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Relationship model: a network model for integrating human expertise with systematic distributed processes

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SUMMARY

In this paper we offer an integrated flexible system in which two inter-related models interact. One: the systems environment model that is inherent in all large enterprises and defines the logical enterprise organizations, units, division of work and responsibilities. Two: the Relationship model, which is a dynamic network derived from the data provided by the distributed expertise of the systems environment model representing several types of relationships among the units. This network model can be probed to produce related units with specific relationships to efficiently initiate a change, plan a change, adjudicate and implement a change. Each unit of the network can initiate a proposal for a new change by exploring its effect on the rest of the network; once a proposal for change is explored, its implications are evaluated and approved, a coordinated change is planned and implemented in a timely and organized manner while every constituency has been prepared for the planned change. While the proposed model can easily be adapted for organizations with well-defined systems environment models, this paper focuses on the design, integration and implementation of the Relationship network and its processes for information technology (IT) within a large telecommunication company with an existing systems environment model. Copyright © 2010 John Wiley & Sons, Ltd.

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1. INTRODUCTION

In a large and diverse telecommunication organization, information technologies (IT) draw technical experts from many smaller organizations to provide the wide variety of services that they provide. The overall management of the operations requires a well-defined process model that effectively represents the working relationships between each of the sub-organizations. Historically, the IT decisions and policies were made centrally for the entire organization. The central approach offers consistency and ease of managing and implementing changes in the entire enterprise. However, large companies and organizations find themselves more and more in largely distributed environments where changes in one unit may inadvertently affect many others resulting in waste, degradation of productivity and quality.

Much of the tools and methods used to model business processes concentrate on upstream process activities (leading to the final product), usually to the exclusion of mid-stream transitional activities

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(the inter-relationships between business and the IT) and downstream activities that incorporate the implemented processes into work routines. Furthermore, often models do not consider the existing social infra structures that already exist in large organizations. These include not only the computer-based information systems, but also all other aspects of the business that the IT must serve.

In this paper, we propose two inter-related models for a large telecommunication organization. First, an existing system environment model that provides a clear picture of the enterprise's computer-based information system, which spans hundreds of applications, thousands of servers, desktop environment for tens-of-thousands of users and network connectivity for all of them. The complexity of the system is mainly in the distribution of the working units and the functionality that each provides for the entire system. This model is typical in most organizations and provides the logical and hierarchical structure of each unit, divisions and areas of responsibility for each.

Second, and the purpose of this work, is to augment the existing systems environment model of an organization by modeling the inter-relationship between the units involved in the IT (Relationship Model). Owing to the distributed nature of the IT areas, design decisions made independently by a unit will often have a significant impact on the other units. Here, we propose to enhance the existing systems environment model to represent the specific types of relationships between various units. This model should ideally provide guidelines to each unit as to which other units are influenced by it or will influence it through the changes made in their units. Such a system will effect change and will improve communication and the overall productivity in the organization. It also provides an improved awareness of the resources that already exists in the organization. Our model integrates the human expertise and objectivity with systematic distributed processes that will incorporate all stakeholders resulting in improved decision-making processes to effect change. Although the models can easily be adapted for other organizations with defined logical organization of units other than IT, this paper treats IT within a large telecommunication company.

For this model to be accurate and useful, the information must be collected from the experts in the field. The systems environment model defines the technology areas, owners and experts for each working unit who will be able to provide the best possible relationship data. We believe that this model will offer a more successful way to implement effective systems.

1.1. Potential advantages of the relationship model

The objective is to develop a model to define the relationships among technology areas identified in the organization's systems environment model that offers flexibility and can be adapted to be applicable to a variety business domains and services. The Relationship model will evolve over time to help coordinate the specific activities of the technology areas more efficiently. For the model to accurately reflect the needs of the technology areas (TA), experts; i.e., technology area owners are asked to provide key information.

The Relationship Model integrated with the Systems Environment Model can provide important functionality such as

- an efficient and obvious tool for interaction among related technology areas on activities relevant to their domains.
- a tool to implement coordinated changes more effectively.
- a planning tool to coordinate major infrastructure changes that span multiple technology areas including organizational and budget impacts.
- a tool for TA owners to define their interface requirements and minimum standards to facilitate information flow. This will result not only in improved communication among technology areas, but will also result in a reduction of waiver traffic.
- a model to simulate and evaluate the impact of a possible standard change before a final decision is made.

The Relationship Model and the processes it provides are key factors in other aspects:

- It allows any technology area to initiate a proposal for a new direction or a change.
- It encourages initiation of innovative ideas.

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- It encourages the dissemination of information and collection of relevant data.
- It encourages community participation by inviting input from distributed IT experts.
- It encourages well-thought plans for new directions.
- It is easier to motivate the acceptance of a new direction or change.
- It can provide good time/performance management by involving the relevant technology areas.

1.2. Related work

Much in-depth work in the field of automated distributed knowledge management has been reported [1–3]. Roos *et al.* [4] adopt the approach of policies and domains. With policy objects consisting of two parts: a passive relationship that defines a relationship between an automated manager and target domains, and an active policy object, a form of proxy manager, to achieve the objectives specified in the passive relationship for the automated manager. The active policy object administers the managed objects in the domain by polling them. Sloman [1] does this modeling as a hierarchical management structure separating management policy from the automated managers who interpret the policy to facilitate the dynamic changes within a distributed management system. In this model, one set of policies defines the manager-proxy relationship and another set defines the responsibility of the manager-proxy with the object domains. Other works with encoding of policies and behaviors into proxy managers are reported in [5, 6].

A well-established methodology for change management consists of a number of steps [7, 8]:

1. Assessment of the impact of changes (resources and services affected).
2. Creation of a Change Plan (how to implement the change).
3. Verification of the Change Plan (review by an appropriate team).
4. Testing the Change Plan.
5. Implementation of the change.

Workflow technologies have been employed to automate and coordinate large-scale change management [9], and project management techniques [10]. Construction of a Change Plan in step 2 requires the knowledge of service dependencies. Discovering dependencies has been reported in [11], whereas representing dependencies are detailed in [12, 13]. Automating the construction of Change Plans was the primary focus of [14] as a first step toward broader automation of change management. The required formalisms for workflow specifications and their resulting systematic activity have been deemed rigid in [15], where they advocate for a flexible representation of business processes and their supporting systems in an evolving environment. The significance of incorporating human expertise in the decision-making processes is highly evident in [16]. In this paper, we offer an integrated flexible system in which two inter-related models interact. One: the systems environment model that is inherent in all large enterprises and defines the logical enterprise organizations, units, division of work and responsibilities. Two: the Relationship model, which is a dynamic network derived from the data provided by the distributed expertise of the systems environment model representing several types of relationships among the units. The Relationship model is a new approach and along with its resulting processes are designed to be flexible, built upon the human expertise and systems environment model and the need for interaction between their work units in a distributed environment, encourages initiation of innovation and participation, and facilitates efficient coordinated change and dissemination of information.

1.3. Overall organization and approach

The design of the Relationship model and the implementation of the resulting processes were carried out in several stages that can provide the guidelines for new organizations interested in adopting such a network model. The design stages and the organization of this paper are summarized as

- Stage one, getting to know the environment, involved several initial interviews with technology area owners and design of a questionnaire used for the initial interviews see Appendix A.

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- Analysis of collected information was carried out in stage two of the research. The information was analyzed and the essential relationship categories among technology areas were identified as described in Section 2. A datasheet to collect the relationship data from the technology areas was subsequently designed, see Appendix B.
- All the identified technology area owners were interviewed in stage three. The purpose and the description of the relationship model, the importance of collecting input directly from experts in the field and the *Datasheet* were described to each technology area owner during the interviews. Attempts were made to address concerns and discover issues that may not have been addressed by the designed *Datasheet*. The relationship data and the principal data structures needed for efficient implementation of the relationship network model are described in Section 3. In parallel to these efforts, a complex process, *Planning a Change*, was designed to ensure that the major aspects of the model and the required input from technology areas were adequately addressed in our design. Each technology area owner was asked to complete one *Datasheet* per technology area and provide input to the Relationship Model.
- At stage four, a Relationship Matrix along with processes to describe how to enter, correlate and address inconsistencies of the data collected from the technology area owners was implemented. The 'Change' and 'Planning a Change' processes and their sub-processes and illustrating examples are described in detail in Section 4. Section 5 presents sample templates to be used by the developed processes.
- Finally at stage five and in Section 6, we completed the project by proposing the design of a graphical web-based system with suggestions for minimal graphical views for IT users and technology area owners.

2. RELATIONSHIP CATEGORIES

The analysis of data collected from the initial interviews with several technology area owners resulted in identifying key relationship categories identified as R1, R2, ..., R5. Each technology area owner was asked to determine whether any of the following relationships exist between his/her technology area, TA, and any of the other technology areas identified in the Systems Environment Model.

R1: *Coordinated planning*: Identify the technology areas that must coordinate their activities with your TA either at decision-making or at planning stages, relationship category R1.

R2: *Provide training and/or resources to*: Identify the technology areas that your TA must provide training or resources to so that they can implement a change/new direction. List the type of training and/or resources, for example how to use a new software package, consultation and expertise, hardware, software, licenses, personnel, consulting, funding, etc., relationship category R2.

R3: *Receive training and/or resources from*: Identify the technology areas that must provide your TA with training or resources needed to implement a change/new direction. List the type of training and/or resources, for example how to use a new system, consultation and expertise, hardware, software, licenses, personnel, consulting, funding, etc.

R4: *Receive advanced notification of a change*: Identify the technology areas that must notify your TA of their planned changes in advance. Specify a reasonable time of advanced notification.

R5: *Notify others of a change in advance*: Identify the technology areas that your TA must notify in advance. Specify a reasonable time of advanced notification.

Others: Define the relationship(s) that are missing from the above, and identify the technology areas that are related to your TA in this category.

The last category, others, was to allow for any relationship type that was not accounted for in the preceding five categories. After interviewing all the technology areas, it became evident

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that the *High Availability Services* would not fit any of the identified categories. The role of the *High Availability Services* is to verify that the requirements of 'Highly Available' and/or 'Fault Resilience' associated with a product is feasible. Therefore, rather than defining a relationship category, the role of this technology area is accounted for in the approval process as will be demonstrated in the presentation of the 'Planning a Change Process'.

3. PRESENTATION OF BASE DATA

The Systems Environment Model identifies the technology areas through a logical division of the responsibilities within the IT and its organization resulting in a tree structure. Such a hierarchical model is normally present in any large organization. The Relationship Model focuses on the leaf nodes of the tree structure, namely the technology areas, and defines relationships among them resulting in a graph or network model. The selected method for data representation presented in this paper is based on the efficiency to create, modify, access and build various data structures for higher-level operations. It provides an efficient and fast interface for high-level languages, database systems and web design.

3.1. Raw data

The data collected from the technology area owners in the *Datasheet*s are referred to as the raw data (a sample *Datasheet* is included in Appendix B). A total of 66 technology areas (identified by the systems environment model) were asked to provide the relationship data by completing a customized *Datasheet* for their specific technology areas. Each *Datasheet* was partially completed with the data collected from other technology areas during the initial interviews up to the point of the formal request. The *Datasheet* identifies the technology area owner, the person contacted to provide the relationship information, a functional description and the relationship table. Furthermore, each *Datasheet* is addressed by its complete path name. The path name corresponds to the category used in the Technology Owners table provided by the System Environment Model. The path address is used in an abbreviated form to refer to a technology area. For example, the technology area B.4.c refers to the System Software/Middleware/Mainframe. The completed *Datasheet*s are made available to all technology areas electronically in a specific Relationship Model shared IT-storage area.

3.2. Relationship Matrix

The data from the 66 relationship tables are collected in a Relationship Matrix as an abstract data structure. The Relationship Matrix is in fact representing a total of five relationship graphs corresponding to each of R1 to R5 relationship categories. For example, when a technology area needs to coordinate with the technology areas that must participate in the implementation of a change, the graph that represents the R1 relationship is of interest. However, R2 graph is used when a technology area needs to communicate with those that must receive resources from it. The Relationship Matrix represents all relationship types among technology areas. All possible relationship graphs, or networks, can be derived from the Relationship Matrix. The advantage of this abstract presentation and collection is in its availability in one structure, ease and speed of access. In Section 3.3, we will present data structures for actual implementation of the required functionality related to the Relationship Matrix.

The matrix has 66 rows and columns corresponding to the 66 technology areas. Row I of the matrix, *REL*, represents the relationships between the technology area, I, and all other technology areas. Column I of the matrix records the relationship of other technology areas with technology I. The column information is used for cross-referencing the relationships for areas that have not yet provided data or where there is an inconsistency between the inputs provided by the two technology areas. Column *OK* is used to indicate receipt of *Datasheet* for each technology area. Therefore,

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$REL(I, OK) = X$ indicates receipt of *Datasheet* from technology area I. A partial and small sample of the Relationship Matrix is included in Appendix C. The following process describes the steps to be taken in recording new data in the Relationship Matrix. The process to update/modify the existing data is similar.

3.2.1. Recording relationship data in the Relationship Matrix REL (*'The MATRIX'*). The steps of accumulating, correlating and checking consistency of the relationships based on the information provided by the technology owners is a continuous process. The progress is made as data is received from input sources; i.e., technology areas and judicial decisions made based on the information provided from the technology area owners.

The Process provides a mechanism to check for inconsistencies. The ideal approach suggests that when a major inconsistency is detected between two technology areas, the event be recorded in a Waitlist, the two technology areas be informed of the inconsistency and asked to provide a resolution. Although this is the ideal approach, the practical aspects of receiving input from the technology areas within a reasonable time period prevents its execution. An alternative approach is used to handle the major inconsistencies, as detailed below; it keeps a record of the differences in the relationships encountered, the technology areas in question and a proposed resolution in an *Inconsistency list*. The list is made available to the technology areas for information so that they may pursue other resolutions if desired. The experience shows that most proposed resolutions are accepted and the inconsistencies are mainly due to a simple oversight. A sample *Inconsistency list* is included in Appendix D.

1. Receive a new *Datasheet* from a technology area, *Source*.
2. Compare the newly received data for consistency with previously received *Datasheet*s from other technology areas. These are the areas that have already provided input. We need to check the relevant entries for consistencies and record the category of the relationship inconsistency if any:

   For ∀ TA with REL(TA, OK) = X Do {begin consistency check

   If (REL (TA, Source) = R1 & Source.Datasheet.TA.Relationship ≠ R1) OR
   (REL(TA, Source) ≠ R1 & Source.Datasheet.TA.Relationship = R1) Then
   Consistency Verification (TA, Source, R1)
   If (REL(TA, Source) = R2 & Source.Datasheet.TA.Relationship ≠ R3) Then
   Consistency Verification (TA, Source, R2)
   If (REL(TA, Source) = R3 & Source.Datasheet.TA.Relationship ≠ R2) Then
   Consistency Verification (TA, Source, R3)
   If (REL(TA, Source) = R4 & Source.Datasheet.TA.Relationship ≠ R5) Then
   Consistency Verification (TA, Source, R4)
   If (REL(TA, Source) = R5 & Source.Datasheet.TA.Relationship ≠ R4) Then
   Consistency Verification (TA, Source, R5)
   end consistency check}

3. Copy the relationship provided by Source in the row *Source* of the *REL* matrix:
   $REL(Source, *) = Source.Datasheet.Relationship^{T}$
4. Mark the *OK* entry for the *Source* technology area with *X* for complete.
   REL(Source, OK) = X
5. Partially complete the relationship entries for technology areas that have not yet provided input by recording the relevant information provided by *Source*. Technology areas will receive the partially completed *Datasheet*s so that they can observe the input from others:
   REL(TA, Source) = REL(TA, Source) ∪ REL(Source, A)
6. Periodically use the *REL* matrix information, one row/technology area, to update the already completed *Datasheet*s. It is important to update the *Datasheet*s, as the descriptions in them will be used for the final model. To do this update, we use records from the *Inconsistency list* and the *REL* matrix.

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Consistency Verification (Technology area: TA, Technology area: Source, Rtype)
If Rtype = R1 Then #Record the inconsistency in Inconsistency list

Source	R1	TA	Source.Datasheet.TA.description
TA	R1	Source	TA.Datasheet. Source.description

If Rtype $\neq$ R1 Then

Make a judgment based on the input already provided and on the existing management policies.

Adjust the Relationship Matrix entries based on the decision. Complete this step.

If the inconsistency is considered major then #Record the inconsistency in Inconsistency list

Source	R1	TA	Source.Datasheet.TA.description
TA	R1	Source	TA.Datasheet. Source.description

Inconsistency list: *Inconsistency list* is a file that records the status of an inconsistent data, relationship category, between two technology areas *Source1* and *Source2*. *Source1* is the technology area that most recently provided a data inconsistent with the data that technology *Source2* previously provided. *Inconsistency list* records are made available to all technology areas for review and further input. Each record has the following form:

Source1	*Relationship*	*Source2*	*Description provided by Source1*
Source1 ID	Rtype(s)	Source2 ID	Justification by Source1
Source2	*Relationship*	*Source1*	*Description provided by Source2*
Source2 ID	Rtype(s)	Source1 ID	Justification provided by Source 2

Proposed resolution: Rtype(s) for Source1
Rtype(s) for Source2

3.3. Principle data structure to represent the relationship data

The raw data, as collected from the technology area owners through the *Datasheet*s designed for each technology area, are available for the construction of a data structure. The data structure can then be used to design and implement any software system that needs to use and manipulate the relationship data.

The key components of the relationship data is to be represented in a data structure that satisfies several important properties. The data structure must provide fast and efficient access to the essential data. It must allow for the data to be easily modified without affecting the design and the implementation of the relationship model and its functions. Since the data may be used for multiple purposes, it must be structured so that it can be used by different programming paradigms for a variety of implementations such as WEB-based programming, C++, Java, databases or any language/application with more sophisticated data structure support.

For each technology area TA:

- Functional description of the technology area TA, as described by the owner.
- A separate list of technology areas having each of R1, R2, ..., R5 type relationships with TA.
- For each existing relationship between technology area TA and the destination technology area, DTA, a description field to describe the nature or the reason for the relationship as provided by the owners.

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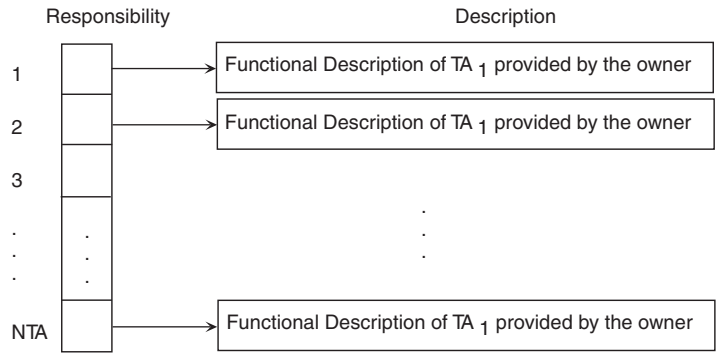

Figure 1. Basic data structure describing responsibility for technology areas.

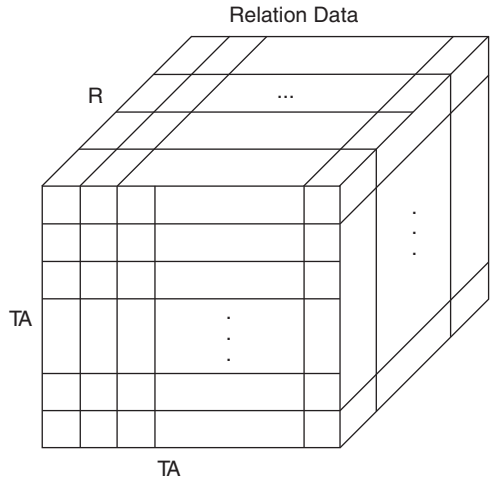

Figure 2. Relationship Matrix.

3.3.1. Proposed data structure. The data structure proposed here is basic, easy to access and can be implemented in any programming language of choice. More sophisticated data structures are easily derived from the proposed structure.
NTA: Total number of technology areas.

Responsibility (1:NTA): An array of size NTA indexed by technology area address that points to the functional description of the indexed technology area, Figure 1. This data can be displayed in response to inquiries about the specific technology area to give an accurate description of the scope of its responsibility. The information in this field is provided by the technology area owners and should be easy to access and modify.

Relation Data (1:NTA, 1:5, 1:NTA): A three-dimensional array with three indices corresponding to technology area address, relationship category and technology area address, respectively, Figure 2. If a relationship of type R exists between two technology areas TA1 and TA2, a one is entered in the Relation Data (TA1, R, TA2) entry. R is a relationship category between 1 and 5. Relation Data (TA, 1, .) returns an array of NTA elements of a sequence of 0's and 1's. The position corresponding to each one is the address of a technology area having an R1 relationship with TA. To get all relationship types that exist between two technology areas TA and DTA, the five entries of the second index must be examined.

RelReason (1:NTA, 1:NTA): If a relationship exists between two technology areas TA1 and TA2, then a description of the reason for the existing relationship between the two as provided by TA1 is obtained in RelReason (TA1, TA2) entry, Figure 3. Furthermore, a description to describe the

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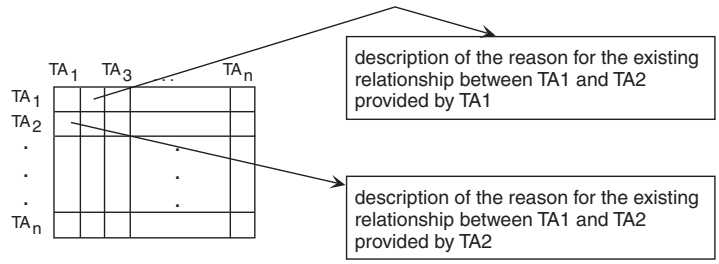

Figure 3. Description of relationship between technology areas.

reason for the existing relationship between the two as provided by TA2 is obtained in RelReason (TA2, TA1) entry. In many instances, these are the same description. However, TA1 and TA2 may provide different reasonings. It may be important to have the differences. In case the description results in inconsistencies, the technology area owners will be able to resolve them as needed.

4. MODELING PROCESSES FROM THE RELATIONSHIP DATA

Once the Relationship network model is designed and implemented as above, various processes can be modeled and implemented to allow for coordinated activities and operation. The relationship data is used to model and implement two key processes. Each unit belonging to the network can propose a desired change by developing a detailed proposal for a change 'Planning a Change'. The initial proposal for change by any unit is submitted for review and feedback to all units that may be impacted by it, the result of completing this coordinated process will be either a complete plan for implementing the change that needs to be approved by the proper authority or is a well-documented rejection of the proposal. The 'Change' Process takes place once a proposal for a change is approved for implementation through the 'Planning a Change' process. These processes provide solutions to decision-making and implementation problems involved in effecting a change that are inherent in a distributed environment. This section describes in detail the models for 'Change' and 'Planning a Change' processes. For each process, the implementation is presented followed by a detailed example to demonstrate the steps. Several templates are used in the processes that are described in Section 5.

4.1. Change process

A technology area, *Source*, initiates a change by first receiving input from all technology areas that are impacted by the change. Next, it forms an *Implementation Committee* consisting of all impacted areas to coordinate and devise an *Implementation Plan* detailing the implementation strategy and the steps to be followed. The four stages of the Change process are defined as four sub-processes:

- Receive approval for initiating the change: This step is needed if there is a requirement for either 'Fault Resilient' or 'Highly Available'.
- Form the Implementation Committee: The technology areas related with R1who will be impacted by the proposed change and will form the *Implementation Committee.*
- Plan and implement a change: The *Implementation Committee* will devise a detailed plan to implement the change.
- Advanced notification: All affected technology areas are notified of the specifics of the upcoming change as it relates to them.

4.1.1. Forming the implementation committee sub-process. A centralized approach is adopted for forming the *Implementation Committee*. The process consists of getting input from all technology areas that are affected by the proposed change; those indicating that they will be impacted by the

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change are related by $R1$ relationship and will form an *Implementation Committee* to carry out the change to ensure that all aspects of the plan are accounted for. It will involve traversing specific sections of the relationship network at various stages of the process.

In the following, Original Source *OS* refers to the technology area that initiates the change and will generate a *Notification of Change Template*. The set of technology areas related to a source with relationship $R1$ is the *Planning Committee* for that source. Every member of the *Planning Committee* will receive the *Notification of Change Template* from its source and will respond with 'impacted' or 'not impacted'. Those indicating 'impacted' will join the *Implementation Committee*. This process continues until all technology areas reachable from *OS* and related with $R1$ have consulted with their *Planning Committee*s.

1. The original *Source* prepares an initial *Notification of Change Template*, see Section 5.1.

#Initialization

Source = OS

Implementation Committee = {OS}

Source set = {OS} # set of TAs that needs to form their own Planning Committees

$\text{Planning Committee}_{\text{Source}} = \{\forall \text{TA} \ni \text{OS R1 TA}\}$ # set of all TAs related to OS with R1

$\text{Visited} = \{\text{OS}\} \cup \text{Planning Committee}_{\text{Source}}$ # set of all TAs invited to respond

2. *Source* sends the *Notification of Change Template* to all technology areas, *TA*, related to it by $R1$ relation.

For every generated $\text{Planning Committee}_{\text{Source}}$ Do{
If ($|\text{Planning Committee}_{\text{Source}}| \neq 0$){

The original source, *OS*, requests status review of the *Notification of Change Template* from every member, *TA*, of the*Planning Committee*. Each *TA* will return a status as either *impacted* or *not impacted* by the change and a description of the nature of impact if any.

Request Status Review (OS, TA, Notification of Change Template, status, description)
$\text{For } \forall \text{TA} \in \text{Planning Committee}_{\text{Source}} \ni \text{status} = \text{impacted}$
Implementation Committee = Implementation Committee ∪ {TA}

For every member of this *Source*'s *Implementation Committee* that is not in the *Source set*, check the status review of its *Planning Committee*.

$\forall \text{Source} \in \text{Implementation Committee} \;\&\; \notin \text{Source set}$ {

$\text{Planning Committee}_{\text{Source}} = \{\forall \text{TA} \ni (\text{TA R1 Source}) \& (\text{TA} \notin \text{Visited})\}$

$\text{Visited} = \text{Visited} \cup \text{Planning Committee}_{\text{Source}}$

Source set = Source set ∪ {source}

}

End If}

End do}

4.1.2. Plan and implement a change sub-process

1. Once the *Implementation Committee* has been formed, the original Source, OS, reviews the responses from the members of the *Implementation Committee* and incorporates them into the *Notification of Change template* finalizing the template.

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2. The *OS* will then send the resulting *Notification of Change* to every member of the *Implementation Committee* and requests an *Implementation Plan* within a defined time period.
3. The *Implementation Committee* invites input from the *Consultation Committee*. This committee consists of all technology areas, TA, that are related to the members of the *Implementation Committee*, ITA, by R2 and R3 relationships and that are not already members of the *Implementation Committee*:

$$\begin{aligned}&\text{Consultation Committee} =\\ &\{\forall\ \text{TA R2 ITA} \ni \text{ITA} \in \text{Implementation Committee } \&\\ &\qquad \text{TA} \notin \text{Implementation Committee}\} \cup\\ &\quad \{\forall\ \text{TA R3 ITA} \ni \text{ITA} \in \text{Implementation Committee } \&\\ &\qquad \text{TA} \notin \text{Implementation Committee}\}\end{aligned}$$

#The one level consultation with R2 and R3 related technology areas is adequate for the *Implementation Committee* to be thorough.

The input from *Consultation Committee* must address

- List of resources the technology area needs to implement the change.
- Justification for the listed resources.
- Time estimates needed for implementing the change, given the required resources.

4. The *Implementation Committee* devises an *Implementation Plan* that includes
   - Order of events to take place and the time table for each event.
   - The technology areas associated with each event and the action to be taken by them.
   - The resources to be provided to technology areas by others, based on input from *Consultation Committee.*
   - List of expertise and experts to provide consulting for each stage of the implementation.
5. The completed plan is finalized for implementation.

4.1.3. Advanced notification sub-process

1. An *Advanced Notification Template* must be sent to the members of the *Consultation Committee* as well as the technology areas, TA, not members of but related to the *Implementation Committee* by R5. The *Advanced Notification* Template in its most complete form is the same as the *Implementation Plan* generated by the *Implementation Committee*. However, the *Implementation Committee* may break down segments of the *Implementation Plan* into relevant information for each technology area. This breakdown of information based on relevance has the advantage of being direct, to the point, and not overwhelming for the target technology areas. This approach is recommended when a complex change is to take place.

$$\begin{aligned}&\forall\ \text{TA} \in \text{Consultation Committee} \qquad \text{Send(TA, Advanced Notification for TA)}\\ &\forall\ \text{TA R5 ITA} \ni \text{TA} \notin (\text{Implementation Committee} \cup \text{Consultation Committee})\ \&\\ &\qquad \text{ITA} \in \text{Implementation Committee}\\ &\qquad\qquad\qquad\qquad \text{Send(TA, Advanced Notification for TA)}\end{aligned}$$

4.2. Example to demonstrate steps of the change process initiated by OS

The sub-graph of Figure 4 shows an example Relationship Model. The solid portion of the graph shows all technology areas having an $R1$ relationship with *OS* and all their subsequent successors related with $R1$. Additional relationships among these nodes are also shown. The dashed portion

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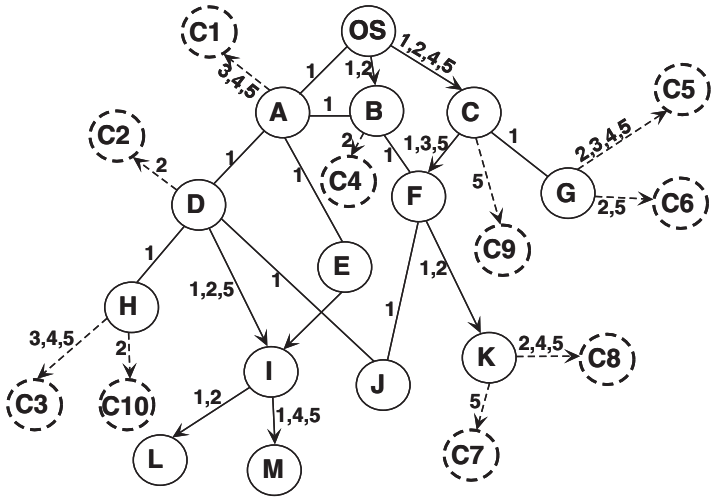

Figure 4. Example relationship graph.

Table I. Status review data for Figure 1.

TA	A	B	C	D	E	F	G	H	I	J	K	L	M
Impact status	I	N	I	I	I	I	I	I	I	N	N	N	N

of the graph shows the technology areas that are not related by $R1$ relationship. Those areas will be involved in the Advanced Notification step, Section 4.1.3.

4.2.1. Form implementation committee. The R relationship types are shown as numbers on the edges. $R1$ relationships are bi-directional; directions of the rest of the relationships are from source to destination as indicated by arrows.

Example Data: The final status review data for a change initiated by *OS* for the graph of Figure 1 is shown in Table I. *I* indicates that the technology area *TA* will be impacted by the proposed change and *N* indicates that the change will not impact them.
Steps through the process are presented in Table II.

4.2.2. Plan and implement a change. *OS* will incorporate the descriptions provided by the members of the *Implementation Committee* into the *Notification of Change Template* and will send it to them with a request for *Implementation Plan*. It may also devise a first draft of an *Implementation Plan* as a starting point for the *Implementation Committee* to work on toward a final plan for the change:

$\forall$TA $\in$ Implementation Committee

Request Implementation Plan (Notification of Change Template, Os, Implementation Plan)

At this stage, members of the *Implementation Committee* will invite technology areas that are related to them by R2 and R3 (to receive and/or provide training due to the proposed change) to form the *Consultation Committee.*

Implementation Committee: {Os, A, C, D, E, F, G, H, I}

Consultation Committee: {C1, C2, C3, C5, C6}

Note that C4 and C8 are not members of the *Consultation Committee* since their predecessors, K and B, had indicated that they were not impacted by the change. The *Consultation Committee*

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Table II. Steps of forming an implementation committee for Figure 1.

1. Initialization: Source: OS, Imp: {OS}, Source set: {OS}, $Plan_{OS}$: {A, B, C}, Visited: {OS, A, B, C}

2. Status From A, B, C: (I, N, I), Imp: {OS, A, B, C}

3. Source: {A}
$Plan_A$: {D, E}
Visited: {OS, A, B, C, D, E}
Source set: {OS, A}

4. Source: {C}
$Plan_C$: {F, G}
Visited: {OS, A, B, C, D, E, F, G}
Source set: {OS, A, C}

5. Stat. from D, E: (I, I), Imp: {OS, A, B, C, D, E}

8. Stat. from F, G: (I, I), Imp: {OS, A, B, C, D, E, F, G}

6. Source: {D}
$Plan_D$: {H, I, J}
Visited: {OS, A, B, C, D, E, G, H, I, J}
Source set: {OS, A, C, D}

7. Source: {E}
$Plan_E$: {I}
Visited: unchanged
Source set: {OS, A, C, D, E}

9. Source: {F}
$Plan_F$: {J, K}
Visited: {OS, A, B, C, D, E, G, H, I, J, K}
Source set: {OS, A, C, D, E, F}

10. Source: {G}
$Plan_G$:Φ
Visited: unchanged
Source set:
{OS, A, C, D, E, F, G}

11. Stat. from H, I, J: (I, I, N), Imp: {**OS, A, B, C, D, E, F, G, H, I**}

14. Stat. from I: (N)

15. Stat. from J, K: (N, N)

16. Stat. from K: (N)

13. Source: {H}
$Plan_H$: {J}
Visited: unchanged
Source set: {OS, A, C, D, E, F, G, H}

14. Source: {I}
$Plan_I$: {L, M}
Visited: {OS, A, B, C, D, E, G, H, I, J, K, L, M}
Source set: {OS, A, C, D, E, F, G, H, I}

17. Stat. from J: (N)

18. Stat. from L, M: (N, N)

Implementation Committee: {OS, A, B, C, D, E, F, G, H, I}.

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reviews the *Notification of Change Template* and provides input to the *Implementation Committee*. The *Implementation Committee* then devises the final *Implementation Plan*.

4.2.3. Advanced notification. The *Implementation Committee* prepares an *Advanced Notification Template* to notify the related technology areas of an upcoming change. It includes a description of the change, the technology areas affected by them, the resources available to them, detailed action to be taken by the affected technology areas and a time table of the events to take place.

Send the *Advanced Notification* to the *Consultation Committee*: {C1, C2, C3, C5, C6}
Send *Advanced Notification* to the technology areas related to the *Implementation*

Committee by R5 that are not already in *Consultation Committee* or in the

Implementation Committee: {C9, C10}.

4.3. Planning a change initiated by technology area, Source

The first step in the change process is the preparation of a detailed proposal and plan generated in collaboration with the affected technology areas. A technology area, *Source*, uses this process to collect input and feedback from other technology areas in response to its proposal for a change. This process provides evaluation reviews including feasibility analysis and constraint issues related to the proposed change, cost analysis, resource requirements and time estimates for implementing the change. As a result, a well-informed decision as to whether to implement the new direction can be made. This process is particularly important when a major or a complex change is being contemplated in a distributed system. This process only involves the technology areas that are related by $R1$.

1. A *Source* technology area prepares a *Proposal Template*, see Section 5.3.
2. The *Source* then invokes a *Planning Committee*. This committee consists of the *Source* and all the technology areas related to the *Source* by $R1$.
3. The *Planning Committee* will establish a review process and builds an *Evaluation Template*, see Section 5.4.
4. Each member of the *Planning Committee* will complete an *Evaluation Template*.
5. The *Planning Committee* will define the areas of responsibility if any of its members need further input to complete the evaluation:
   - Members needing further input will then invoke their own *Planning Committees*, those that are related to them by $R1$, and request an evaluation of the task at hand. This process continues until all evaluations are complete (repeat from step 3).
6. Once all evaluations have completed, the committee will review the outcomes to provide a unified report to the *Source* technology area. This report includes records of complete history of the evaluation process and its participants.

4.3.1. Implementation of 'planning a change process' initiated by Source. Only those technology areas related by $R1$ relationship will directly participate in the evaluation process. $R5$ related technology areas may be invited to provide input only if a *Source* technology area requests it.

 # Source prepares a '*proposal template*'; sends it to all technology areas related to it by '$R1$.'

Initialization:

Source = OS

SourceSet = Φ # set of TAs that needs to form their own Planning Committees

Visited = Φ # set of all TAs invited to evaluate the proposal

Plan-a-change(Source, Proposal Template, Evaluation Template)

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The original *Planning Committee* prepares a final report consistent with their established process and submits it to the original *Source*.

Plan-a-change is a recursive process:

Plan-a-change(Source, Proposal Template, Evaluation Template) {begin plan

SourceSet = {Source} ∪ SourceSet
Planning Committee = {Source} ∪ {∀TA ∋ ∃Source R1 TA}
Visited = Planning Committee ∪ Visited
If |Planning Committee| ≠ 1{begin committee plan

- Planning Committee will establish a process to make a recommendation based on the evaluations completed by all of its members and will follow the process.
- Source records the Planning Committee membership and addresses to their Evaluation Templates in its own Evaluation Template.
  # Since Source invokes the *Planning Committee*, it is automatically a member. It does not record itself as part of the *Planning Committee* in its *Evaluation Template.*
- Planning Committee records Source ID in their respective Evaluation Templates.
  For ∀ TA ∈ Planning Committee Do {begin evaluation outcome
  # Each member of the *Planning Committee* completes an *Evaluation Template* with one of the following outcomes:

  - **O1**. not(IMPACT)&ACCEPT. # The proposed change does not impact this technology area, this technology area accepts the changes. Evaluation process is complete.
  - **O2**. IMPACT&ACCEPT&FINAL. #The proposed change impacts this technology area. The proposal is acceptable by this technology area. The recommendation is final. Evaluation process is complete.
  - **O3**. Not(ACCEPT). # This technology area rejects the proposal. The evaluation process is complete.
  - **O4**. IMPACT&INPUT&not(FINAL). # The proposed change impacts this technology area. This technology area needs input from its peers before it can make a final recommendation. Continue the evaluation process by coordinating with peer technology areas.

  end evaluation outcome}

If (∃ TA ∈ Planning Committee Evaluation $\text{Template}_{\text{TA}}$.Outcome = O4) {
# Only members of *Planning Committee* with O4 outcome will continue to invoke new *Planning Committees* for further evaluation and input. They will also record events in their history fields.

- Planning Committee will break-up the proposal into responsibility areas/tasks and assigns a task to each member of the Planning Committee with O4 outcome for further evaluation.}

The responsibility/task breakdown may be the entire proposal. The task breakdown must be done so that a single packet is sent to each of the *R*1 related technology areas in the next round of evaluation. It is the responsibility of the *Planning Committee* to make sure that a technology area with multiple *R*1 relationships with the *Planning Committee* will receive a single task assignment; i.e., members of the *Visited* list have already participated in the evaluation.

For ∀ Source ∈ Planning Committee ∋ Evaluation $\text{Template}_{\text{Source}}$.Outcome = O4 &
Source ∉ SourceSet Do
Plan-a-Change(Source, Proposal Template, Evaluation $\text{Template}_{\text{Source}}$)
end committee plan}
If (|Planning Committee| = 1) & (Source ∈ Planning Committee ∋ Evaluation
$\text{Template}_{\text{Source}}$.Outcome = O4){
#*Source* is the only one left to evaluate
Source must provide an evaluation with an outcome other than O4. It may request input from its un-visited R5 related technology areas to provide an evaluation other than O4.}

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Table III. Initial and final outcomes of evaluation of proposal for change for Figure 1.

TA	A	B	C	D	E	F	G	H	I	J	K	L	M
Initial Outcome	O4	O4	O4	O4	O1	O4	O4	O1	O4	O2	O3	O4	O2
Final Outcome	O3	O3	O2	O2	O1	O3	O1	O1	O1	O2	O3	O3	O2

If (|Planning Committee| = 1) OR
(∃ No TA ∈ Planning Committee ∋ Evaluation Template$_{\text{Source}}$.Outcome = O4) {
# 'Complete Evaluation' by recording the *Planning Committee*'s final evaluation in the *Source*'s *Evaluation Template* and backtracking to the original *Source*, the proposal initiator.

In the Evaluation Template$_{\text{Source}}$ {

While Evaluator.ID ≠ Source.ID {

For ∀ Source ∈ Planning Committee Do {

If all members of the Planning Committee have outcomes other than O4 {

Redo your evaluation and record an outcome other than O4}

Source = Source ID.Evaluator's Evaluation Template}

}}}

end plan}

Example
The initial and final outcomes from technology areas that participated in the evaluation process of the proposal for a change initiated by *OS* for the example graph of Figure 4 are shown in Table III.

The following abbreviations are used in the illustration:
P-a-C: Plan-a-change; *SS*: SourceSet; *SID*: Source ID, *EID*: Evaluator ID; *PC*: Planning Committee; *ET*: Evaluation Template; *OC*: Outcome; *V*: Visited; *PET*: Pointer to Evaluation Template. Please refer to the Evaluation Template for more information on its fields.
Steps through the process are presented in Table IV.

Finally, the original *Planning Committee* will review the evaluations and will generate a report to the original Source *OS* once every one of its members has provided an evaluation with outcomes other than O4.

5. TEMPLATES

These templates are described with minimum requirement fields in this section. New fields may be added to account for additional information as needed.

5.1. Notification of change template

- Source ID: *Source* technology area ID initiating the change.
- Status Needed By: Date to receive status to form the *Implementation Committee.*
- Resource Requirements Needed By: Date to receive all resource requirements from the *Consultation Committee.*
- Implementation Plan Needed By: Date for the Implementation Committee to complete the *Implementation Plan*.
- Description: *Source* provides detailed description of the upcoming change.
- *Visited Committee*: Technology areas that provided status input, each member provides the following information in response to the Source's request for status:

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Table IV. Steps through the planning a change process for Figure 1.

Level 0—Step 1;
P-a-C(*OS, Proposal template, Evaluation template*)
SS: {OS}; PC: {OS, A, B, C}; V: {OS, A, B, C}

$\mathbf{ET}_{OS:}$SID: OS EID: OS OC: Initially blank PC: {A, B, C} PET_A, PET_B, PET_C

Level 1—Step 2; *P-a-C*(*A*, …)
SS: {OS, A}; PC: {A, D, E};
V: {OS, A, B, C, D, E}

$\mathbf{ET}_{A:}$SID: OS EID: A OC: O4 PC: {D, E} PET_D, PET_E

Level 2—Step 3; *P-a-C*(*D*, …)
SS: {OS, A, D}
PC: {D, H, I, J}
V: {OS, A, B, C, D, E, H, I, J}

$\mathbf{ET}_{D:}$SID: A EID: D OC: O4 PC: {H, I, J} PET_H, PET_I, PET_J

Level 3—Step 4

$\mathbf{ET}_{H:}$SID: D EID: H OC: O1

Level 2—Step 3

$\mathbf{ET}_{E:}$SID: A EID: E OC: O1

Level 3—Step 4; *P-a-C*(*I*, …)
SS: {OS, A, D, I}
PC: {I, L, M}
V: {OS, A, B, C, D, E, H, I, J, L, M}

$\mathbf{ET}_{I:}$SID: D EID: I OC: O4 PC: {L, M} PET_L, PET_M

Level 1—Step 6; *P-a-C*(*B*, …)
SS: {OS, A, B, D, I, L}; PC: {B, F}
V: {OS, A, B, C, D, E, F, H, I, J, L, M}

$\mathbf{ET}_{B:}$SID: OS EID: B OC: O4 PC: {F} PET_F

Level 2—Step 7; *P-a-C*(*F*, …)
SS: {OS, A, B, D, F, I, L}
PC: {F, J, K}
V: { OS, A, B, C, D, E, F, H, I, J, K, L, M}

$\mathbf{ET}_{F:}$SID: B EID: F OC: O4 PC: {J, K} PET_J, PET_K

Level 3—Step 4

$\mathbf{ET}_{J:}$SID: D EID: J OC: O2

Level 3—Step 8

$\mathbf{ET}_{K:}$SID: F EID: K OC: O3

Level 1—Step 9; *P-a-C*(*C*, …)
SS: {OS, A, B, C, D, F, I, L}; PC: {C, F, G}
V: {OS, A, B, C, D, E, F, G, H, I, J, K, L, M}

$\mathbf{ET}_{C:}$SID: OS EID: C OC: O4 PC: {F, G} PET_F, PET_G

Level 2—Step 10; *P-a-C*(*G*, …)
SS: {OS, A, B, C, D, F, G, I, L}
PC: {G}
V: unchanged

$\mathbf{ET}_{G:}$SID: C EID: G OC: O4 PC: {}

G re-evaluates to O1; Back track to C
C re-evaluates to O2; Back track to OS

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Table IV. *Continued.*

Level 4—Step 5; *P-a-C*(*L*, ...) SS: {OS, A, D, I, L} PC: {L} V: {OS, A, B, C, D, E, H, I, J, L, M} **ET**$_{L}$:SID: I EID: L OC: O4 PC: { } L re-evaluates to O3; Back track to I I re-evaluates to O1; Back track to D D re-evaluates to O1; Back tract to A A re-evaluates to O1; Back track to OS	*Level 4—Step 5* **ET**$_{M}$:SID: I EID: M OC: O2	F re-evaluates to O3; Back track to B B re-evaluates to O3; Back track to OS

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- Status: Impacted/Not impacted
- Description: Brief description of the reason of the indicated status
- *Implementation Committee*:
  Technology areas who returned an 'Impacted' status are members of this committee. Each member provides the following information in response to *Source's* request for an *Implementation Plan*:
  - Member ID: Technology area ID.
  - Description: Detailed description of the impact.
  - Resources: List of resources provided to the technology areas and the technology areas providing them.
  - Time: Date by which this technology area will implement the change affecting it.
  - Action: Action to be taken by the technology area by the above date.
- *Consultation Committee*:
  The members of this committee are related to the *Implementation Committee* by R2 and R3. Each member provides the following information in response to a request from the *Implementation Committee*:
  - Member ID: Technology area ID.
  - Resource Requirements: List of resources needed, the technology areas to provide them and justification for the need.
  - Time estimate: Time needed to implement or be able to deal with the change.

5.2. *Implementation plan*

- Source ID: Source technology area ID responsible for initiating the change.
- Implementation Committee: Members of the Implementation Committee who devised this plan.
- Sequence of Events: For each event provide the following information:
  - Time: Date for each event.
  - Event Description: Description of this stage of change.
  - Technology Area(s) Involved: Technology area(s) associated with this event.
  - Action: Detailed action to be taken by each of the above technology area(s) for this event at the given date (or time period).
  - Resource: List of resources and technology areas to provide and/or receive them for this event.
  - Expertise: List of experts and expertise associated with this event to provide guidance.
  - Status: Status of completion of the event (successful, conditional, etc.).

5.3. *Proposal template*

- Source ID: Proposer's technology area ID.
- Description: A complete description of the proposed change.
- Advantages: A list of all the perceived advantages as a result of the new change.
- Disadvantages: A list of all the possible disadvantages/ramifications.
- Analysis: Analysis documentation providing details of what it takes to implement the new direction. This document should include requirements, compatibility, resources, cost, etc.
- Availability Level: Access availability requirement, 'Fault Resilience' and 'Highly Available' levels need special processing.
- List of R1 related technology areas (ID's) to the *Source*.
- Number of task breakdowns.

Notes: A decision as to which fields must be completely by the Source and which ones may be partially completed before a review can be initiated should be made as applicable.

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5.4. Evaluation template

- Source ID: Source will be responsible to collect input from.
- Evaluator's technology area ID.
- Outcome Flags: Flags used to make a recommendation (select one):

INPUT: Yes: This evaluator needs more input from its peers.
No: This evaluator does not need further information from its peers.
FINAL: Yes: This evaluator has either received input from its peers or does not need input from its peers. In either case, the Outcome Flags reflect the final recommendation.
No: The Outcome Flags are not final yet, may wait for input from peers.
IMPACT: Yes: The proposed change impacts this technology area.
No: The proposed change does not impact this technology area.
ACCEPT: Yes: This technology area accepts the proposal.
No: This technology area rejects the proposal.

- Pointers to Evaluation Templates of technology areas related to this evaluator by R1. This field is used only if this evaluator is a Source (i.e., will need to form a new Planning Committee).
- Planning Committee (other than Source ID):
- Evaluation: The evaluator technology area documents its reasoning and justification, which include:

Pros
Cons
Resources/training requirements
Personnel needs
Time estimates, time frame needed to implement the changes
Cost estimates
Descriptive document and justification

- History: Record outcomes from all technology areas that provided evaluation.

Possible outcomes and actions to be taken:

O1. not(IMPACT)&ACCEPT: The proposed change does not impact this technology area. This technology area accepts the changes. Evaluation process is complete.
O2. IMPACT&ACCEPT&FINAL: The proposed change impacts this technology area. The proposal is acceptable by this technology area. The recommendation is final. Evaluation process is complete.
O3. Not(ACCEPT): This technology area rejects the proposal. The evaluation process is complete.
O4. IMPACT&INPUT&not(FINAL):The proposed change impacts this technology area. This technology area needs input from its peers before it can make a final recommendation. Continue the evaluation process by coordinating with peer technology areas.

6. SUGGESTIONS FOR FUTURE WORK AND ADDITIONAL FUNCTIONALITY

A graphical system will be of great importance to any systems environment model. A relationship view based on the relationship data can give a pictorial view of the relationships among technology areas. The graphical system should be designed so that a given technology area can request to view all technology areas that are related to it by a specific relationship category. It may also request to view all technology areas that are related to it by any relationship categories. WEB-based system would an ideal approach for the graphical system design. The efficiency, availability and ease of

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use are crucial factors in making the model a useful tool that technology areas can rely on. It can provide simple and useful functionality such as

GetRel (TA, R): which returns the list of all technology areas related to TA by relationship R for as many levels as needed. A minimum set of such functions to be implemented as part of the Relationship Model available to the technology area owners may consist of: Planning a Change, Implement a Change, Distribute Advanced Notification, Request Information, Distribute Information/Announcements, Financial Impact Evaluation.

Similarly, desirable functions available to IT users would be: Functional Description of a given technology area, List of Related Technology Areas to TA by (R1, R2, R3, R4, R5, All), View X-levels of Related Technology Areas to TA by (R1, R2, R3, R4, R5, All), A Description of the Reason for Existence of a Relationship, View Technology Areas with Certain Property (key words can be derived from the technology areas functional description for this purpose).
Furthermore, Functions are needed to allow modifications in the Relationship Model such as: Add New Technology Area to the Model, Delete an Existing Technology Area from the Model.

7. CONCLUSION

In this paper, we presented a new flexible Relationship model for a large telecommunication enterprise developed to inter-relate with an existing systems environment model representing the complex and distributed computer-based information system infrastructure of the organization spanning hundreds of applications, thousands of servers, desktop environment for tens-of-thousands of users and network connectivity for all of them. The Relationship model is developed from a combination of the information provided by the systems environment model and the human expertise at each of the working divisions. The process involves collecting accurate data from experts and the systems environment model (initial interviews with technology owners, Appendix A, identifying key relationship categories among various entities based on their required interactions (Analysis of information from expert interviews, Section 2, and design of a datasheet to obtain relationship data from experts, Appendix B), developing a Relationship Matrix with processes to allow for efficient modifications due to possible changes in future relationships (Sections 3–3.2), developing the basic data structures as the building blocks for higher-level software and database systems (Section 3.3) and design and implementation of coordinated processes such as 'Planning a Change' and 'Change' (Section 4). Furthermore, this model incorporates participation and innovation by all involved (any technology area may initiate a request for change, Section 4.3); it provides a tool for informed and coordinated decision-making, and facilitates efficient communication among related groups (all affected units will provide evaluation of the proposed change before a change is approved, Section 4.2). The model can easily be adapted for any large organization with a well-defined system environment model.

APPENDIX A

A.1. Appendix A. Initial interview questionnaire

A sample questionnaire to be used for Interview with the Technology Owners: (This questionnaire is a working one and is updated dynamically as related topics are brought up in the course of this research).
Date:
Technology Area:
(Use the same title as in the existing tree structured Systems Environment Model)
Technology Owner:
Some of these questions may not apply to your technology area or you may find that they have the same answer when applied to your area. Please indicate them as such and try to answer as many of them as possible.

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1. Define the function of the technology area. Please make a list of all the functions that your group is responsible for. It is important that the work be described from your perspective, as you are most familiar with the day-to-day operations of your unit. An overall unit description is usually based on the logical division of your work and may not cover details that are needed to establish a relationship model.

Input to your technology area:

2. From whom does your technology area receive services[‡] from?
3. For each technology areas you listed in question 2, describe the nature of services that they provide for your area:
4. In the table attached, indicate the technology areas that impact you as 'Input' and describe the way their decisions, direction, and function impact yours.
5. (Note that the technology areas that impact you may be different from those that provide you with services).
6. What support/resources do you need from these technology areas in order to accomplish your objectives? If the resources you need are different from the technology areas, please list them separately. For example, you may need to know in advance that a technology area that impacts you is reviewing a specific product.
7. Explain the current method of interaction (if any) with the technology areas that impact you.
8. Explain what method of interaction with the technology areas that impact you would improve the overall planning, progress and communication for your working environment.
9. If you can, explain if this method will be beneficial to the technology areas that impact your technology area or provide services to you.

Output from your technology area:

10. Whom does your technology area serve?
11. For each technology areas you listed in question 9, describe the nature of services that your area provides.
12. In the table attached, indicate the technology areas that are impacted by your area as 'Output' and describe the way your decisions, direction, and function impact them.
13. (Note that the technology areas that are impacted by you may be different from those that you provide services to).
14. What support/resources do you need in order to accomplish your objectives? If the resources you need are different for the technology areas you interact with, please list them separately.
15. If you are aware, name the group(s) that are the secondary recipient of the result of your work, for example a technology area may use the result of your work for its development of an application that is later used by another technology area.
16. Are the resources/products that you need provided from within your own technology area?
17. If not, name the technology areas that can provide you with the resources/products you need. For example, your technology area may partner with another to accomplish its task.
18. Which technology areas are responsible to ensure that resources are available to support the products you need? For example, peripheral devices for a computer hardware, compatible software/application for a given computer platform, suitable operating system for specific application, etc.
19. What is the current method of interaction (if any) with the above-named technology areas (questions 11–16)?
20. If you can, explain what method of interaction with the technology areas that are impacted by your area would improve the overall planning, progress, and communication for your working environment.
21. If you can, explain if this method will be beneficial to the technology areas that are impacted.

[‡] 'Services' in the context of this document refers to any deliverables or outcomes from a technology area. Examples would be an application design, a program, hardware, technology expertise and consultation, etc.

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22. Having thought in detail about the relationship of your technology area with others, comment on the key technology areas that should be involved in the planning and decision-making regarding the technology needs directly or indirectly related to your projects. Please be as specific as possible by providing one or more examples.
23. Explain which technology life cycles affect you and how?
24. Which one of the technology life cycles in question 21 are you responsible for?
25. Are there certain decisions/directions/technology standards that affect you more than the others? Please name them and explain how they impact you.
26. Is there a title that describes your technology area/function better than the one used in the current Systems Environment Model?
27. What would you like to see added/modified in the model?

APPENDIX B: DATASHEET

B.1. Technology area relationship model datasheet

Objective: The objective of this project is to develop a model to define the relationships among technology areas identified in the Systems Environment Model. The model will evolve over time to help coordinate the activities of the technology areas more efficiently. For the model to accurately reflect the needs of the technology areas, experts i.e., technology area owners are asked to provide the information.

The relationship model when integrated with the Systems Environment Model will help in the following possible ways:

- Provide an efficient and obvious tool for interaction among related technology areas.
- Provide a tool to implement coordinated changes more effectively.
- Can be used as a planning tool to coordinate major infrastructure changes that span multiple technology areas including organizational and budget impacts.
- Technology area owners can use the model, to define their interface requirements and minimum standards to facilitate information flow. This will result not only in improved communication among technology areas, but will also result in a reduction of waiver traffic.
- The model can be used to simulate and evaluate the impact of a possible standard change before a final decision is made.

Complete one form per Technology Area.
ID: Complete Path Name
Technology Area: your TA
Contact Person:
Date:
Function of the Technology Area: (accurately reflect the scope of the responsibilities)

Relationship Category: The following identifies the types of relationships among technology areas. Please review the list carefully and identify all the technology areas that are related to your TA with the correct category. For each related technology area, provide a clear description to verify the impact/nature of the relationship. Give actual examples to help verify the relationship.

Category	*Relationship*
1.	*Coordinated planning* (identify the technology areas that must coordinate their activities with your TA either at decision-making or planning stages).
2.	*Provide training and/or resources to* (identify the technology areas that your TA must provide training or resources to so that they can implement a change/new direction). List the type of training and/or resources, for example how to use a new software package, consultation and expertise, hardware, software, licenses, personnel, consulting, funding, etc.
3.	*Receive training and/or resources from* (identify the technology areas that must provide your TA with training or resources needed to implement a change /new direction). List the type of training and/or resources, for example how to

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use a new system, consultation and expertise, hardware, software, licenses, personnel, consulting, funding, etc.

4. *Receive advanced notification of a change* (identify the technology areas that must notify your TA of their planned changes in advance). Specify a reasonable time of advanced notification.
5. *Notify others of a change in advance* (identify the technology areas that your TA must notify in advance). Specify a reasonable time of advanced notification.
6. *Others*, define the relationship(s) that are missing from the above, and identify the technology areas that are related to your TA in this category.

Sample partial datasheet table of technology areas (a total of 66 for the actual Telecommunication Enterprise)

Technology area (TA)	Relationship(s)	Description of impact of the relationships
A. Computing hardware:		
1. Hardware—Desktop		
a. Infrastructure servers		
b. Fixed desktop		
c. Laptop		
d. Handheld		
2. Hardware—Midrange		
3. Hardware—Mainframe		
B. System software:		
1. OS—Desktop		
a. Infrastructure servers		
b. Fixed desktop		
c. Laptop		
d. Handheld		
2. OS—Midrange		
3. OS—Mainframe		
4. Middleware		
a. Desktop		
b. Midrange		
c. Mainframe		
5. Naming services (DNS, WINS)		
6. Messaging (MNET backbone)		
7. Web services		
8. High availability services		
C. Networks:		
1. Physical transport layer (STMnet)		
2. Bulk data		
3. SNA (APPN)		
4. Datakit		
5. USWNet (TCP/IP)		
6. Host connectivity		
7. Video transport		
...		

Suggestions/Improvements:

APPENDIX C: RELATIONSHIP MATRIX

The X entries in the '*ok*' column correspond to the technology areas that have provided input. Their relationship with those technology areas that have not provided input is reflected in the unmarked (no X) entries. The actual matrix is 66 by 66 for the actual Telecommunication Enterprise. A partial completed matrix is presented.

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ok	T/ A	A1a	A1b	A1c	A1d	A2	A3	B1a	B1b	B1c	B1d	B2	B3	B4a	B4b	B4c	B5	B6	B7	B8	C1	C2	C3
	A1a																	1					
X	A1b								1,4,5	1,4,5	1,4,5												
X	A1c								1,4,5	1,4,5	1,4,5												
X	A1d								1,4,5		1,4,5												
	A2																	4					
X	A3												1,3,4,5			1,3,4						1,3,4	1,3,4
	B1a														1,5								
X	B1b		1,4,5	1,4,5	1,4,5										1,5		1,4,5						
X	B1c		1,4,5	1,4,5											1,5		1,4,5						
X	B1d		1,4,5	1,4,5	1,4,5										1,5		1,4,5						
X	B2														1,4,5		1	4					
X	B3						1,2,4,5									4,5						4,5	4,5
X	B4a																						
X	B4b							1,4	1,4	1,4	1,4	1,4,5					4,5			2			
X	B4c						1,2,5						4,5										
	B5								1,4,5	1,4,5	1,4,5	1						1					
X	B6	1				5						5					1						
	B7																						
	B8														3								
	C1																						
	C2						1,2,5						4,5										
	C3						1,2,5						4,5										

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APPENDIX D: INCONSISTENCY LIST

A sample report of major inconsistencies between relationship data provided by the technology area owners. The list corresponds to the Relationship Matrix of Appendix B.

Inconsistency list:

Source1	*Relationship*	*Source2*	*Description provided by Source1*
B3. OS-Mainframe	None	F. Mass Storage	None
Source2	*Relationship*	*Source1*	*Description provided by Source2*
F. Mass Storage	1, 4	B3. OS-Mainframe	Need to know if OS will support hardware

Proposed resolution: 1, 5for B3. OS-Mainframe
1,4 for F. Mass Storage

Source1	*Relationship*	*Source2*	*Description provided by Source1*
B3. OS-Mainframe	4, 5	G4.3Application Development Tools	
			Notify others of release level changes and provide product testing resources
Source2	*Relationship*	*Source1*	*Description provided by Source2*
G4.3Application development tools			
	1	B3.OS-Mainframe	OS decisions have direct impact on the selection and availability of the required tools for application development

Proposed resolution: 1, 4, 5 for both B3. OS-Mainframe & G4.3Application development tools

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