

1B Processor Deployment: Leading the Way to Flawless Execution

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Deploying the 1B processor involved installing and retrofitting it in a live, fully operational 4ESS™ switch. The customer requirements for deploying the 1B processor were simple, clear, and stark: “flawless execution with no interruption to service.” To accomplish this, special bus switches were designed to allow peripheral units to be switched from the 1A to the 1B processor as part of the retrofit. The aggressive schedule called for installing the 1B processor in 134 AT&T switches in only 16 months. This paper describes the unique customer-supplier partnering approach used to meet the customer requirement of “flawless execution.” It also discusses the major leadership-based procedures used to improve processes and eliminate risks.

Objective

Today’s telecommunications industry is characterized by great competition and a rapidly increasing rate of change. As customer demands for services and features increase, AT&T is responding by adding capabilities to its 4ESS™ switch-based network. Replacing the 4ESS switch/1A processor with the new 1B processor was a critical project for AT&T; it had to be done to extend the life of the 4ESS switch into the 21st century. The 1B processor had to be installed in each of the 134 4ESS switch sites in the AT&T network over a period of only 16 months to support a later generic software update that would provide customers with new software-based services and features. Most importantly, it had to be done flawlessly—with no interruption to the high quality and service reliability on which AT&T’s customers depend. The project team’s prime imperative in deploying the 1B processor was “flawless execution”; it had to be right the first time in virtually every aspect. The 1B project team was not only responsible for managing the deployment of the 1B processor, but was also empowered to be creative in its approach. To ensure the quality and minimize risks associated with the 1B deployment, the major initiatives of the project team were:

- Strong customer-supplier partnering, including a shared leadership approach to the planning and the implementation stages of the project team;
- Project management audits conducted to evaluate processes and the degree of adherence to policies and guidelines and to identify potential risks early enough to take corrective action; and
- Short-duration quality improvement teams (QITs) that focused on areas that required process improvement.

As a result, the project team made numerous process improvements that benefited the 1B project. Many of these will provide the foundation for long-term process improvements that will enhance future projects.

The 1B processor was developed for the AT&T Network Services Division (NSD) customer to solve resource problems in the AT&T network’s 4ESS switch. As local exchange carriers (LECs) expressed interest in the 1B processor, similar initiatives were put in place to deploy the processor into their networks.

The sections that follow describe the planning work that was performed by development, project management, and the NSD customer to ensure that the deployment

objective of “flawless execution with no service interruptions” would be met.

Development Planning for Flawless Execution

The primary goal in the installation and retrofit of the 1B processor was to provide a safe, reliable method of introducing the new processor into a live 4ESS switch while minimizing service interruption. To ensure a smooth and reliable transition, members of the project team:

- Developed special hardware and software to allow testing during various phases of the installation and to minimize the time it would take to cut over service from the 1A to the 1B processor;
- Formulated thorough, accurate step-by-step procedures for the office technicians who would perform the installations and retrofits;
- Sequenced the large number of tasks into several phases that were standardized, scheduled, and executed during an 11-week period; and
- Integrated the schedule, software, hardware, and procedures to ensure their accuracy and usability through extensive testing.

Transitional Hardware. Before the 1B processor and its associated equipment were allowed to communicate with the 4ESS office equipment, they had to be tested in a “stand-alone” mode. Special switches were developed and installed in each retrofit site so that 4ESS switch peripheral units and the 3B attached processor could be quickly switched from the 1A to the 1B processor during the retrofit procedure. These switches were designed to eliminate crosstalk between the two processors and to provide the 1B processor with limited access to key office equipment controlled by the 1A processor. The stand-alone 1B processor’s capabilities to access the 4ESS peripheral equipment was essential to the safe performance of limited access testing. The 1A processor had control, allowing the 1B processor access to the 4ESS switch periphery.

To support this control, an additional piece of hardware—the generated control pulse (GCP) capture and recovery unit—was installed with the conversion switches. If the 1A processor encountered a problem during limited access testing, the 4ESS switch fault recovery programs could signal the GCP capture and recovery unit to return control automatically to the 1A processor, thereby aborting all processor access con-

Panel 1. Abbreviations, Acronyms, and Terms

APS—Attached Processor System
CPRP—Corporate Product Realization Process
GCP—generated control pulse
LEC—local exchange carrier
NS—Network Systems
NSD—Network Services Division
QIT—quality improvement team
WMS—Work Management System

nections to the 4ESS switch. When it was safe to return to limited access testing, the NSD personnel would manually set the GCP capture and recovery unit to allow the 1B processor access to the 4ESS periphery. The conversion switches and the GCP capture and recovery unit were designed to be used only as 1B processor retrofit support tools. When the retrofit activities are completed, this interim equipment is removed from the offices.

Transitional Software. Software designers modified existing retrofit software tools and developed new software to support the 1B installation and retrofit. These tools, which loaded and verified the 1B processor’s generic software, were modified to operate within the 1B processor’s memory spectrum. The *1B contingency* capability was developed to allow control to be returned to the 1A processor if necessary. The new software supported the 1B contingency during retrofit and limited access testing during the 1B installation interval.

In the current retrofit process, the new generic software is loaded into the 1A processor. As soon as the switch meets the acceptance criteria for standard office performance, the old generic software is removed from the system. At this point the old generic cannot be recovered unless the system is reinitialized. Software developed for the 1B processor can back up and recover the old 1A processor generic software in case control must be returned to the 1A processor after completion of the 1B processor retrofit.

Limited access testing evaluates how well the 1B processor is accessing the 4ESS switch equipment. Software was developed to control the 1B processor’s access to 4ESS switch equipment and to test whether the 1B processor and the 3B Attached Processor System (APS) could exchange message signals.

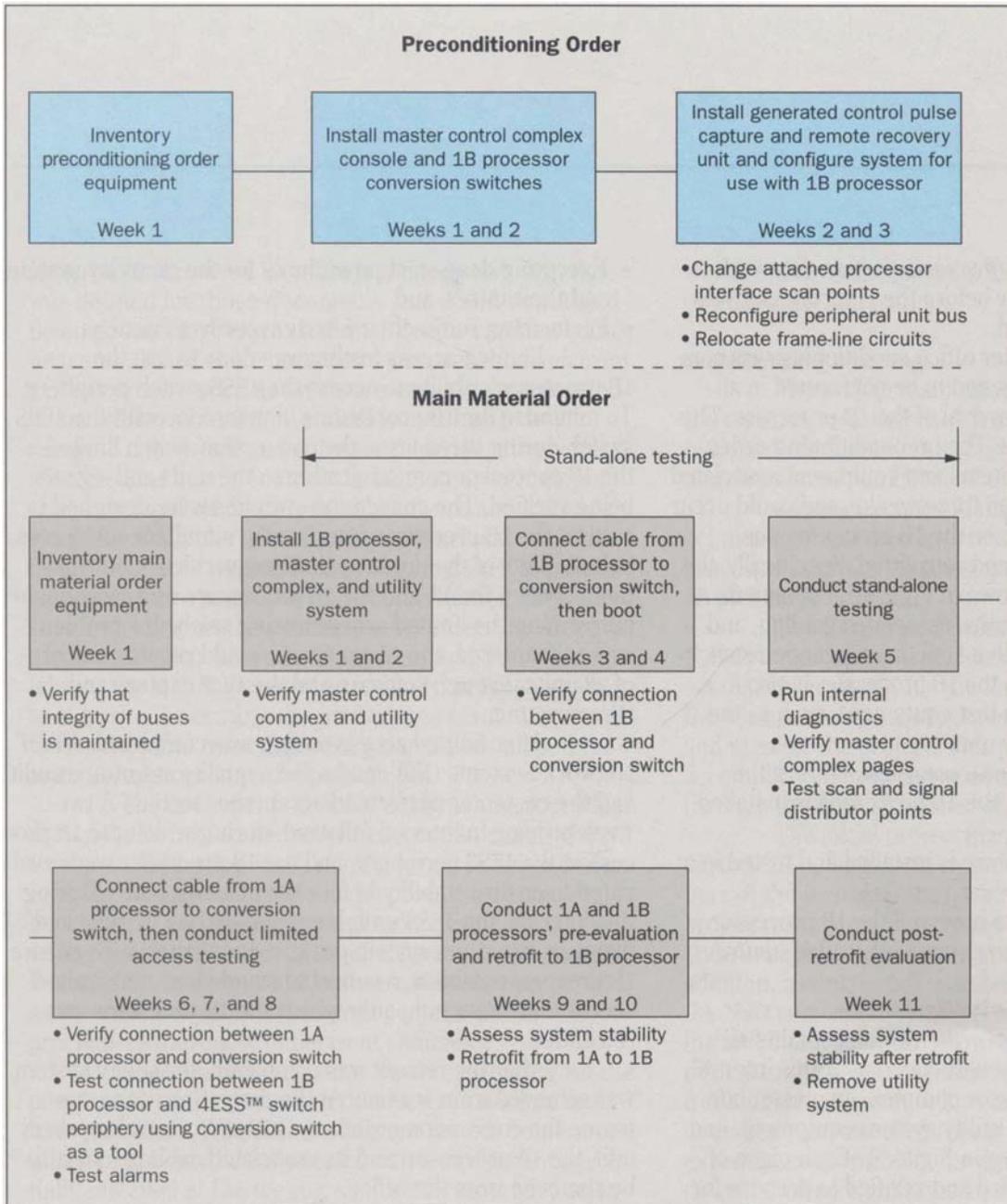


Figure 1. The preconditioning order contains seven conversion switches, their associated cabling, and other hardware required to install the switches and connect them to the 1B processor. The main material order, which contains all work items and equipment associated with the 1B processor installation and retrofit, consists of the 1B processor complex, its master control complex console, the utility system equipment, and various test tools.

Documentation of Procedures. Procedures were documented in standard customer documents, which are used by hardware installers and NSD personnel. Technical experts within the development organization provided information, sometimes in the form of written step-by-step instructions, to document developers.

Document developers refined the procedures throughout the various phases of testing and field deployment. During the initial deployment, the document developers were on site to observe the accuracy and usability of the documents. As the rollout continued and the installers and NSD personnel requested changes and

enhancements to the procedures, the document developers analyzed and incorporated all that were appropriate into the documentation.

Sequence of Events for Installation and Retrofit. The sequence of events outlined for 1B installation and retrofit are:

1. Office conditioning,
2. Site preparation, and
3. 1B processor installation and retrofit.

Office conditioning. To prepare for the 1B installation and retrofit, equipment in some offices had to be relocated, replaced, and/or removed to make space for

the 1B processor. Called *office conditioning*, this work could occur up to one year before the 1B processor was scheduled to be retrofitted.

Site preparation. After office conditioning was completed, specific work items had to be performed in all offices to prepare for the arrival of the 1B processor. This was called *site preparation*. The preconditioning order, which contained all work items and equipment associated with site preparation, lasted three weeks, and could occur as early as six months before the 1B processor was scheduled to be installed and retrofitted. Specifically, the preconditioning order, shown in Figure 1, contained seven conversion switch units, associated cabling, and other hardware required to install the conversion switch units and connect them to the 1B processor. It also included other installation test equipment, such as the GCP capture and recovery unit.

1B processor installation and retrofit. During the 11-week interval in which the 1B processor is installed and retrofit:

- The 1B processor hardware is installed and tested in a stand-alone environment,
- Tests are run to evaluate how well the 1B processor accesses the 4ESS switch equipment (called *limited access testing*), and
- Finally, the 1B processor is retrofitted.

The *main material order*, which contains all work items and equipment associated with this interval, consisted of the 1B processor complex, its master control complex console, the utility system equipment, and various test tools, as shown in Figure 1. Each piece of this equipment was installed and verified to prepare for stand-alone testing of the complex.

In the stand-alone testing environment, the 1B processor cabling terminated at the conversion switches to restrict the 1B processor from having access to the 4ESS switch periphery or the 3B APS computer. Input/output messages were transmitted through the utility system. Because the 1B processor had no access during stand-alone to the generic software and database that normally reside on the 3B disk, the software and database were kept on the utility system disk and loaded into the 1B processor's secondary memory by manual request. Stand-alone testing consisted of:

- Diagnosing the 1B processor,
- Testing master control complex console pages,

- Executing dead-start procedures for the memory system and their buses, and
- Performing rudimentary system recovery actions.

Limited access testing was done to test the 1B processor's ability to access the 4ESS switch periphery. To minimize the 1B processor's interference with the 4ESS switch during these tests, the conversion switch limited the 1B processor communication to the units and signals being verified. The conversion switches were designed to restrict the 1B processor from having simultaneous access to both units of the duplex pair being verified. Coordination between the 1A and the 1B processors was essential to performing the limited access testing safely. If a problem was encountered, the 1A processor could regain control of all units through software and the GCP capture and recovery unit.

After limited access testing was completed, AT&T Network Systems (NS) conducted a quality assurance audit and the customer performed acceptance testing. A two-week proving-in interval followed, during which the 1A processor, the 4ESS periphery, and the 1B processor were evaluated to ensure stability before retrofit took place. During this interval, the 4ESS switch equipment had to meet and maintain minimum system performance criteria. To ensure 1B processor stability, a subset of stand-alone and limited access tests were run, after which the 1B processor was retrofitted.

After the retrofit was completed, the utility system was removed from service. At the discretion of the customer, the conversion switches, GCP capture and recovery unit, the 1A processor, and its associated cabling may also be removed from the office.

Testing. Given the requirement that the 1B processor had to be installed and retrofitted in a live, fully operational 4ESS switch, the goal was to define a method to accomplish this task while minimizing the possibility of service interruption. The task at hand was twofold: (1) to develop quality customer documentation that focused on accuracy, completeness, and usability; and (2) to perform testing to ensure that the goal was achieved.

Documentation was verified using a series of formal reviews and lab/site testing by a team of members assembled from the development, documentation, training, and customer (NSD) organizations.

Planning. All documents associated with the 1B installation during the preconditioning and main

material orders were identified, and a testing schedule was defined for those documents that could be verified through testing. Before customer documentation could be tested, it had to be reviewed by representatives from various areas—such as hardware and software development, NSD, and testing—and all issues had to be resolved. Hardware and software dependencies were identified for each document to be tested, including a schedule of when the required hardware and software would be available. After the dependencies were satisfied, documents were tested at as many sites as possible on one or more prototype and preproduction 1B processors and, later, on the production 1B processor. Documents were also tested in the system and development labs, at the training center, and, finally, at the customer testing site. Executing the procedures many times at different sites and from different perspectives helped the team members refine the procedures.

The customer had defined a benchmark at which draft documentation had to be delivered to enable the NS Customer Education and Training group to begin designing courses on how to install a 1B processor. To meet this benchmark, documentation had to be developed and tested in parallel with hardware and software development. Because the hardware and software were not stable, and some software was not yet developed, the documented procedures inevitably underwent changes.

Implementation. Testing was performed from the perspective of the customer, that is, the installers and NSD personnel. All procedures were tested. Some procedures could only be fully tested when equipment was initially installed at the testing site, as, for example, when the 1B processor and conversion switches were installed. Other procedures could be tested in their entirety many times. Because of the tight schedules for installing 1B processors in system labs, all documentation could not be tested during each installation; instead, specific documents were chosen to be tested. Early in the testing interval, certified installers used preliminary documentation to install a 1B processor in one system lab to generate feedback on how well the documents were being developed. This process identified discrepancies between the system and procedures early in the testing cycle and provided invaluable feedback on document organization. Each testing site—system/development lab testing, training center testing, and integrated test net-

work testing—also played a major role during document development and testing.

Project Team Planning

The project team was responsible for building the team, formulating the plan, developing the quality plan, and establishing a strong customer-supplier relationship across all phases of the project team.

Building the Team. Using a formally appointed project manager and a documented project management process was critical to the successful realization of the 1B processor project.

The Corporate Product Realization Process (CPRP) organization was chartered to document the project objectives, assemble the team and, with input from the team, develop an integrated project plan to manage and monitor the project. This plan defined the work to be accomplished, from the sales agreement in July 1990 through the final 1B processor retrofit in April 1995.

The initial project management team, chartered in April 1990, included a technical manager and six members of the technical staff, whose experience ranged from project management to a wide variety of technical experience in engineering, manufacturing, and installation. In addition, having a staff member who was an employee of the NSD customer organization ensured an understanding and integration of customer and supplier activities critical to the project's success. This team reported to its traditional management line, as well as to the program manager. Because the program manager had ultimate executive responsibility for the project, his support was essential when significant financial and process obstacles were encountered.

After members of the CPRP team developed an executive summary of the project's scope and objectives, they began contacting all the organizations that would play a role in the success of the project. They identified nine distinct functions, or *phases* (shown in Figure 2), typically at the third or fourth management level, with 47 separate subphases. Typically, a subphase is a second-level supervisor or technical manager organization. Each fourth-level phase manager was asked to identify a representative—a single point of contact for that organization in all issues related to the project—and to provide a mission statement for the overall organization and each subphase.

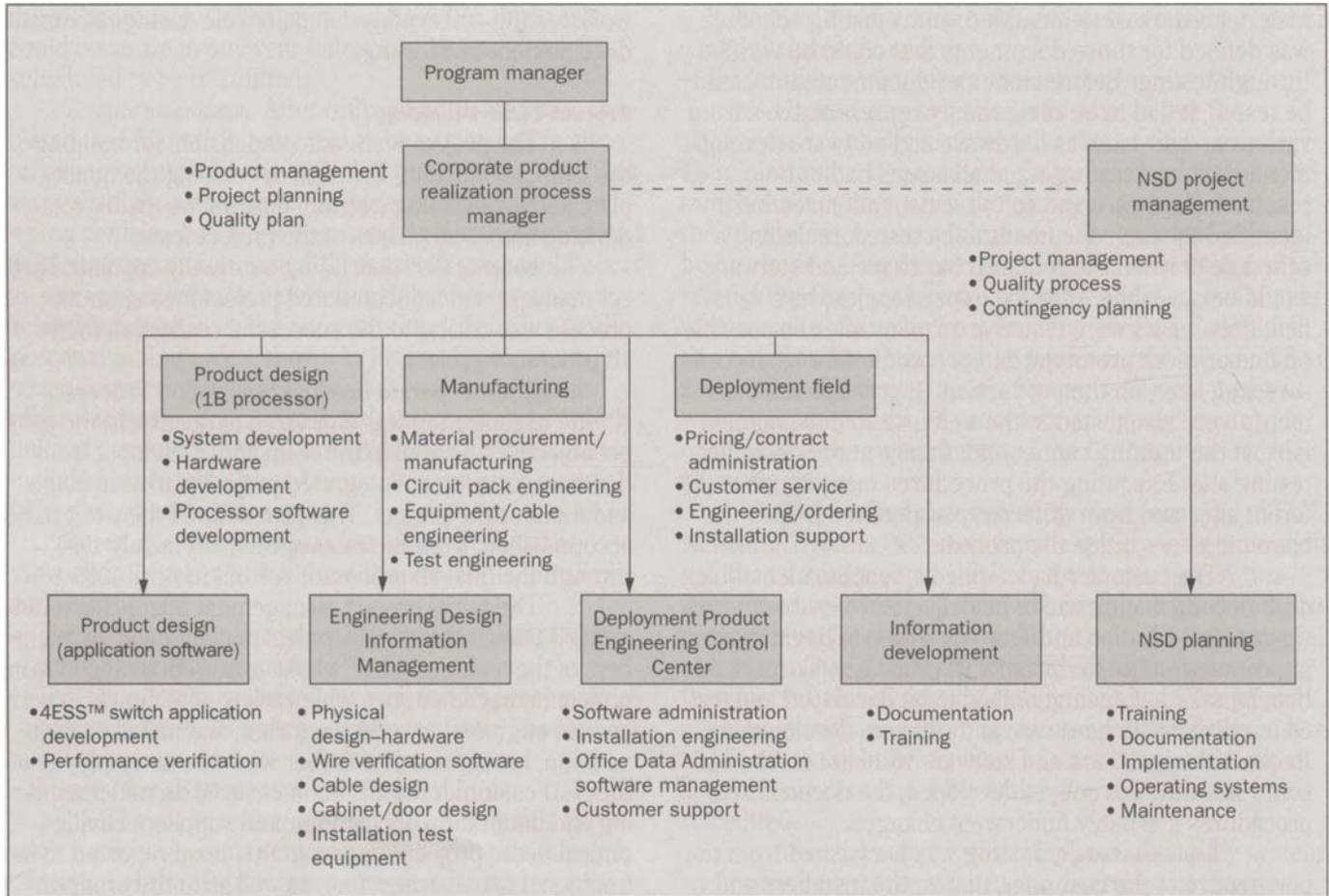


Figure 2. The 1B project team phases and high-level subphases.

The mission statement, which contained the manager's name, the organization's mission, and a list of the organization's suppliers and customers, was signed by the manager and included in the project plan. Signing the mission statement was the first in a series of steps to ensure that managers were aware of and committed to the needs of this project and would provide the appropriate support when required.

When all the project contacts were identified and mission statements documented and signed, a project kickoff meeting was held to give the entire team a detailed overview of the project's objectives and an opportunity to ask questions of all the subject-matter experts and team members in attendance. Fourth-level phase managers were encouraged to attend and present their organization's mission and how they would interact

with all other members on the team. This was an opportunity to identify missing organizations and begin to clarify dependencies between organizations. The representatives who were part of this team would meet on a monthly basis for the rest of the project's life to review project status and identify and resolve issues that needed special attention.

In addition to the working project team meetings, an executive-level project review was scheduled at least quarterly to ensure that the project stayed on track and that every member of the project team maintained the appropriate level of commitment.

Building the Plan. As soon as the project management team was assembled and had obtained the first

round of commitments to support the project, it set out to complete the project plan. The plan was divided into four major sections, including:

- The executive summary,
- Individual phase overviews,
- The project schedule, and
- The project quality plan.

The executive summary gave all team members a view of the project's objectives. The individual phase overviews defined the contributing organizations, their specific representatives, staffing profiles for each organization, and a risk analysis with contingency strategies to minimize the risks as much as possible. Yet to be completed were the project's schedule and quality plan.

The kickoff meeting of the CPRP project was an important first step in building the remaining sections of the plan. At this session, the entire project team—consisting of approximately 60 second-, third-, and fourth-level managers—was introduced to the project. The topics presented at the meeting included a general overview of the project's scope and objectives, presented by the project manager, and the product's design, presented by the development team. The customer also presented the first of many insights into the critical need for the project's success.

Given the knowledge gained from the kickoff meeting, the team began setting the project schedule. The objective was to build a totally integrated schedule of activities for all organizations involved. This included a work breakdown structure, which listed all tasks to be performed, their durations, and their predecessor-successor relationships, both within and between organizations. The resulting plan contained 1,200 tasks stored in a PC-based project management program called Time Line.

The Time Line program helped the project manager develop the critical path throughout the project's life. Understanding this critical path enabled the project manager to negotiate with organizations that either needed to improve their process performance or add staff to meet the needs of the project. The tool also allowed the project manager to identify new tasks on the critical path as the project progressed. This ability to understand—early in the project—the implications of small schedule changes on the final objectives was valuable for determining what corrective actions needed to be taken to meet the final objectives.

Integrating the processes of all the project's organizations helped the project team to pursue the necessary

process improvements effectively. Two significant examples of this are reductions in the time it took to produce a new circuit pack artmaster, which contains a drawing and documentation of the circuit pack, and to deploy a Class A change notice.

As testing progressed, team members realized that some production circuit pack artmasters would have to be reworked. If the work were performed using the standard processes, it would have taken 32 weeks, enough time to jeopardize the project's schedule. But because team members knew the critical path through all the processes, negotiations focused on these tasks, and the work was completed in just 16 weeks.

For Class A changes, the customer challenged the team to develop a process that would drastically reduce the existing 270-day interval from finding a problem to fully deploying its solution in the field. After the 1B project team conducted a detailed analysis of the work to be done and took part in exhaustive negotiations, they developed a process that could deliver emergency changes to the field in 71 days. This reduction could not have been accomplished without the detailed process knowledge provided by the total project plan.

As soon as the project schedule was documented, reviewed, and signed off on by all phase managers, the final touches were applied to the project quality plan. The project schedule now listed the completion dates of major milestones. The intent of the quality plan was to describe, in detail, the customer's expectations of when each milestone should be passed. The plan started with a matrix that defined when each quality element was due, which organization was responsible for its delivery, and who the customer for the deliverable was. In addition, the project team reviewed each deliverable and documented an agreed-to description, or descriptions, ensuring that the customer and supplier had a common view of the deliverable. After the project team documented and reviewed this portion of the plan, it was also signed off on by the management of all contributing organizations. The review and signature process, used for annual updates of the plan, was an important ingredient in the ongoing understanding and commitment to the objectives of this project.

Developing a Quality Plan. During late 1990 and early 1991, as members of the project team were developing the project plan, it became obvious that they needed

a comprehensive set of quality gates, metrics, and specific exit criteria to ensure that the project was in fact "on schedule." During that time, the Partners in Quality forum initiated an effort to align the NSD and NS quality processes to standardize and document a set of mutually acceptable quality gates for use in all projects.

The 1B project team borrowed liberally from the work being done by NSD to identify a high-level set of quality gate exit criteria and expanded the number of "gates" from 10 to 25. This document would span five years—from Gate 1, front-end process review, through Gate 25, post-deployment review, scheduled for July 1995. The 1B quality plan was co-authored by the 1B CPRP organization (with input from all phase managers) and the NSD Technology Management organization. A significant amount of effort went into defining deliverables between phases and between succeeding gates (usually three to four months apart), delineating key components by phase owner and detailed exit criteria. Figure 3 shows the level of detail described for one of Gate 24's eight components.

To further emphasize the importance of meeting the exit criteria, progress payments were tied to successful completion of most gates. As the project progressed, all gates were passed on schedule. Although there were exceptions to specific exit criteria at some gates, NSD permitted passing the gate as long as a well-defined, committed, and tracked plan for closure existed. Most exceptions were closed before the next gate was passed. The 1B processor project taught the project team that it is possible to prepare a plan that can be implemented over a long period of time if the project team has a detailed understanding of the realization process. Because quality gates are process metrics, the components and metrics must be defined by the process owners, that is, the project team. Once defined, these process metrics enable the project team to manage supplier performance, remove variability from the process, detect and correct defects earlier in the process, and manage risk associated with changes.

Customer-Supplier Relationship. The success of the 1B project depended not on developing and implementing the perfect plan, but, rather, on cultivating a strong customer-supplier relationship, or partnering, across all phases of the project team. This allowed the team to manage change and its associated risks openly,

in sight of the entire team, including the NSD representative. The 1B project team did a good job of predetermining how they would manage change together. When change occurred, as it inevitably does, no hiding of evidence, no cover-ups, and no finger-pointing were necessary. Instead, all team members involved in the change bonded together to define the problem quickly, analyze the cause, and resolve it. Sometimes simple one-on-one negotiation worked; sometimes the project team leader handled the negotiation; and sometimes QITs and/or process management teams made extensive efforts to resolve the problem.

The 1B project also taught the team members never to underestimate the importance of open, honest project communications, both horizontally (within the project) and vertically (to upper management). Communication is one of the most difficult things to achieve, even on a project that stresses open, honest interchange. Misunderstandings, disagreements, and even open hostilities erupted among team members. Communication was handled at all levels. If team members could not resolve an issue, they could take it to the project team leader either immediately or at the monthly team meeting, where it was opened as an action item and assigned to a fourth-level management owner. If team members could not resolve the issue, it was taken to the monthly executive meeting. At all levels, the spirit was one of "How can we meet the project needs?" not "We don't do that because..."

Although it was uncomfortable at first to have the customer representative at every project meeting, the representative's participation kept the project team focused on what was really important to the customer. Without the close relationship between the NSD customer representatives and the project team, and the data collected from all project phases, the team might well have made some project decisions differently. The success of the project—measured by the customer's stated satisfaction—is testimony to the success of a close customer-supplier relationship.

Project Audits. A project audit is a formal evaluation by an independent group to provide an objective, impartial appraisal of a project, or some critical part of it. The primary goals of the audit are to improve the project and to identify potential risks and problems early enough to take corrective actions before they even materialize, and certainly before they become crises. In short, audits iden-

tify areas for improvement and increase the overall probability of a project's success.

The 1B processor used project audits extensively as a major quality tool. Because of the project's importance to AT&T and the need for flawless execution, a key ingredient in the project audits was partnering. The customer participated in each audit to ensure that all customer needs, expectations, and requirements were met.

Comprehensive project audits were conducted throughout the 1B project:

- A system architecture audit was held early in the project to verify that reliability and functional requirements were met.
- A hardware design audit verified that detailed design specifications were accurate.
- A software development audit ensured compliance with the software development methodology, such as the effective use of design and code inspections.
- Planning audits assessed the adequacy of both the manufacturing and deployment plans.
- Several project management audits were conducted by an internal quality group and outside consultants to ensure the effectiveness of the project management system.

The deployment planning audit, held before the rollout of the 1B processor, identified areas that needed strengthening. These included problem resolution, change management, site management, communication management, and risk management associated with the deployment phase of the project. A cross-functional QIT approach addressed each of these areas. The goal of the QITs, which used a systematic, data-oriented methodology to analyze problem areas and identify solutions and countermeasures, was to make immediate improvements for the 1B project, and to translate these into process changes that would benefit future projects. In just three months of using this approach, with only a part-time, but focused, effort, the QITs identified significant process changes and improvements that addressed all major issues.

For example, the risk management QIT was responsible for identifying and addressing any remaining potential risks associated with deploying the 1B processor. First the team defined and documented a risk management process, consisting of risk identification, analysis, and response. Next, the team applied the process to the 1B delivery, installation, and retrofit phases of deployment.

Potential areas of risk were identified and a qualitative high/medium/low approach was used to assess the probability of occurrence and the extent of negative impact. The most important risk considerations were the impact on end-customer service and on the overall deployment schedule.

The risk management QIT identified several other high-risk areas, including the use of "old" versions of procedure documents, physical activity too close to operating equipment, and the installation of equipment in active signal paths. They quickly defined and implemented action plans to eliminate or mitigate each risk area.

Project audits, as well as other major quality initiatives, have helped lead the way to flawless execution—a customer imperative on the 1B project. Partnering with the customer was essential to improving the project, the product, and processes in a proactive way using this quality tool.

NSD 1B Project Management Team

To maintain the focus on service reliability and flawless execution during the 1B project, the NSD 1B project management team, along with NS and AT&T Bell Laboratories, implemented several deployment strategies. These included using a controlled introduction period, providing on-site 1B processor development support from NS and NSD in early 1B installations, emphasizing the use of project tracking and monitoring tools, and implementing contingency planning.

Controlled Introduction. *Controlled introduction* describes the gradual deployment and retrofit of 1B processors early in the 1B project. During controlled introduction, the number of 1B installations and retrofits for 28 offices was increased incrementally each week over a six-month period. Early in the rollout, one retrofit was scheduled per month; this was increased gradually to full deployment of four retrofits per week. Introducing the 1B processor into the AT&T switched network in this manner minimized the potential impact of any problems that may have gone undetected during development and installation.

Critical markets were carefully avoided during the controlled introduction period. Offices with unique traffic mixes, such as small/medium/large calling volume and international offices, were scheduled early to verify the unique features associated with those traffic types.

Figure 3. The level of detail described for one of the eight components in Quality Gate 24.

Component: Gate 24. Three NSD-defined hardware exit criteria.

Exit Criteria

24.3.1 The following is a list of NSD hardware criteria that must be met for Quality Gate 0 (full deployment completed) (priorities are based on NSD definitions):

1. No open hardware emergency (E) priority. Modification requests (MRs) on current release except those identified in the last 15 days.
2. No open hardware high (H) priority MRs on current release except those identified in the last 30 days.
3. There must be 5 or fewer open medium (M) and low (L) priority MRs. Development will provide a list of open M and L priority MRs on current release.

Note: The Bell Labs definition of *closed* is when a solution is known and proven in the lab.

NSD expectation:

All MRs, open or closed, must be assigned a change notice (CN) number with a completion target date, and will be tracked through implementation.

Another element in the focus on service reliability during the 1B project was the use of the Plano 4ESS switch. The 1B project used the Plano 4ESS switch to verify the 1B installation and retrofit process in a live office environment and to verify the performance of the 1B processor during call processing of live traffic. The focus was on a robust simulation of a field office installation and retrofit, along with maintaining the safe procedures in a lab office.

Network management controls were used to remove all traffic from the Plano 4ESS switch so that the 1B installation and retrofit process could be verified safely. After the verification process was completed, traffic was restored for the Thanksgiving peak calling period. Traffic was removed again to perform several 1B retrofits in succession to allow both the NSD technical support groups and the on-site work force the opportunity to gain additional retrofit experience and assess the retrofit process reliability in a controlled environment.

After the retrofit verification phase was completed, a controlled number of via-traffic calls were routed

through the Plano 4ESS switch. This allowed the 1B to process "live" traffic under controlled conditions, which could be quickly reversed. For five weeks, network management controls gradually increased the traffic routed through the Plano 4ESS switch running the 1B processor. During this time, the 1B processor handled all traffic with no service problems.

On-Site 1B Installation and Retrofit Support. NS technical support representatives and NSD 1B development team members provided on-site support to several early 1B installation and retrofit offices. NS provided on-site support to eight offices, and NSD 1B development provided on-site support to six offices. This combined team published status and problem reports daily, identifying and resolving problems early. Providing on-site support enabled the NSD 1B development team to observe 1B installations and thereby identify and address areas for improvement early in the project. This also gave NS technical support personnel additional hands-on experience.

NS developed a comprehensive installation status and problem tracking system, Tracker, for the

1B project. It provided universal access for NS installation and an easy, menu-driven format for reporting status and problems. A direct result of the deployment planning audit QITs, Tracker fulfilled the need for an effective two-way communication system with the field. Tracker was used by the NSD 1B project management team, NS Affiliate Sales Division project management, and CPRP, among others, to monitor installation status and problems, and to ensure that any reported troubles were resolved quickly. The system generated automated reports to make timely, useful information readily available to those who needed it.

Tracker status reports were augmented by the Work Management System (WMS), a ticketing system used by the NSD on-site work force. Personnel in the field added status and problem data to the WMS ticket on a daily basis, providing additional information for the NSD 1B project management team.

Tracker augmented the Assistance Request System as a vehicle for identifying and managing problems. Tracker focused primarily on office-specific problems, whereas the Assistance Request System addressed long-term problems that would affect the entire system. By using Assistance Request to focus on root cause analysis and process improvements, problems were eliminated at their source and did not reappear in other offices.

Contingency Planning. To minimize the impact of a major 1B fault on an in-service 1B office, the 1A processor could be reactivated using the 1B contingency feature. If a major 1B fault occurred during controlled introduction, the 1B processor could be removed from service and replaced by the 1A processor. Some development effort and extensive planning took place to ensure that the 1A office data would be kept current and that the 1A processor could recover after a period of inactivity. The 1A office data in 1B offices was kept current with the 1B office data using an off-line processor. The updated information was then downloaded to the 4ESS switch, making an updated 1A office data image available immediately. The procedures to implement the 1B contingency feature were documented, and the process for deciding whether to invoke the feature was developed. Customer Education and Training developed a video to ensure that NSD maintenance personnel were familiar with the procedure should it need to be implemented. It has not been necessary to implement the 1B contingency feature.

Conclusion

To meet the customer requirement for "flawless execution with no interruption to service," the 1B project team used a unique customer-supplier partnering approach, project management audits, and QITs to deploy the 1B processor. Many of the process changes and improvements initiated on this project are being standardized for future projects. Working together, developers, project management, and the NSD customer have succeeded in retrofitting 134 offices, thereby extending the life of the 4ESS switch into the 21st century.

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