The System Administration Maturity Model - SAMM

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ABSTRACT

The Capability Maturity Model (CMM), published by the Software Engineering Institute has been used by software development organizations to improve the processes used to develop software products.

The System Administration Maturity Model (SAMM) is an adaptation of the CMM to make it more relevant for system and network administration organizations. The SAMM seeks to describe the key processes required for a system and network administration organization to flourish into higher levels of process maturity and enjoy the benefits associated with mature organizations such as high quality products and services produced on time, and within budget limits.

Introduction

The motivation to apply process maturity concepts initially described in the Capability Maturity Model (CMM) to system and network administration comes from the many similarities between the two disciplines of software engineering and system and network administration. Although many disciplines struggle with issues regarding requirements, effort, manpower, budget, schedules, and quality, not all such disciplines work with highly inter-related subsystems where seemingly innocuous changes made by one individual impact the availability or performance of the entire system. The disciplines of network and systems administration and software engineering also share a common tendency to exploit the unique talents of single individual contributors.

Many of the common problems that are shared between system and network administration and software engineering are targeted for solution with the application of process maturity concepts. The application of process maturity concepts has already begun to pay dividends in software engineering organizations [6]. It is expect that the same types of results can be obtained from an emphasis on process maturity in the field of system and network administration.

A basic premise of process maturity efforts is that the quality of a product is determined by the quality of the process used to create it. High quality, robust processes applied in a network and systems organization will yield high quality products and services provided by that organization. Conversely, weak or immature processes will yield less than optimal products and services and results in an immature organization.

Characteristics of immature organizations include chaotic conditions, budget over-runs and schedule delays. Immature organizations often rely very heavily on the super-human effort of key individuals for success. In contrast, mature organizations are often characterized as producing highly reliable products and services in accordance with budget and schedule limits. The reliance on key individuals is replaced with an emphasis on a team atmosphere.

Process Maturity

The term *process* describes the means by which people, procedures, methods, equipment, and tools are integrated to produce a desired end result. The motivation to discuss process issues is derived from the fact that focus on singular components of the whole process will not yield the most effective improvements. In the past, administrators themselves have heavily focused on tools and methods with specific attention to automaton. Are we automating the right thing? Not much attention has been paid to the integration of all of the components of the system administration process. Thus some of the improvements we have made have fallen short of our own expectations, or the expectations of groups such as our management or end users.

In order to finally reap the rewards of improvement efforts, a systematic approach is required. A supportive foundation where one improvement is the basis for another is necessary. In the past, efforts that focused on tools or methods might not have been supported by policies and procedures for example. The SAMM describes the path from chaotic conditions to optimized conditions.

Each level of maturity and the improvements described as being associated with that level builds on the previous level and improvements. The model describes a framework of standardized states and conditions. Each organization must define how to achieve these states or conditions to eventually move to the next maturity level. Obviously, as system administrators support a wide variety of users, and the organizations that employ us have a wide range of priorities, the different processes created by each network and system administration group will vary widely. That these various implementations will vary should not detract from the fact that the implementations are based on the same framework of states and conditions.

It is important to note that, for the most part, problems facing network and system groups are not technical. Issues of communication, commitments, priorities and politics are common problems at most sites. Often problems such as these contribute to our personal frustration and organizational ineffectiveness to a much greater degree than technical problems do.

Historical Basis for Maturity Model

As described above, the SAMM is based on the CMM. It is useful to note however that the CMM is rooted in the quality control movement that began in the 1930's with the concepts of statistical quality control for primarily manufacturing operations. Inspired by the work of Deming and Juran, Philip Crosby offered a maturity framework for quality management. This framework describes five evolutionary stages in adopting quality practices. Adaptation of this framework to software development practices inspired the initial version of the CMM. These practices have once again been adapted to network and system administration to create the SAMM.

Quality management concepts have been refined as they have moved through the various disciplines beginning with manufacturing. Refinement is required as each new discipline such as software engineering presents greater problems for process improvement efforts in terms of complexity, technological issues, and coordination.

Use of SAMM

The SAMM can be used to create a road map for process maturity in system and network administration groups. The model can be used to create action plans for organizational improvement and excellence. The SAMM also provides a framework for assessment and evaluation.

Sites that might consider using the SAMM should be warned that this model is created for very large organizations. A small group with only a few members might find this model to be too cumbersome. This is not to say that SAMM is useless to smaller organizations, simply that difficulty to apply SAMM to a smaller group is acknowledged. It is also acknowledged that this model might appeal most to large corporate sites.

Organizations that are expected to enjoy the greatest success with SAMM are those where executive management is supportive of the concept of process improvement for all groups at the site (the network and system administration group and the user base as well as any intermediate organizations such as facilities and maintenance). In an environment such as this, it is expected that cooperation levels between the users, the intermediate organizations, and the network and system administration group will be much higher because all parts of the organization are working to achieve the same objectives.

Structure of SAMM

Key process areas are associated with one of five maturity levels. Organizations are all assumed to be level one organizations until they have been assessed to be higher. Assessment involves demonstration of organizational competence in key process areas. Eighteen key process areas are described with each having from two to fifteen key process activities. Competence in a process area involves commitment to the key process activities. The process areas are grouped to be associated with a single maturity level. The maturity level is a plateau on the path to higher maturity levels. Each maturity level must be achieved in numerical order to provide a solid foundation for later levels. Levels should not be skipped. See Table 1.

The fire fighting analogy in Table 1 suggests a simply way to relate to the various maturity levels. At level one the network and systems group is in crisis mode. A fire is being fought, but the battle is being lost. At level two, the network and systems group is fighting fires, but learning lessons during the fire fight about good, effective techniques. At level three, the organization enters a state of fire appreciation. It is acknowledged that there are fires,

Level	Title	Characterization	Analogy
1	Initial	Ad hoc process	Fire fighting – loosing
2	Repeatable	Disciplined process	Fire fighting – lessons
3	Defined	Standard, consistent process	Fire Appreciation
4	Managed	Predictable process	Fire Detection
5	Optimizing	Continuously Improving	Fire Prevention

Table 1: Five Maturity Levels

and the organization begins to understand the unique characteristics of different types of fire. At level four, focus shifts to detection of smaller fires before they evolve into major fires. At level five, fire prevention is the main theme.

Descriptions of terms

Champion – The term champion is used often to identify one or more key individuals who take responsibility for various facets of process improvement. These champions can be internal such as members of the network and systems administration group, or external such as users or members of other interested organizations like a quality assurance organization. Specific champions described are champions of quality assurance, technological change, and process improvement. In the event that experts in the areas of quality, technology, or process are available outside the network and systems group they should be utilized to provide an objective view.

Customer – The term customer is used when referring to the actual paying customer of a site. This would be the person or organization that purchases the products or services created by the supported organization.

Engineering – The term engineering is often used when describing the network and systems group. This an intentional usage of the term to bring attention to the fact that system and network administration is an engineering discipline.

Implementation – The term implementation is used to refer to the actual solution deployed by the network and systems administration group to meet requirements. The implementation could be a product, service or activity.

Life Cycle – The term life cycle refers to the period of time beginning with the conception of an idea for a network and systems related activity, product or service and ends when that activity, product or service is no longer available for use.

Network and systems group – This is the default term used to describe the system administration organization. It is understood that not all such organizations have responsibility for networking related functions. Ideally, SAMM users can put the name of their own organizations in place of the term network and systems group.

Supported organization – The term supported organization is used to describe the organizations that consume the products and services of the network and systems administration group. Ideally both parties, the supported organization and the network and systems engineering group are aware of their relationship with each other.

Key Process Areas & Activities

The key process areas are described below. Each description includes a title, abbreviation, association with the correct maturity level and sections for purpose, requirements, goals and discussion.

Level	Characterization	Key Process Area
2	Repeatable	Requirements Management
		Project Planning
		Project Tracking
		Subcontract/Vendor Management
		Quality Assurance
		Configuration Management
3	Defined	Process Focus
		Process Definition
		Training
		Integrated Management
		System & Network Engineering
		Intergroup Coordination
		Peer Review
4	Managed	Quantitative Process Management
		Quality Management
5	Optimizing	Defect Prevention
		Technology Change Management
		Process Change Management

Table 2: Process Areas by Maturity Level

Key process activities are numbered for easy reference.

For example, the first key process area is Requirements Management (RM) which is associated with the repeatable level (level 2). There are two activities associated with the RM area RM-1, and RM-2. See Table 2.

Requirements Management (RM) – Repeatable

Purpose: to generate and document a common understanding between the supported organization and the network and systems group of the requirements that will be addressed by the network and systems effort.

Requires: the creation and maintenance of an agreement with the supported organization.

Goals: Plans and activities are kept consistent with the agreed upon requirements.

Key Process Activities

1. The network and systems group reviews documented requirements before they are accepted as commitments or presented to the supported organization as commitments.
2. The network and systems group uses the reviewed requirements as the basis for plans, activities and products and/or services.

Discussion: Requirements are the foundation for most types of activities providing a clear description of what is expected by the supported organization. Most commonly, requirements documents are associated with large scale projects. However, requirements can be written for services and activities to clarify expectations also. In addition to functionality or feature requirements, other issues such as performance, user interface, and documentation should be considered as items to cover during requirements gathering.

Project Planning (PP) – Repeatable

Purpose: to establish plans for performing network and system effort and managing the activities associated with projects, products, and/or services.

Requires: estimates, commitments, definition, reviewed requirements.

Goals: Document an agreement of estimates, activities, and commitments.

Key Process Activities

1. The network and systems group participates in the project planning activities of the organizations they support (from beginning to end).
2. Network and systems planning is initiated in the early stages of, or in parallel with, the planning activities of the supported organizations.
3. Commitments regarding plans, activities, products, and services are reviewed with network and systems management prior to being made to the supported organizations.
4. A life cycle with predefined stages is identified for use.
5. The plan is developed according to a documented procedure.
6. The plan is documented.
7. Information or equipment required to maintain control of the project or activity is identified.
8. Estimates regarding the scope of the project or activity are derived according to a documented procedure.
9. Estimates for the effort and cost of the project or activity are derived according to a documented procedure.
10. Estimates for computing/networking resources (hardware and facilities) are derived according to a documented procedure.
11. The project schedule is derived according to a documented procedure.
12. Project risks are identified, assessed, and documented.
13. Plans to acquire required software resources (internally developed or purchased software – operating system and application software including customization) are derived.
14. Project planning data is recorded.

Discussion: Project planning within the network and systems group can be driven by the supported organizations when they require products or services from the network and systems group, or undertaken internally when the network and systems group determines that a particular action is appropriate. A main point here is that many projects undertaken by the supported organizations at a site require products or services from the network and systems group. Therefore, the network and systems group should participate in the early planning of such activities undertaken by the supported organizations. Early involvement will allow for better communication and allow time for both organizations to develop a project plan. Example projects and activities which might originate in the supported organization are departmental moves and new production, build or release schedules.

Another benefit achieved through participating in the development of project plans for the supported organization is visibility to the clear statement of goals for projects and activities found in the plan, as well as, statements of responsibility for the activities described in the plan.

Project Tracking (PT) – Repeatable

Purpose: to monitor actual performance of the network and systems group relative to estimates documented in the plan.

Requires: tracking and review of accomplishments and results

Goals: Track actual results of the network and systems group against the plan, and take corrective action when required. Effected groups agree to commitment changes if required.

Key Process Activities

1. A documented plan is used for tracking the project activities and communicating status information.
2. Revisions to the project plan are made according to a documented procedure.
3. Commitments and changes to commitments are reviewed with management according to a documented procedure.
4. Changes in the supported organization that might impact the network and systems organization are communicated to the network and systems group.
5. Actual scope of the project or activity is tracked (some measure of size and/or complexity). Corrective action is taken when required.
6. Actual effort and costs of the project or activity are tracked and corrective actions are taken when required.
7. The schedule documented in the plan is monitored, and corrective action is taken when required.
8. Technical activities are tracked including status information and problem resolution details.
9. Risks associated with cost, resources, schedule and technical aspects of the project or activity are tracked.
10. Replanning data is recorded.
11. Reviews are conducted within the network and systems organization to track technical progress, plans, performance and issues against the project plan.
12. Formal reviews to address the accomplishments and results of the project are conducted at selected milestones according to a documented procedure.

Discussion: Successful project tracking allows the network and systems organization to identify schedule and resource issues before major deadlines or commitments are missed. Part of project tracking involves information moving both to and from the supported organizations. Project review meetings can be held with or without the attendance of representatives of the supported organization as appropriate.

Subcontract and Vendor Management (SVM) – Repeatable

Purpose: to select qualified subcontractors and vendors and manage them effectively.

Requires: selection of subcontractors and vendors, establishing commitments and relationships with the subcontractors and vendors including review of performance and results.

Goals: Communication regarding mutual commitments between the network and systems group and the subcontractors and vendors. Track actual results against commitments and feed information back to subcontractors and vendors.

Key Process Activities

1. Activities to be subcontracted or addressed by vendors are defined, planned, and documented according to a documented procedure.
2. Subcontractor and vendors are selected based on an evaluation of their ability to provide products and/or services according to a documented procedure.
3. The agreement between the network and systems organization and the subcontractor/vendor is used as the basis for managing the relationship.
4. Changes to the agreement or activities are resolved according to a documented procedure.
5. Management reviews are conducted periodically between the managers of the network and systems organization and the management of the subcontractor or vendor.
6. Technical reviews are conducted with the subcontractor or vendor to encourage communication (Reviews of new products and contractor skills or abilities).
7. Formal reviews to address the accomplishments of the subcontractor or vendor and results including service performance and/or new products are conducted at specified phases (of a project or calendar cycle) according to a documented procedure.
8. The quality assurance activities of the subcontractor or vendor are monitored according to a documented procedure.
9. The configuration management activities of the subcontractor or vendor are monitored according to a documented procedure.
10. The network and systems group conducts acceptance testing as part of the delivery of the products and/or services provided by the subcontractor or vendor according to a documented procedure.
11. The performance of the subcontractor or vendor is evaluated on a periodic basis and the evaluation is reviewed with the subcontractor or vendor.

Discussion: Vendors and subcontractors play a key role in most network and system groups. Vendors supply most of the hardware and software used to build and maintain systems and networks. They are expected to honor commitments related to prices, delivery schedules, bug fixes, and compatibility issues. Hardware and software vendors are also expected to provide new technologies to address the needs (described or unknown) of the supported organizations. Subcontractors are the various consultants or experts we might hire on an as needed basis or for outsourcing support of specific functions. Other groups that should be considered subcontractors are the organizations at the site chartered to provide services to the network and systems group such as a facilities or physical plant organization or even a finance or purchasing group.

Quality Assurance (QA) – Repeatable

Purpose: to provide visibility to the process being used and the results being achieved by the network and systems organization.

Requires: reviews and audits and communication of results of reviews and audits.

Goals: Compliance of activities, products and services to applicable standards, procedures and requirements is verified objectively.

Key Process Activities

1. A quality assurance plan is prepared for the project or activity according to documented procedures.
2. Quality assurance activities are performed in accordance with the Quality assurance plan.
3. Quality assurance champions participate in the preparation and review of the project plan, standards, and procedures.
4. Quality assurance champions review the activities of the network and systems group to verify compliance to project plans and standards.
5. Quality assurance champions report results of audits and reviews to the entire network and systems group.
6. Deviations from plans and standards are documented and addressed according to a documented procedure.

Discussion: The theme of this key process area is the collection of information. Quality assurance activities will heighten the level of quality consciousness in the network and systems group through routine feedback of quality related information. Participation of champions who are quality focused as opposed to technically focused in the project planning efforts will bring greater attention to quality issues to be considered early in the design of products and services.

Configuration Management (CM) – Repeatable

Purpose: establish and maintain integrity of the activities, products, and services through the entire life cycle.

Requires: identification of configuration items and systematic control of changes to any configurable items.

Goals: Changes to identified activities, products, and services are controlled.

Key Process Activities

1. A configuration management plan is prepared for each project or activity according to a documented procedure.
2. A documented configuration management plan is used for the basis of configuration management activities.
3. A library is established as a repository for configurational information including status information and change justifications.
4. The items to be placed under configuration management are identified.
5. Change requests against configuration items are initiated, recorded and tracked according to a documented procedure.
6. Products and services created and released by the network and systems group are controlled according to a documented procedure.
7. Reports documenting configuration management activities are developed and made available to effected groups and individuals.

Discussion: Network and systems groups have many configurational items that are candidates for configuration management. Various system files, application software, OS revisions, kernels, and network diagrams are just a few. Robust configuration management of these and other items will help ensure that changes that are made are justified and the release of these changes is coordinated. The integrity of the changes can also be improved with configuration management practices.

Network and Systems Process Focus (PF) – Defined

Purpose: Champion the process activities that improve the overall process capability of the network and systems group.

Requires: an understanding of the network and systems group processes and initiating activities to assess, develop, maintain and improve these processes.

Goals: Process development and improvement activities are coordinated across the network and system group including assessing the strengths and weakness of various processes.

Key Process Activity

1. Network and systems processes are assessed periodically, and action plans are developed to address the assessment findings.
2. The network and systems group maintains a plan for process development and improvement activities.
3. New processes, methods, and tools used in parts of the network and systems group are monitored, evaluated and if appropriate released to the entire group.

4. Training in network and systems processes is coordinated.
5. The entire network and systems group is kept informed of process improvement related activities.

Discussion: As the network and systems group moves to higher levels of maturity, processes will naturally be refined. The process focus of the group is required to continue improvements. It is also necessary to have process champions available to consult within the network and systems group on process issues and conduct assessments as needed.

Network and Systems Group Process Definition (PD) – Defined

Purpose: To develop and maintain processes and improve process performance across the projects, services and activities of the network and systems group.

Requires: collection and release of organizationally significant process related information to the network and systems group.

Goals: Standard processes for the network and systems group are created and maintained. Information related to the use of standard processes is collected and made available.

Key Process Activity

1. Network and systems group standard processes are developed and maintained according to documented procedures.
2. Descriptions of project life cycles that are approved for use by the network and systems organization are documented and maintained (phase overlap, waterfall).
3. Guidelines to tailor the standard processes are developed and maintained.
4. A process database of information such as quality and productivity data is created and maintained.
5. A library of process related documentation is created and maintained.

Discussion: As the maturity level of the network and systems group increases, it is necessary to support the refinement of processes with the general availability of all process related information. Both general information such as reference materials and project specific information such as quality and productivity data should be made available.

Training – (T) Defined

Purpose: to develop skills and knowledge of individuals to enable them to perform roles effectively and efficiently.

Requires: identification of the training needs of the networking and systems group and development or acquisition of training to meet identified needs.

Goals: Appropriate training is provided to the right people at the right time.

Key Process Activity

1. Training plans outlining the training needed by the network and systems group as a whole, or the various project or activity teams are created and maintained.
2. The training plan is developed and revised according to documented procedure.
3. The training of the network and systems group is acquired in accordance with the training plan.
4. Internal training courses are developed and maintained according to a documented procedure.
5. An assessment process is developed to determine if necessary skills are already possessed by the staff or should be acquired through training.
6. The network and systems group maintains a record of all staff training.

Integrated Management (IM) – Defined

Purpose: to integrate the engineering of network and systems related products, activities, and services with management activities to move from simply tracking problems to anticipating problems.

Requires: a project plan and standard organizational processes.

Goals: The project and activities are planned and manged according to the defined processes.

Key Process Activity

1. Standard processes are tailored according to a documented procedure.
2. Project plans are developed and revised according to a documented procedure.
3. Projects and activities are managed in accordance with the defined process.
4. The process database is used as a source of information for planning and estimating.
5. The scope of the activities or project is managed according to a documented procedure.
6. The effort and cost associated with a project or activity are managed according to a documented procedure.
7. Use, availability, and/or performance of computing hardware, software, and/or networking resources are managed according to a documented procedure.
8. Critical dependencies and critical paths identified in the project plan are managed according to a documented procedure.
9. Project risks are identified, assessed, documented, and managed according to a documented procedure (including risk indicators and early identification of risks).

Discussion: Activities associated with integrated management are feed by the previously described project tracking processes and the standard organizational processes. The goal is to use historical project tracking information to begin to anticipate problems and either prevent them or minimize their effects.

System and Network Engineering (SNE) – Defined

Purpose: to perform a well defined engineering process that integrates all network and systems engineering activities to produce correct and consistent products and services efficiently and effectively.

Requires: requirements, design, implementation, integration, testing

Goals: Network and systems related tasks and activities are defined, and consistently performed as required to produce consistent products and services.

Key Process Activity

1. Appropriate engineering methods and tools are integrated into the defined network and systems process.
2. The requirements of a supported organization are developed, maintained, documented and verifyed by analyzing them according to the defined network and systems process.
3. The design for a project or activity is developed, maintained, documented, and verified according to the defined network and systems processes to accommodate requirements and to form the basis for implementation.
4. The implementation is developed, maintained, documented, and verified according to network and systems engineering processes to meet requirements and design goals.
5. Testing is performed according to network and systems processes.
6. Integration testing of the implementation is planned and performed according to network and systems processes.
7. System and acceptance testing of the implementation is planned and performed to demonstrate that the implementation satisfies its requirements.
8. Documentation used to operate and maintain the implementation is developed and maintained according to the network and systems processes.
9. Data on defects identified in peer reviews and testing are collected and analyzed according to network and systems processes.

Discussion: The system and network engineering process area brings greater attention to the sound engineering practices (such as analysis, test and acceptance) that are required to create and maintain the products and services associated with the network and systems group.

Intergroup Coordination (IC) – Defined

Purpose: to establish a means for the network and systems group to participate actively with other groups in the organization to ensure that the activities, products, and services are best able to satisfy the customer needs effectively and efficiently.

Requires: disciplined interaction and coordination

Goals: To reach agreement of requirements, commitments and priorities with other groups.

Key Process Activity

1. The network and systems group participates along with the supported organization and the customer or end users of the supported organization in establishing requirements where appropriate.
2. Representatives of the network and systems engineering group work with the supported organization and other intermediate organizations to coordinate technical activities and resolve issues.
3. A documented plan is used to communicate intergroup commitments and to coordinate and track the commitments and activities.
4. Critical dependencies between groups are identified and tracked according to a documented procedure.
5. Intergroup issues not resolvable by the individual representatives are handled according to a documented procedure.
6. The supported organizations conduct periodic technical reviews and interchanges to provide visibility of the needs of the end customer.

Discussion: The intergroup coordination process area focuses on the ability of the network and systems group to address customer needs. In many cases, the supported organization produces products or services that could be enhanced with the application of network and systems group effort. Only if the network and systems group is aware of these opportunities can they meet the needs of the end customer.

Peer Reviews (PR) – Defined

Purpose: to remove defects from network and systems group activities, products and services early and efficiently.

Requires: examination of the activities, products and services by peers to identify defects.

Goals: Defects in activities, products and services are removed.

Key Process Activity

1. Peer reviews are planned, and the plans are documented.
2. Peer reviews are performed according to a documented procedure.

3. Data from the peer review is recorded.

Discussion: Products, activities, and services subject to peer review are identified in the network and systems engineering processes. Time for reviews is scheduled in the project plan. Reviews do not need to be limited to the traditional code review where specific lines of code are examined. Network and systems group activities, products, and services can be reviewed in a peer setting using a variety of other means such as role play, simulation, document reviews and test cases.

Quantitative Process Management (QPM) – Managed

Purpose: quantitatively control the process performance of network and systems group processes.

Requires: establishing goals, measuring against goals, analysis of measurements.

Goals: The process capability of the network and systems group is known in quantitative terms.

Key Process Activity

1. The plan for quantitative process management is developed according to a documented procedure.
2. The network and systems group process management activities are performed in accordance with the quantitative process management plan.
3. The strategy for data collection and analysis is determined based on network and systems group processes.
4. The data used to control defined software process quantitatively is collected according to documented procedure.
5. Network and systems group processes are analyzed and brought under quantitative control according to a documented procedure.
6. Reports documenting the result of quantitative process management activities of the network and systems group are prepared and distributed.
7. The process capability baseline for network and systems group processes is established and maintained according to documented procedures.

Discussion: The emphasis in this process area is on the quantitative results of the processes used by the network and system group. Data is collected to characterize the capability of the network and systems group processes. Process capability describes the range of results that can be achieved by following a specific process. Capability information is used within the network and systems group to adjust process performance goals for future activities, products, and services.

Quality Management (QM) – Managed

Purpose: to develop a quantitative understanding of the quality goals for the network and systems group products, activities, and services.

Requires: defined quality goals and plans to achieve quality goals.

Goals: Establish measurable goals for quality levels and priorities. Progress to achieve quality goals is quantified and managed.

Key Process Activity

1. Network and systems group quality plans are developed and maintained according to a documented procedure.
2. The network and systems group quality plans are the basis for quality management activities.
3. Quantitative goals for products, activities and services are defined, monitored and revised throughout the life cycle of the product, activity or service.
4. The quality of network and systems group products, activities and services is measured, analyzed, and compared to quantitative quality goals throughout the life cycle of the product, activity, or service.
5. The quantitative quality goals of the network and systems group are shared with, or responsibility assigned to, network and systems group subcontractors or vendors as appropriate.

Discussion: Quality management practices build on the quality assurance practices of the network and systems group. The focus shifts form data collection to the management of the quality of the activities, products and services in quantitative terms.

Defect Prevention (DP) – Optimizing

Purpose: to identify the cause of defects and prevent them from recurring.

Requires: historical defect information from similar activities, products, and services, as well as, defect information from early stages of design or testing of a given activity, product, or service.

Goals: Common causes of defects are sought out, prioritized, and eliminated.

Key Process Activity

1. The network and systems group develops and maintains a plan for defect prevention activities.
2. At the beginning of a task or activity, the members of the networking and systems group meet to prepare for the task or activity and the related defect prevention activities.
3. Causal analysis meetings are conducted according to a documented procedure.
4. Causal information from various tasks and activities is reviewed at the by the entire

network and systems group periodically to share information and set priorities.

5. Defect prevention data is documented and tracked across the network and systems group.
6. Revisions to the network and systems group processes resulting from defect prevention activities are incorporated according to documented procedures.
7. Defect prevention information (status and results) is shared with the entire network and systems group periodically.

Discussion: Root cause analysis is key to defect prevention. Obviously if several different defects are caused by an identifyable and preventable root cause, these detected defects can be eliminated in the future from any products or services that might utilize the effected item.

Technology Change Management (TCM) – Optimizing

Purpose: to identify new technologies and move them into the network and systems group in an orderly manner.

Requires: identification, selection, and evaluation of new technologies.

Goals: New technologies are evaluated for their effect on the quality and productivity of the network and systems group, as well as, the supported organizations. Appropriate new technologies are integrated.

Key Process Activity

1. The network and systems group develops and maintains a plan for technology change management.
2. Champions of technological change work with the entire network and systems group to identify areas of technology change.
3. The entire network and systems group is kept informed of new technologies.
4. Champions of technological change analyze the network and systems group processes to identify areas that need or could benefit from new technology.
5. Technologies are selected and acquired for the network and systems group according to a documented procedure.
6. New technologies are tested before a new technology is introduced into routine use in the network and systems group.
7. New technologies are incorporated into the network and systems group processes according to documented procedures.

Discussion: Technological change is a major issue for most network and system groups. This key process area focuses on those technologies that will advance the levels of quality and/or productivity in the network and systems group. These technologies might directly or indirectly benefit the supported organization when they are integrated.

Process Change Management (PCM) – Optimizing

Purpose: to continually improve the network and systems processes with the intention to improve quality, increase productivity, and decrease cycle time for activities, products and services.

Requires: management sponsorship to proactively identify, define, and implement improvements to network and systems group processes.

Goals: continuous, organization wide process improvement.

Key Process Activity

1. A process improvement program is established to empower all members of the network and systems group to improve network and systems processes.
2. Champions of process improvement coordinate network and systems group process improvement activities.
3. The network and systems group develops and maintains a plan for process improvement according to a documented procedure.
4. Network and systems group process improvement activities are performed in accordance with the documented process improvement plan.
5. Network and systems process improvement proposals are handled according to a documented procedure.
6. Various members of the network and systems group actively participate in the development of process improvement ideas for specific process areas.
7. If possible, network and systems process improvements are tested on a pilot basis to determine their benefits and effectiveness before they are introduced into routine use.
8. When an improvement is moved from pilot use to routine use, the improvement is deployed according to documented procedures.
9. Records of network and systems group process improvement activities are maintained.
10. The entire network and systems group is provided with process improvement information including status and results on an event driven basis.

Discussion: Continuous improvement at every level of the organization is sought. Even the processes that allow the network and systems group to mature can be improved. Process change management seeks to bring process innovations into the network and systems group in a controlled way to encourage continuous process improvement.

Common Practices by Maturity Level

A few common system and network administration practices are described below with reference to the various maturity levels. The intention is not to say that accomplishment of any or all of these tasks as described will place an organization at the specific level. This mapping is simply to show some of the changes required of the higher level key process areas.

Level 1 – Initial

New user – Verbal requests are addressed as time permits or escalated with management.

Software install – New or upgraded software is installed whenever & where ever makes the most sense at the moment.

Hardware install – New or upgraded hardware is installed whenever & where ever makes the most sense at the moment.

Problem report – Problems are sometimes reported by users by mail or phone to a random administrator.

Security – No specific security standards or policies exist.

Disk capacity – Disk space is in short supply. No information on usage rates is available. Project managers of supported organizations often fight among themselves regarding disk space.

Backups – Backups are usually done according to a weekly schedule.

Level 2 – Repeatable

New user – Procedure to request and create an account is well documented. Cycle time for requests is monitored.

Software install – Installation guidelines are understood. Time spent installing and configuring software is tracked.

Hardware install – Installation standards are understood. Time spent installing and configuring hardware is tracked.

Problem report – Process to report problems is well understood by users and cycle time for problem resolution is monitored.

Security – Various security standards are clearly documented. Security violations are monitored.

Disk capacity – Acceptable disk capacity levels are established. Capacity is periodically monitored.

Backups – Failure conditions for backups are understood. Failure rates and effort to resolve problems are tracked.

Level 3 – Defined

New user – Head count expansion information is provided to signal new account requests are expected. Revision of procedure.

Software install – Installations are planned with the supported organizations Reasons for install/upgrade are recorded.

Hardware install – Installations are coordinated with supported organizations and vendors. Reasons for install/upgrade are recorded.

Problem report – Problems are mapped to root causes. Group reviews solutions to resolutions suggested to address root causes.

Security – Group reviews security incidents for root vulnerabilities. Resolutions are discussed, tested and released.

Disk capacity – Capacity planning is addressed in project plans written by supported organizations and reviewed by the network & systems group.

Backups – Training is provided for network and systems group to enhance backup programs and procedures.

Level 4 – Managed

New user – Cycle time numbers are used to adjust staffing to meet demand and requirements.

Software install – Productivity measures and goals for installation created.

Hardware install – Productivity/problem data is compare to goals for installs, tests and demos.

Problem report – Cycle time and resolution quality information is used on a regular basis to access effectiveness of problem reporting and resolution system.

Security – Effectiveness of group reviews is studied.

Disk capacity – Metric for disk availability is created and used.

Backups – Backup system is certified with high reliability rating.

Level 5 – Optimizing

New user – Accounts are electronically requested and verified.

Software install – Problems with software installs are documented and avoidable with new procedures.

Hardware install – New hardware technologies are evaluated & integrated.

Problem report – New problem reporting system installed to better meet user requirements for ease of use.

Security – Internal contest to establish better security practices is established.

Disk capacity – Project tracking information combined with metrics of utilization are used to predict needs.

Backups – Backup process is revisited with input from supported organizations re: production schedules.

Instrumentation

The following method can be used to roughly estimate the maturity level of a network and systems group within the scope of the SAMM.

Each key process activity is examined and a single score awarded for the entire organization being assessed. In the case of the Requirements Management key process area (RM) there are two key process activities. A score is determined for each activity in the key process area and the average of those two scores is the score of the area. The matrix below lists the characteristics associated with various scores (0, 2, 4, 6, 8, and 10). Borderline scores (situations that fall between those specified) can also be awarded (1, 3, 5, 7, and 9).

To describe a network and systems group as being at the repeatable maturity level (level two), all key process areas associated with that level must be qualified or receive an area score of 8. See Table 3.

Conclusions

The SAMM process improvement framework presents a challenge to the field of network and system administration. In the past, some might have considered it a matter of pride to think of system administration as some sort of magic and consider our processes to be a collection of black boxes. In order to advance the state of our profession, it is necessary to diagram and document those familiar black boxes.

Acknowledgement

The Capability Maturity Model (CMM) is developed and maintained by the Software Engineering Institute (SEI) of Carnegie Mellon University as a tool to assist software development organizations with developing higher quality software. Simply listing this work as a reference doesn't seem appropriate given the fact that it is the entire basis for this paper.

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Rating	Score	Characterization
Poor	0	No ability No interest Ineffective results
Weak	2	Partial ability Fragmented usage Inconsistent results
Fair	4	Implementation Plan defined Usage in major areas Consistent positive results
Marginal	6	Implementation across organization Usage in most areas Positive measurable results
Qualified	8	Practice is integral part of process Consistent use across organization Positive long term results
Outstanding	10	Excellence in practice well recognized Consistent long term use Consistent world class results

Table 3: Evaluation Matrix

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