**FEDERAL INFORMATION
PROCESSING STANDARDS PUBLICATION
MARCH 7, 1969**

IMPLEMENTATION OF THE CODE FOR INFORMATION INTERCHANGE AND RELATED MEDIA STANDARDS

HARDWARE STANDARDS
INTERCHANGE
CODES AND MEDIA

U.S. Department of Commerce/National Bureau of Standards

Foreword

The Federal Information Processing Standards Publication Series of the National Bureau of Standards is the official publication within the Federal Government for information relating to standards which are adopted and promulgated under the provisions of Public Law 89–306 and Bureau of the Budget Circular A–86 titled, Standardization of data elements and codes in data systems. These publications collectively constitute the FEDERAL INFORMATION PROCESSING STANDARDS REGISTER.

The publications in this series are used to announce and maintain Federal Information Processing Standards. Also, these publications are issued to provide standards information of a general interest and a complete index of relevant standards publications and specifications.

Publications in this series which announce the adoption of standards provide necessary policy, administrative, and guidance information for their effective implementation and utilization. In most cases, a copy of the technical specifications of the standard are affixed to the announcing publication. When this is not possible, the source where copies of the standards specification can be obtained will be cited.

Suggestions for improvement which are gained by the use of Federal Information Processing Standards and Publications are welcomed. These should be addressed to the National Bureau of Standards, Center for Computer Sciences and Technology, Office for Information Processing Standards, Washington, D.C. 20234.

A. V. ASTIN, *Director*

Federal Information

Processing Standards Publication 7

March 7, 1969

IMPLEMENTATION OF THE CODE FOR INFORMATION INTERCHANGE AND RELATED MEDIA STANDARDS

Federal Information Processing Standards Publications are issued by the National Bureau of Standards under the direction of the Bureau of the Budget in accordance with the provisions of Public Law 89-306 and Bureau of the Budget Circular No. A-86.

PURPOSE.—To provide further details concerning the implementation and applicability of the Federal Information Processing Standards (FIPS), Code for Information Interchange (FIPS 1), Perforated Tape Code for Information Interchange (FIPS 2), and Recorded Magnetic Tape for Information Interchange (800 CPI, NRZI)(FIPS 3).

EXPLANATION.—White House memorandum to heads of departments and agencies, dated March 11, 1968, signed by President Lyndon B. Johnson approved as Federal Standards the United States of America Standard Code for Information Interchange and associated standards for recording the code on perforated and magnetic tape media. (Copy of this memorandum is attached as app. A.) Also the memorandum stated that the Department of Commerce would provide details of these standards and their application.

These standards were announced through the FEDERAL INFORMATION PROCESSING STANDARDS REGISTER on November 1, 1968 as FEDERAL INFORMATION PROCESSING STANDARDS PUBLICATIONS 1, 2 and 3. These FIPS PUBS noted that the Secretary of Commerce by separate letter addressed to the heads of Federal departments and agencies would provide details concerning implementation plans and specific areas of application, and when released, information concerning this letter would be the subject of a future FIPS PUB.

The Secretary of Commerce on March 7, 1969, released the implementation letter cited above. This letter and accompanying instructions (attached as app. B) supplement the information contained in FIPS PUBS 1, 2 and 3.

Questions concerning these standards publications or their application as well as comments or recommendations for revision should be directed to the National Bureau of Standards, Center for Computer Sciences and Technology, Washington, D.C. 20234.

THE WHITE HOUSE
WASHINGTON

March 11, 1968

MEMORANDUM FOR THE HEADS OF
    DEPARTMENTS AND AGENCIES

I have today approved a recommendation by the Secretary of
Commerce, submitted under provisions of Public Law 89-306,
that the United States of America Standard Code for Infor-
mation Interchange be adopted as a Federal standard.

In my memorandum to you of June 28, 1966, I stressed the
need for achieving, with industry cooperation, greater com-
patibility among computers. The earlier adoption of the
Standard Code for Information Interchange as a voluntary
standard by the United States of America Standards Institute
reflects a national concern with this need.

The adoption of this code as a Federal standard is a major
step toward minimizing costly incompatibility among our vast
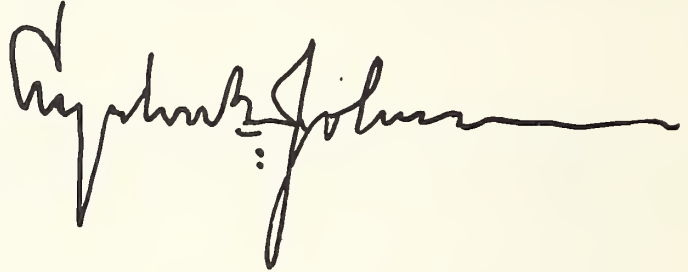Federal computer and telecommunications data systems.

I have also approved recommendations of the Secretary of
Commerce regarding standards for recording the Standard Code
for Information Interchange on magnetic tapes and paper
tapes when they are used in computer operations.

All computers and related equipment configurations brought
into the Federal Government inventory on and after July 1,
1969, must have the capability to use the Standard Code for
Information Interchange and the formats prescribed by the
magnetic tape and paper tape standards when these media are
used.

The standard code will be used as the basic code in those
networks of the National Communications System whose primary
function is either the transmission of record communications
or the transmission of data related to information process-
ing. The standard will be implemented on a time-phased
basis that is to be specified in National Communications
System long-range plans.

The heads of departments and agencies are authorized to waive the use of these standards only under compelling circumstances of particular applications. Such waiver is to be coordinated with the Department of Commerce (National Bureau of Standards) before it is exercised so that the Department may effectively accomplish the goals of the Federal computer equipment standards program conducted under Public Law 89-306.

The Department of Commerce will provide you with the details of these standards and their application.

Lyndon B. Johnson

THE SECRETARY OF COMMERCE
WASHINGTON, D.C. 20230

March 7, 1969

MEMORANDUM FOR THE HEADS OF
    DEPARTMENTS AND AGENCIES

SUBJECT: Application of Federal ADP Code
          and Media Standards

    By Memorandum addressed to the Heads of
Departments and Agencies on March 11, 1968, the
President directed that all computers and related
equipment configurations brought into the Federal
Government inventory on and after July 1, 1969,
must have the capability to use the American
Standard Code for Information Interchange (ASCII)
and ancillary standards. The responsibility for
providing Federal agencies with details of these
standards and their application has been delegated
to the Department of Commerce.

    The attachment to this memorandum provides
the details referred to by the President.

Maurice H. Stans

Maurice H. Stans

Attachment

1. Introduction

Public Law 89-306 authorized the Secretary of Commerce to make appropriate recommendations to the President relating to the establishment of uniform Federal automatic data processing standards. The President, on March 11, 1968, approved as Federal standards the USA Standard Code for Information Interchange (ASCII), as well as standards implementing the Standard Code in perforated tape and magnetic tape media (see Attachments 1 and 2). The announcement also delegated the responsibility of providing details on these standards and their application to the Secretary of Commerce. A glossary of the specialized terms employed in this paper is included as Attachment 3.

2. Purpose

The purpose of this memorandum is to identify the objectives of these standards and relate the specific standards to these objectives, and to provide instructions for application.

3. Objectives

The objectives of Public Law 89-306 are to provide for the economical and efficient purchase, lease, maintenance, operation and utilization of automatic data processing equipment by Federal departments and agencies. The development, adoption and implementation of appropriate information processing systems standards will contribute to the objectives of P.L. 89-306 by providing such benefits as:

a. Improved cost effectiveness in the procurement and continued use of information processing systems and equipment, including supporting software.

b. Extension of the economic benefits of data processing and computing through increased compatibility between and within systems, sharing of facilities among users, and simplified methods and procedures for the use of information processing facilities.

c. Increased freedom of selection of equipment which conforms to compatibility standards, and hence increased competition among suppliers of information processing equipment and supporting services.

d. Greater flexibility in the use of programs and data in computers provided by all suppliers, facilitated by appropriate standards for compilers and validation techniques.

One of the vital elements in realizing these objectives is the provision of the highest practical level of compatibility for the interchange of information in machine-processible form within and between information systems, including input/output equipment, source data automation equipment, other associated equipment, and communication systems. This includes the maximum use of standard programming languages and recording techniques so as to minimize the need for reprocessing, reordering, or converting of information in information processing operations.

A standard coded character set, standards which prescribe the method of representing the coded character set in media used for input/output purposes, and a standard collating sequence, are also basic requirements for compatible interchange of data in automatic data processing operations. It is becoming increasingly difficult to distinguish between data which will always remain inside the originating installations and that which may now or later be needed elsewhere. Moreover, an installation under one manager's control and performing only the tasks of a single organizational unit now is frequently spread over multiple locations, or may have many remote terminals. In such a situation the distinction between internal and external information flows almost disappears. Use of the same character set, code, media and collating sequence for installation files eliminates the need for such distinctions and hence will facilitate interchange.

It is the intention of the Federal ADP Standards program that all installations adopt the

ASCII code, media and sequence standards and that progress be made toward this objective in as rapid a manner as is economically and technically feasible.

These Federal ADP standards do not extend to the internal structure of the central processing unit or peripheral devices. In general, therefore, computers may operate in any mode and use any internal code which the equipment manufacturer deems most efficient.

4. Scope of Application

The President's memorandum of March 11, 1968, and these instructions, apply to computers and related equipment configurations brought into the Federal inventory or acquired or leased with Federal funds as set forth in Paragraph 3, BoB Circular A-54 Revised June 27, 1967. They also apply to data systems developed for implementation by or for Government agencies, and to data developed outside the Federal Government at Government expense if such data is to be a part of the data base of a Federal agency. Related equipment includes all character-oriented equipment in which magnetic tape or perforated tape is produced for input to a computer based data system or received as output from a computer based data system. These instructions also apply when transmission terminal equipment and facilities are procured primarily in support of a computer based data system.

The President's memorandum applies to new or used equipment brought into the inventory from outside. Complete systems and systems components can also be transferred between agencies, or between installations within an agency. The General Services Administration facilitates such transfers by availability notices. Whenever equipment is available through these avenues which conforms to or can be adapted to the standards, it will be given preference over equipment which does not conform and cannot be adapted.

Central processor, peripheral or other related equipment used substantially full time as part of the control element in a larger system, where that larger system (weapons control, for instance, or a manufacturing process) is not itself primarily concerned with information activities, is not within the scope of

application of these Federal standards. However, since general purpose equipment used in these systems may be used elsewhere at a later date, agencies should conform to the ASCII standards wherever possible.

5. Instructions for Implementing the Standards

Most of the computers and related equipment currently in use by the Federal Government are of a generation which pre-dated the approved Federal ADP standards. In view of the Government's investment in this equipment, the transition to these standards will be made on an evolutionary basis as equipment is replaced or added, computers are reprogrammed and data systems are redesigned. It is not the intention at this time to require the immediate conversion of existing data systems and equipment for the sole purpose of conforming to Federal ADP standards. Utilization of existing non-standard systems and equipments should be continued as long as economically advantageous.

On the other hand, when a system conversion of any magnitude is planned (new or more powerful hardware, machine-independent software or, especially, remote-access operation), an agency must not only conform to the Presidential order by acquiring the prescribed hardware or software capability, but must include in its plans the actual introduction of ASCII character set, code, media and sequence standards as soon as consideration of economics and personnel permit. While techniques for interchange shall be given priority, introduction of the standards for character coded data and program storage within installations and conversion of appropriate existing files shall also proceed as rapidly as possible.

Specifically, when interchange and internal file techniques are updated from Hollerith, binary-coded decimal, pure binary and six-bit-oriented codes and media, the ASCII character, code, media and sequence standards shall be applied. In no case may a non-standard alternative be introduced.

More efficient utilization of magnetic tape and other media for interchange and for installation files is sometimes realized by the use of non-standard techniques (packed numerics, floating point, pure binary). Where such techniques have already been adopted, local use

may be continued until Federal standards applicable to these techniques are promulgated. To facilitate United States of America Standards Institute (USASI) and Federal standards development, agencies making heavy use of such techniques should advise the National Bureau of Standards of the form, degree and length of use, application, and technical or cost advantages of the representations used. If the use of these techniques established prior to the issuance of applicable Federal standards is to carry past a replacement or augmentation procurement, the waiver procedure (see sec. 9) must be followed.

The memorandum of March 11 requires that all computers and related equipment configurations brought into the Federal Government inventory on and after July 1, 1969, must have the capability to use ASCII and the formats prescribed by the magnetic tape and paper tape standards when these media are used. The following instructions apply:

a. **New Installations.** The standard code and the magnetic tape and paper tape standards shall be implemented in new additions to the inventory, and their use must be specified in requests for proposals in all cases where there are no significant existing tape files or program libraries which prevent their immediate use. The supporting software shall be compatible with the character set, code, media and collating sequence of the approved Federal standards.

b. **Replacement of Computers and Related Equipment.** Introduction of replacement computers often involves reprogramming and file conversion. Such reprogramming and file conversion may be completed when the replacement becomes operational, particularly if the data system has undergone major revision. In this case, the standards and supporting software shall be fully applied upon conversion. If the reprogramming and file conversion is to be completed over a prescribed time period, the standards shall be phased in as the reprogramming and conversion is accomplished.

Replacement equipment added to the inventory which does not require signifi-

cant reprogramming effort must immediately utilize the approved standards wherever technically possible and economically feasible.

c. **Augmentation of an Existing Computer Configuration.** It is sometimes necessary to augment an existing computer installation with additional computer, peripheral or related equipment which must make use of the same media files as the older equipment. In this case, use of the standards may have to be deferred until segments, subsystems or the entire system can be converted to the standards. Added equipment should if possible have ASCII capability; if not, the waiver procedure (see sec. 9) must be invoked. New capabilities added to an existing installation or system, such as remote terminals or a source data acquisition subsystem, should make use of the approved standards wherever technically possible and economically feasible. If the full character set of ASCII cannot be applied, the largest possible character subset (see sec. 8) should be used, and the ASCII collating sequence observed.

6. Interchange Between Installations

One of the benefits to be derived from character set, code, collating sequence and input/output media standardization is improved ability to exchange data between installations of computers and related equipment. The full benefits of standardization will be realized as input/output equipment which uses the standards replaces the present inventory. The ASCII character set and implementing input/output media standards shall be used whenever data is interchanged between two installations which have equipment conforming to the standard. The standards also can be used effectively for interchange between installations even though some of the installations involved do not yet use the standard media within their data processing operations.

Agencies which already receive large quantities of machine-readable submissions from other Government sources or from outside organizations are often required, usually empowered, and almost always expected, to specify

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acceptable media, codes and formats. For this reason, and because the Federal ASCII standards are in exact accord with the USASI national character, code, media and sequence standards, such agencies should take the lead in utilizing ASCII techniques themselves, and are encouraged to require it of their sources at the earliest practical date.

7. ADP—Telecommunications Interface

ASCII is also a standard for telecommunication networks. Some Federal telecommunications systems operate in ASCII; others will when updated in conformance with the plan for the National Communications System (administered by the Office of Telecommunications Management in the Executive Office of the President). Therefore, users of all computer systems and components which will use Federal communications sytems for the transmission of data shall consult with the Office of Telecommunications Management as to interface requirements.

8. Character Sets

ASCII defines a set of 128 characters commonly used in information processing and communications. Ninety-four characters of the set are graphic symbols (upper and lower case alphabet, decimal digits, punctuation and special symbols); thirty-two are used for control functions; the remaining two are "space" and "delete." This set of 128 characters, when coded in binary format, requires a minimum of seven bits for a unique representation of each character. Representation of this binary code on standard-conforming paper tape is by seven bits. Representation on standard-conforming magnetic tape is by eight bits. The magnetic tape standard specifies that the eighth bit will be recorded as "zero." The recording of "one" in the eighth channel will be governed by the procedures for expanded sets specified in paragraph d. below. Many computing, data processing, and communications applications require only a limited character set. Other applications may require a character set of about the ASCII size, but with very different graphics (Cyrillic alphabet, mathematical sym-

bols). Still others may require a very much larger set (general library applications, cartography, typesetting).

Permitted character sets are as follows:

a. **Basic or standard set.** Use of ASCII as promulgated and officially maintained by USASI, and as registered in the National Bureau of Standards FEDERAL INFORMATION PROCESSING STANDARDS REGISTER (FIPS Register). This should be used wherever the capability exists and wherever additional graphic or control characters are not absolutely necessary.

b. **Subsets.** Use of a smaller number of ASCII characters, the individual character code assignments remaining unchanged. Examples are a 16-character "numeric" subset and various high speed printer subsets. Use of one or more of these ASCII subsets is a powerful tool in bridging the conversion gap prior to the procurement or utilization of hardware with full ASCII capability.

c. **Extended sets.** Use of alternate assignments of the 128 binary patterns. This may be accomplished by use of the ASCII control characters SO (Shift Out), SI (Shift In) and ESC (Escape). Such use may be planned by agencies having special requirements, but must not be finalized until approved by NBS and entered in the FIPS Register. Once an extended set has been identified and approved and entered in the FIPS Register it may be used for applications and by installations other than the original without specific approval by NBS.

d. **Expanded sets.** Use of the complete 256 eight-bit character codes made possible by the availability of eight information channels on standard magnetic tape and other media with a capacity for eight data bits. The character set of the expanded code must include the character set of the original code. Use of expanded sets must be approved by NBS and entered in the FIPS Register as described above for extended sets. Once an expanded set has been identified and approved and entered in the FIPS Register it may be used for applications and by installations other

than the original without specific approval by NBS.

The approval and registration of extended and expanded sets will prevent uncontrolled character code assignments from leading to incompatibilities like those which preceded the adoption of ASCII. The register of approved code assignments will be of great value in developing future national and Federal code standards.

9. Waivers

In Section 3, the objectives of the Federal ADP standards program are enumerated. Section 5 provides instructions for furthering these objectives through implementation of the ASCII standards, and recognizes current situations from which evolutionary progress toward the objectives will be achieved. If instances arise in which an agency cannot comply with the provisions of Section 5, the head of the agency is authorized to waive application of these instructions. Generally, two conditions apply in those exceptional cases which would warrant waivers:

a. Significant, continuing cost or efficiency disadvantages will be encountered by the use of ASCII and,

b. The interchange of information with other systems is minimal and is expected to remain minimal.

All waivers and the reasons therefore will be coordinated with the National Bureau of Standards sufficiently in advance of final agency authorization that NBS may consider the impact of the decision on the Federal standards program, and the significance of the action with respect to future national standards participation.

A waiver will not be required for equipment delivered before July 1, 1969, nor for equipment ordered before March 11, 1968 for delivery on or after July 1, 1969. Equipment ordered after the issuance of the Presidential order and before the issuance of this memorandum, for delivery on or after July 1, 1969, and not conforming to the Federal standards, shall be described in memorandum form to the National Bureau of Standards within sixty days of issuance of this letter. In exceptional cases, such as an important and entirely new installation, NBS may request initiation of the full waiver procedure by the agency head.

10. Additional Information

Questions related to these standards or their application as well as comments or recommendations for revisions of these standards should be directed to the Center for Computer Sciences and Technology, National Bureau of Standards, Washington, D.C. 20234.

Attachment 1:
   Approved Federal ADP Standards

Attachment 2:
   Additional ADP Standards Under Development

Attachment 3:
   Glossary of Terms

APPROVED FEDERAL ADP STANDARDS

Three specific standards were approved by the President on March 11, 1968.

    a. The USA Standard Code for Information Interchange, X3.4-1967, usually referred to as ASCII, defines 'the coded character set to be used for the general interchange of information among information processing systems, communication systems, and associated equipment.

    b. The USA Standard Perforated Tape Code for Information Interchange, X3.6-1965, specifies the representation of ASCII in perforated tape and similarly encoded media.

    c. The USA Standard Recorded Magnetic Tape for Information Interchange, 800 CPI, NRZI, X3.22-1967, specifies the representation of ASCII on 9-track, one-half inch magnetic tape at a recording density of 800 characters per inch, using non-return to zero type recording.

ADDITIONAL ADP STANDARDS UNDER DEVELOPMENT

The USA Standards Institute (USASI) Committees X3 and X4 have been working on computer and information processing and related equipment standards for approximately eight years. The X3 Committee has produced 25 approved standards with a greater number in various stages of processing. Most of these are potential candidates for Federal ADP standards. These approved and proposed standards range through character sets, codes, media, transmission conventions, programming languages, vocabulary, problem analysis, and data codes and data formats.

The Federal magnetic tape standard, 800 CPI, NRZI, identified in Attachment 1 is one of a family of three recorded magnetic tape standards. The other two members of the family are:

    a. The proposed USA Standard Recorded Magnetic Tape for Information Interchange, 200 CPI, NRZI, which is intended to provide a relatively low performance tape for low-cost systems use, and

    b. The proposed USA Standard Recorded Magnetic Tape for Information Interchange, 1600 CPI, Phase Encoded, which is intended to provide a relatively high performance tape for systems where such performance can be used effectively. It is based on phase encoding rather than non-return to zero type recording.

All three members of the family involve 9-track recording on one-half inch magnetic tape. Action to adopt the two additional members of the related family of magnetic tape standards as Federal standards can be expected at the earliest practical date.

A proposed USA Standard Magnetic Tape Label for Information Interchange has been circulated to Government agencies for comment both as to its adoption as a USA standard and as a Federal ADP standard. Its approval as a USA standard seems assured. The standard label provides a method of describing the data format of the tape and should facilitate interchange of recorded magnetic tape reels. The response of Federal agencies to the adoption of the proposed label standard as a Federal standard was generally favorable.

A proposed USA Standard Hollerith Punched Card Code was also circulated to Government agencies for comment on adoption as both a USA and Federal standard. The response was quite favorable. This proposed standard is advancing in USASI and internationally. Approval as a Federal ADP standard appears warranted.

Work within an X3 subcommittee (X3.2) is well advanced on a proposed standard edge-punched card in which the ASCII code is punched along one edge of the card as on perforated tape. The proposed standard may offer significant economic advantages for use with low volume data transmission terminals since the format is the same as on perforated tape, and code translation is not required as is the case with Hollerith coded cards.

Government agencies have also been queried on USA approved or proposed standards related to optical character recognition, data transmission, COBOL programming language, and keyboards. Follow-on work on some of these queries is still underway. The Federal COBOL standard is well advanced.

A data transmission control procedures proposal is nearing completion in an X3 subcommittee (X3.3).

Work is in early phases in Committees X3 and X4 on computer/peripheral interfaces, data elements and code standardization, all aspects of credit card standardization, and special purpose punched cards.

GLOSSARY OF TERMS

1. **Binary-coded decimal.**—A system of character coding in which decimal digits are coded in terms of binary digits.
2. **Central processor.**—A unit of a computer that includes the circuits controlling the interpretation and execution of instructions.
3. **Character.**—A letter, digit, or other symbol that is used as part of the organization, control, or representation of data.
4. **Character code.**—The bit pattern assigned to a particular character in a coded character set.
5. **Character-oriented equipment.**—Equipment which acts upon individual characters as contrasted to one which operates upon binary data.
6. **Coded character set.**—A set of characters together with the code assigned to each character for machine use.
7. **Collate.**—To combine items from two or more ordered sets into one set having specified order not necessarily the same as any of the original sets.
8. **Collating sequence.**—An ordering assigned to a set of items such that any two sets in that assigned order can be collated.
9. **Compiler.**—A computer program that prepares a machine language program from a program written in another programming language.
10. **Floating point.**—A number system in which numeric information is represented by an integral number multiplied by a specified power of a fixed positive integer base.
11. **Format.**—The arrangement of data.
12. **Hollerith.**—Pertaining to a particular type of code or punched card utilizing 12 rows per column and usually 80 columns per card.
13. **Machine-independent software.**—Software having characteristics that are independent of the particular machine models upon which it is executed.
14. **Machine processible form.**—Information coded in a language that can be used directly by a machine.
15. **Media** (plural of medium).—The material, or configuration thereof, on which data is recorded, e.g., paper tape, cards, magnetic tape.
16. **Packed numerics.**—Numeric data coded in a compressed manner taking advantage of known characteristics of the data and the medium used for storing and processing the data.
17. **Peripheral equipment.**—In a data processing system, any unit of equipment, distinct from the central processor, which may provide the system with outside communication.
18. **Programming language.**—A language used to prepare computer programs.
19. **Pure binary.**—A code that makes use of exactly two distinct characters, usually 0 and 1.
20. **Remote-access.**—Pertaining to communication with a data processing facility by one or more stations that are distant from that facility.
21. **Software.**—A set of computer programs, procedures, rules and possibly associated documentation concerned with the operation of a data processing system.
22. **Source data automation.**—Automatic capture of information at the source in a form that can be used directly by a machine.
23. **Validation.**—The act of testing for compliance with a standard.

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