality control, mechanical engineering, hospital systems, legislation tracking, and of course, commercial business data processing.

Primary Users

APL2 is used throughout IBM and by a wide variety of IBM customers. APL2 is used in large and small businesses, and is also well suited to educational institutions. APL2 is used by people in many fields, including:

Planners	Forecasters
Analysts	Actuaries
Administrators	Teachers
Scientists	Application
Engineers	programmers

APL2 provides an environment for:

- *Ad hoc* data analysis and problem solving, especially when dealing with incomplete data or ill-defined problems
- Interactive program development by, or working closely with, end users
- Building portable applications that need to run on many kinds of systems
- Building advanced decision support systems
- Research and design of new models and decision technologies
- Teaching the computational aspects of applied mathematics

APL2 brings the tools to do all these tasks together in a single environment.

APL2 accomplishes this by combining:

- Rich data structures, more general and flexible than those provided by most programming languages
- A large set of primitives (built-in functions) that apply to broad classes of data types
- A simple syntax that treats user-defined programs like language primitives
- Support for complex arithmetic
- An interactive environment that permits the user to concentrate on a problem without needing to compile or link-edit
- The ability to be productive knowing just a small subset of the language

Characteristics of APL2

APL2 is:

- An inherently *interactive* language
- Dynamic—nothing is declared
- Array oriented
  - Vector
  - Parallel
- Symbolic
  - Concise, precise
  - National-language independent—a truly *universal* programming language
- Productive
  - Small teams do significant applications
  - Prototyping
- Open
  - Other languages
  - Relational databases
  - Graphics
  - Cooperative processing

Benefits

APL2 and its interactive environment was designed to provide users with the following benefits:

Business and Scientific Applications

APL2 lets users store, select, and manipulate large amounts of data with concise, consistent, powerful operations. It is also useful for statistical analyses and business reports. For example, Figure 1 was produced by the following statements:

```
      )LOAD 2 GRAPHPAK
Saved 1993-04-04 16.28.05
      ⍝    Generate surface data
      ⎕IO←0
      A←○A+⍉A←26 26ρ100(⍳26)÷10
      ⍝    Draw surface
      'XY' SURFACE A
      ⍝    Label axes
      (5×⍳6)SLBLX .25×⍳6
      (5×⍳6)SLBLY .25×⍳6
      0 SLBLZ 0
      ⍝    Write the title
      5 13 4.75 1 STITLE 'SINE'
      VIEW
```
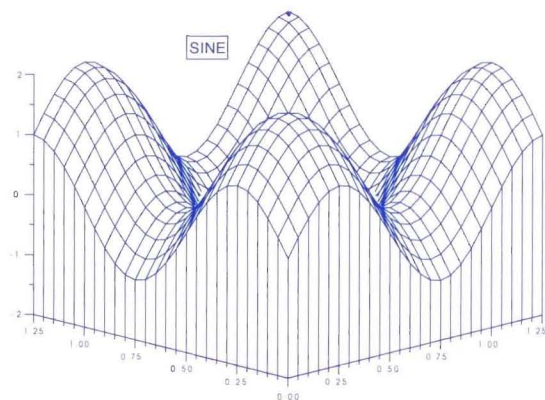

Figure 1. A Surface Chart with User-Defined Labels and a Title

Application Design

APL2 helps developers and users define solutions to their problems. As programmers develop an application, user feedback can be incorporated quickly and easily (often in real time while the developer and user are discussing the issue). This provides a truly iterative design phase.

Tools and Utilities Provided with APL2

A number of tools and utilities are distributed with APL2. These include:

- General purpose (such as EXAMPLES and UTILITY)
- User interface (such as GRAPHPAK)
- Data input and output (such as FILE and PRINTWS)
- Portability (such as MIGRATE and TRANSFER)
- Diagnostic and tuning (such as DISPLAY and TIME)

Using the Auxiliary Processors

The auxiliary processors distributed with APL2 allow the user to perform a number of functions including:

- Access operating system services
- Access databases
- Access various file systems
- Provide graphics and text interaction with display devices

Using the Associated Processors

Associated processors allow applications or users to treat external routines (often written in other languages) as if they were APL functions within the active workspace. For APL2 under CMS or TSO, associated processors also allow data outside the workspace to be treated as APL arrays within the workspace.

External Functions Provided with APL2

A number of programs accessible with associated processors are shipped with APL2. These programs provide valuable extensions to the APL2 system. Users can also write their own external functions in various programming languages.

Recent Enhancements to APL2

- Cross-system shared variables
- Cooperative processing
- Support for additional platforms
- Improved portability between platforms
- Diamond statement separator

Software Requirements

APL2 runs under the control of the following licensed programs and their subsequent releases unless otherwise announced by IBM.

System/370* or System/390* CMS Host

- VM/ESA* Version 1 (5684-112)
- VM/XA* SP Release 2 (5664-308) or later
- VM/SP High Performance Option (HPO) Release 5 (5664-175) or later
- VM/SP Release 6 (5664-167) or later

System/370 or System/390 TSO Host

- MVS/ESA* SP Version 4 (5695-047 or 5695-048)
- MVS/SP* Version 3 (5685-001 or 5685-002)
- MVS/SP Version 2 Release 2 (5665-291 or 5740-XC6) or later, with TSO/E Version 2 (5685-025)
- MVS/SP Version 1 Release 3 (5740-XYN or 5740-XYS) or later, with TSO/E Version 1 (5665-285)
- SMP/E Release 6 (5668-949) or later

OS/2 Environment

- OS/2 Version 2 or later

AIX/6000 Environment

- AIX* Version 3 Release 2 (5756-030) or later for the RISC System/6000*
- AIXwindows* (5601-257) with Motif** 1.2 or later and X11R5 or later for window-based auxiliary processors

Solaris Environment

- Solaris 2.2 or later
- Motif 1.2 or later and X11R5 or later for window-based auxiliary processors

DOS Environment

- DOS 2.1 or later

Models and Simulation

APL2 lets professionals model business and scientific systems. Users can test hypotheses and easily change values for "what if" studies.

Development Productivity

APL2 encourages developers to use application building blocks and common tools that can yield enormous productivity gains. With APL2, developers can design, code, and implement applications in a shorter period of time—and they can react more quickly to program changes.

Production Use

APL2 is an excellent production tool. In addition to its normal interactive mode, APL2 allows production applications to be run in an automated environment without requiring user interaction. It provides a powerful environment with robust error detection and recovery capability. APL2's flexibility allows applications to call other languages and products, and its communication facilities support distributed production environments using client-server protocols.

Well-Planned, Methodical Applications

APL2 promotes modular organization of code, allowing several parts of an application to use common code. Developers can create standard code for different applications.

Meeting Your Application Development Needs

The APL2 Strategy

APL2 provides user access across a wide variety of platforms. Table 1 lists the platforms supported by APL2 products.

Table 1. Platforms Supported by APL2 Products

Product	Platform
APL2/2	OS/2*
APL2/S	Sun** Solaris**
APL2/6000*	AIX/6000*
APL2/PC	DOS
APL2/TSO	MVS
APL2/CMS	VM

Because IBM implementations of APL2 are highly portable across these environments, you spend less time training users and can increase the efficiency of your data processing efforts. Also, because a great deal of the APL2 product code is itself common across recently-supported platforms, it is easier for IBM to add APL2 support for additional systems.

How You Can Benefit from APL2

As an APL2 user, you can benefit in the following ways:

Interactive Environment

APL2 users can solve problems without compiling or link-editing programs.

Fast and Powerful Computing

Computing with APL2 is fast and powerful because APL2 provides problem-solving operations, array manipulation, and immediate execution. APL2 automatically uses special hardware such as math coprocessors and vector facilities.

Improved Programmer Productivity

APL2 reduces coding, builds on its own existing applications, and provides several debugging aids. The auxiliary processors and associated processors provide access to system services outside APL2. The associated processors also provide access to routines written in other programming languages (such as FORTRAN, assembler, C, or PL/I).

Iterative System Design

APL2 provides for iterative system design to aid developers in creating applications that fit their needs.

Built-In TIME Facility

APL2 provides a built-in TIME facility, which identifies bottlenecks for performance tuning. This lets users quickly correct problems without having to study all of the code in an application.

Object Filing System

APL2 offers an integrated object library manager on all platforms (implemented using AP 211). This facility stores any APL array as a component of the file, freeing the user from the details of how or where the data is actually stored. Objects of any size and data type are easily stored and retrieved, by name, using a simple set of commands. Automatic data conversion is performed when accessing object libraries in a multiplatform network configuration.

Cooperative Processing

APL2 offers cooperative processing across a network using TCP/IP. Using APL2's cooperative processing features, you can:

- Share data with an APL2 session on a remote processor
- Communicate with non-APL programs
- Access workstation graphics and editing capabilities from a mainframe system
- Access remote databases and computational power from a workstation
- Distribute parts of an application across multiple machines
- Build a network server

International Applicability

APL2's symbol orientation lends itself to international applications. Users do not need to know English to work with APL2, or to create their APL2 programs. APL2 also has no reserved words, enabling programs to be written in other national languages with no conflict. Additionally, system messages can be received in a variety of national languages.

APL2 supports double-byte character sets (DBCSs). Applications can display and process DBCS data, and APL2's cooperative processing facilities support DBCS. Under CMS and TSO, DBCS characters are also supported in APL2 programs.

Take Advantage of APL2's Language Features

APL2 provides the following language features:

- A wide range of numeric data types, from densely stored 1-bit values through 128-bit complex numbers
- Standard (8-bit) and extended (31-bit) characters
- N-dimensional arrays (up to 63 dimensions)
- Dynamically variable rank and dimensions on all arrays
- Arrays with any combinations of the above types and sizes, providing the equivalent of structured data
- Array items that are themselves arrays, yielding data structuring capabilities that are a superset of those in other languages
- A simple, consistent syntax with few rules
- Primitive functions for a wide range of mathematical and structural manipulations on all of the data structures, operating on the data as a unit, or subitems within it
- Primitive operators, which apply functions in differing ways, multiplying the effective number of functions many times
- Automatic and invisible data conversion where needed
- Automatic range checking of arguments to all primitive functions
- Careful attention to consistent behavior of functions and operators at the limits so that, for example, empty arrays, large numbers, and values at or near zero require no special handling
- User-defined functions and operators that behave syntactically just like the primitive functions and operators

Using the Session Manager

The session manager helps users conduct and control APL2 sessions, either within the system it is running on, or sessions running on other systems, including computers with dissimilar hardware or operating systems. The session manager has similar features in all APL2 products, making it easier for users to adapt to APL2 on a different platform.

Using the APL2 Editors

APL2 provides a variety of editors to be used among the platforms. Editor 1 is a common editor among platforms and allows the user to manipulate lines in a function or operator definition. Windowed editors are also provided.

Related IBM Products Supported by APL2

APL2 communicates with many other products including:

C	NFS
DB2[*]	OSL
ESSL	Presentation Manager[*]
Fortran	QMF[*]
GDDM[*]	SQL/DS[*]
ISPF	AIXwindows

Ordering APL2

Contact your IBM marketing representative or call 1-800-IBM-CALL to order APL2. Direct technical questions to the APL2 help line at 1-408-463-APL2.

Refer to Table 2 for the appropriate product numbers.

Table 2. APL2 Offerings at a Glance

APL2 Product	APL2 Program Number	Hardware Platform	Operating System	Maximum Workspace Sizes
APL2/370	5688-228	IBM 370/390 mainframe	MVS with TSO	2000MB
APL2/370 AE[1]	5688-229	IBM 370/390 mainframe	MVS with TSO	2000MB
APL2/370	5688-228	IBM 370/390 mainframe	VM with CMS	2047MB
APL2/370 AE[1]	5688-229	IBM 370/390 mainframe	VM with CMS	2047MB
APL2/6000	5765-012	IBM RISC System/6000	AIX/6000	1024MB
APL2 for Sun Solaris	5648-065	Sun Microsystems, Inc.	Sun Solaris	1024MB
APL2 for OS/2		Personal computers	OS/2	250MB
Entry Edition[2]	89G1556			
Advanced Edition	89G1697			
APL2/PC	5604-260 (EMEA) 5799-PGG (USA)	Personal computers	DOS	Note 3

Notes:

1. Application Environment. This is a subset product that is used to run previously-developed programs.
2. APL2 for OS/2 Entry Edition does *not* include database access or cooperative processing.
3. Maximum workspace size is approximately 1MB less than installed memory.

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