

ISO/IEC JTC 1/SC 22
Programming languages, their environments and system software interfaces
Secretariat: ANSI (USA)

Document type: Proposed NP (Open)

Title: New Work Item Proposal on Additional Parallel Features in Fortran WG 5

Status: Please submit all votes via the Balloting Portal.

Date of document: 2012-08-29

Source: SC 22/WG 5 (J. Reid, Convenor)

Expected action: VOTE

Action due date: 2012-11-30

Email of secretary: mpeacock@ansi.org

Committee URL: <http://isotc.iso.org/livelink/livelink/open/jtc1sc22>

NEW WORK ITEM PROPOSAL

Date of submission
2012-08-29

Reference number (To be given by the Secretariat)
SC 22 N 4758

Proposer: John Reid, Convener, ISO/IEC JTC1/SC22/WG5

Secretariat: ISO/IEC JTC1/SC22

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A proposal for a new work item within the scope of an existing committee shall be submitted to the secretariat of that committee with a copy to the Central Secretariat and, in the case of a subcommittee, a copy to the secretariat of the parent technical committee. Proposals not within the scope of an existing committee shall be submitted to the ITTF.

A new work item proposal within the scope of an existing technical committee or subcommittee may be made in the respective organization by a national body, the secretariat of that technical committee or subcommittee, another technical committee or subcommittee, an organization in liaison, the technical management board or one of its advisory groups, or the Chief Executive Officer.

The proposal will be circulated to the P-members of the technical committee or subcommittee for voting, and to the O-members for information.

See overleaf for guidance on when to use this form.

IMPORTANT NOTE: Proposals without adequate justification risk rejection or referral to originator. Guidelines for proposing and justifying a new work item are given overleaf.

Proposal (to be completed by the proposer)

Title of proposal (in the case of an amendment, revision or a new part of an existing publication, show the reference number and current title)

English title Additional Parallel Features in Fortran

Scope of proposed project Publish a Technical Specification for parallel programming features in Fortran in addition to those in ISO/IEC 1539-1:2010, with the intention of incorporating the features into the next revision of ISO/IEC 1539-1.

Purpose and justification (attach a separate page as annex, if necessary) . This is to provide standardized syntax and semantics within Fortran for constructs commonly used in parallel programming. The particular constructs proposed were deferred during the development of ISO/IEC 1539-1:2010 because of insufficient time to reach consensus on their details. A clearer consensus has since been reached. To support the goal of program portability, these programmer-requested features should be standardized sooner than the next revision of ISO/IEC 1539-1 to avoid divergent vendor implementations.

Envisaged publication type (indicate one of the following, if possible)

- International Standard Technical Specification Technical Report

Does the proposed project concern known patented items (see ISO/IEC Directives Part 1 for important guidance)

- Yes No If "Yes", provide full information in an annex.

Are there any known accessibility requirements and/or dependencies? Yes No

If yes, please specify in a separate annex.

Are there any known requirements for cultural and linguistic adaptability? Yes No

If yes, please specify in a separate annex.

Target dates for availability

First CD 2013-July-31

Publication 2014-July-31

Proposed development track 1 (24 months) 2 (36 months - default) 3 (48 months)

Meeting Information

concerned.

Guidelines on the completion of a proposal for a new work item (see also the ISO/IEC Directives Part 1)

- a) **Title:** Indicate the subject of the proposed new work item.
- b) **Scope:** Give a clear indication of the coverage of the proposed new work item. Indicate, for example, if this is a proposal for a new publication, or a proposed change (amendment/revision). It is often helpful to indicate what is not covered (exclusions).
- c) **Envisaged publication type:** Details of the types of ISO/IEC deliverable available are given in the ISO/IEC Directives, Part 1 and/or the associated JTC 1 Supplement.
- d) **Purpose and justification:** Give details based on a critical study of the following elements wherever practicable. *Wherever possible reference should be made to information contained in the related Business Plan.*
 - 1) The specific aims and reason for the standardization activity, with particular emphasis on the aspects of standardization to be covered, the problems it is expected to solve or the difficulties it is intended to overcome.
 - 2) The main interests that might benefit from or be affected by the activity, such as industry, consumers, trade, governments, distributors.
 - 3) Feasibility of the activity: Are there factors that could hinder the successful establishment or global application of the standard?
 - 4) Timeliness of the standard to be produced: Is the technology reasonably stabilized? If not, how much time is likely to be available before advances in technology may render the proposed standard outdated? Is the proposed standard required as a basis for the future development of the technology in question, or for adoption in a future regulatory system?
 - 5) Urgency of the activity, considering the needs of other fields or organizations. Indicate target date and, when a series of standards is proposed, suggest priorities.
 - 6) The benefits to be gained by the implementation of the proposed standard; alternatively, the loss or disadvantage(s) if no standard is established within a reasonable time. Data such as product volume or value of trade should be included and quantified.
 - 7) If the standardization activity is, or is likely to be, the subject of regulations or to require the harmonization of existing regulations, this should be indicated.
 - 8) If a series of new work items is proposed having a common purpose and justification, a common proposal may be drafted including all elements to be clarified and enumerating the titles and scopes of each individual item.
- e) **Relevant documents and their effects on global relevancy:** List any known relevant documents (such as standards and regulations), regardless of their source.

NOTE: The following criteria f) and g) do not mandate any feature for adaptability to culture, language, human functioning or context of use. The following criteria require that if any features are provided for adapting to culture, language, human functioning or context of use by the new Work Item proposal, then the proposer is required to identify these features.

- f) **Accessibility:** Indicate here whether the proposed standard takes into account diverse human functioning and diverse contexts of use. If so, indicate how it is addressed in your project plan. Indicate how the guidelines of ISO/IEC Guide 71 (Guidelines for standards developers to address the needs of older persons and persons with disabilities), ISO/IEC TR 29138-1 (Information technology -- Accessibility considerations for people with disabilities -- Part 1: User needs summary), and ISO TR 22411 (Ergonomics data and guidelines for the application of ISO/IEC Guide 71 to products and services to address the needs of older persons and persons with disabilities) have been implemented in the proposal, or why they are not deemed to be relevant.
- g) **Cultural and linguistic adaptability:** Indicate here if cultural and natural language adaptability is applicable to your project. If so, indicate how it is addressed in your project plan. Typical examples of requirements include:
 - 1) for text or speech, the user shall be able to choose the natural language of input and output sentences and the language captured shall be identified;
 - 2) for character coding, the code shall be clearly identified for correct input and rendering;
 - 3) for sorted lists, linguistic user order expectations shall be respected (see ISO/IEC 14651 International string ordering and comparison);
 - 4) cultural variations in the way concepts are perceived in different countries shall be respected; and
 - 5) input methods used in a given country shall also be supported.

For a list of what is required in most IT products, see ISO/IEC TR 19764 (Guidelines, methodology, and reference criteria for cultural and linguistic adaptability in information technology products) and ISO/IEC TR 11017 (Framework for internationalization).

- h) **Cooperation and liaison:** List relevant organizations or bodies with which cooperation and liaison exist or should exist (other organizations).
- i) **Preparatory Work:** When the proposer considers that an existing well-established document may be acceptable as a standard (with or without amendment), indicate this with appropriate justification and attach a copy to the proposal. In this case, provide the document publication date, implementation history and national/global adoption experience.

A Technical Specification, "Additional Parallel Features in Fortran", is proposed.

1. Overall size

S1. The complexity of the TS should be comparable with that of document N1858, from the point of view of both implementation and edits to the standard. This is the essence of Resolution G9 of the Garching meeting (see N1861).

This set of requirements specifies a TEAM facility different from the one in N1858, an EVENT facility as an alternative to the NOTIFY/QUERY facility in N1858, and a simpler set of collective subroutines. It adds new intrinsic procedures for atomic memory operations, but omits the parallel I/O facilities in N1858. On balance, the requirement S1 is satisfied.

2. Teams

Teams provide a capability to restrict the image set of remote memory references, coarray allocations, and synchronizations to a subset of all the images of the program. This simplifies writing programs that involve segregated activities (parts of a climate model, for example) that might be more easily be written independently or may have already been written as independent programs. Teams also provide a mechanism for subdividing the computation for the sake of better performance (such as within local SMP domains). Finally, teams provide the capability to execute procedures (such as library procedures) that use coarrays internally on a subset of the images of a program.

T1: When a block of code is executed on images executing as a team, it should execute on those images as if the program contained no other images. This has the following implications:

- 1. Image indices shall be relative to the team, starting at 1 and ending with the number of images in the team.**
- 2. Collective activities that would involve all images, such as SYNC ALL, allocation and deallocation of coarrays, collective subroutine execution, and inquiry intrinsics such as THIS_IMAGE and NUM_IMAGES shall be relative to the team.**

T2: While an image executes a statement it shall be a member of one and only one team. Access to variables on images outside the current team is not permitted.

T3: It should be possible to split a team into mutually exclusive subsets that are themselves teams. This should be dynamic in order to allow different groupings of images during different stages of execution. It is desirable to have a compact mechanism for an image to specify which team it wishes to belong.

T4: There shall be a construct mechanism for changing the current team, involving the synchronization of all members of the teams at the beginning and end of the construct. The construct shall support separate execution blocks based on team membership. The construct shall make apparent (both to the system and the programmer) where team execution begins and ends.

T5: There shall be a type for variables identifying a team collection (probably an opaque derived type defined in the intrinsic module ISO_FORTRAN_ENV).

T6: There needs to be a mechanism to find the image index relative to the set of an ancestor team. This might best be done by adding an optional argument to IMAGE_INDEX that specifies the ancestor team.

T7: An allocatable coarray that is allocated within a team construct shall be deallocated before execution of the team construct terminates. An coarray that was allocated in a parent team shall not be deallocated within an child team construct.

T8: The restriction that standard input is attached only to image 1 is unchanged, and the designated image is image 1 of the original set of images present at program startup.

3. Collectives

A collective subroutine is an intrinsic subroutine that is executed by a set of images. It performs a computation based on values on the images of the set. Collective subroutines offer the possibility of substantially more efficient execution of reduction operations than would be possible by non-expert programmers. Corresponding routines are widely used in MPI programs.

C1: A call to a collective subroutine is not an image control statement. However, such a call shall appear only in a context that allows an image control statement. Even though calls to collective subroutines involve internal synchronization required by the usual rules for reference and definition of subroutine arguments, they do not facilitate ordering of segments.

C2: If a collective subroutine is invoked on one image, it shall be invoked by the same statement on all images of the current team.

C3: A collective subroutine based on a user-written procedure that applies the required operation to local variables shall be provided. In addition, because they are often needed, there should be specific collective subroutines for SUM, MAX, and MIN for intrinsic types for which the corresponding operations are defined. Forms that provide the result to just one image or to all the images involved should be provided. Beyond this, there should be a collective subroutine that broadcasts a value on one image to a set of images. Coindexed source and result arguments are not permitted.

4. Additional intrinsic atomic subroutines

Atomic memory operations provide powerful low-level primitives for synchronization of activities among images without use of heavy-weight synchronization and lock statements. They can provide substantial performance advantages.

A1: Atomic intrinsic subroutines shall be provided for atomic-compare-and-swap, atomic-integer-add, atomic-bitwise-and, atomic-bitwise-or, and atomic-bitwise-xor. For the integer add and bitwise logical operations, both the direct and "fetch-and" versions should be supplied.

5. Synchronization using events

The NOTIFY and QUERY statements were proposed in N1858, but for matching the execution of a NOTIFY statement on one image with the execution of a QUERY statement on another image, the feature relied on the numbers of times the statements were executed on the images. This mechanism is not robust in the presence of segment reordering; for example, an image that would otherwise be idle might bring other work

forward. The preferred mechanism involves tagged events. The tagging aspect is important for employing this capability in a library routine in such a way that is hidden from, and does not interfere with the caller.

E1: There should be a mechanism to allow one-sided ordering of execution segments. For example, suppose image I executes successive segments I1 and I2 and image J executes successive segments J1 and J2; there might be a need for I1 to precede J2 without the need for J1 to precede I2.

E2: The mechanism should use a data item (tag), accessible on all the images, to identify the event. There shall be a type for variables used as these tags (probably an opaque derived type defined in the intrinsic module ISO_FORTRAN_ENV).

E3: Mechanisms shall be provided to post and test an event, and wait for an event to be posted. Repeated posts to the same event increment a counter internal to the tag and wait decrements the counter. The statements implementing event post and wait are image control statements. The test operation may be implemented by an inquiry function, and hence would not be an image control statement.

E4: If multiple event wait operations specify the same event variable, it is unspecified which one of these operations completes when the corresponding event post occurs.