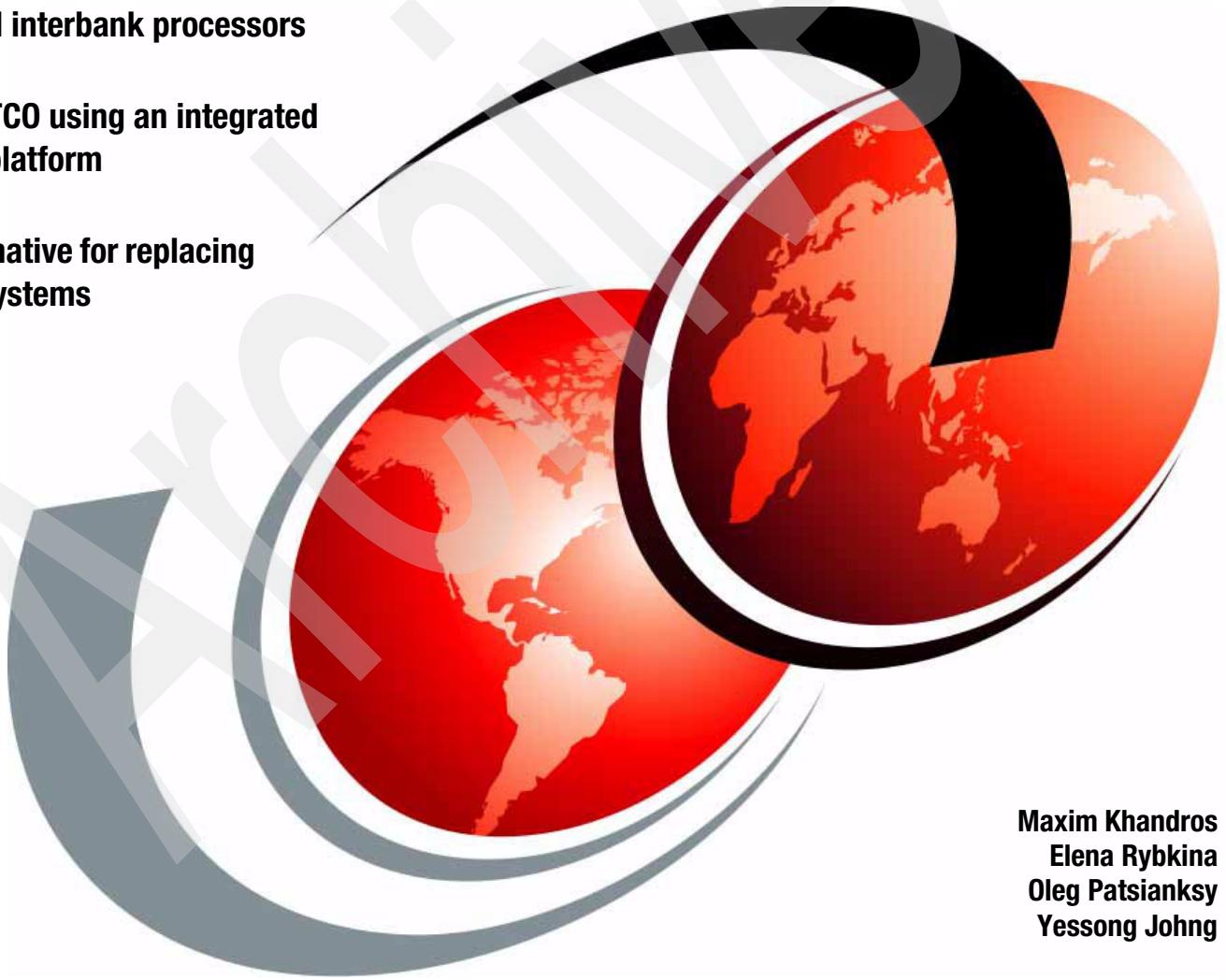
IBM

SmartVista i

High-performance payment processing solution on IBM System i

- Availability and scalability solution for banks and interbank processors
- Reduced TCO using an integrated System i platform
- Real alternative for replacing existing systems



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Contents

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Preface

SmartVista i is an evolution of the BPC SmartVista card processing solution, adapted to run on the System i platform. Combining the comprehensive card processing functionality, modular design, and flexibility of the BPC SmartVista software application with the robustness and fault-tolerance of the IBM System i platform, SmartVista i offers continuous availability, high performance, and scalability.

SmartVista i is a result of extensive collaboration between the BPC research and development team and IBM experts from Russia, the United Kingdom, and the U.S. Built around the growing demands of banks and interbank processors in both mature and emerging markets, the SmartVista i solution represents a reliable and high-performance electronic payment system that takes into account all current payment technologies and ever increasing delivery channels. The SmartVista i high performance ratings mentioned in this paper were recorded during benchmark testing with high volumes of financial transactions at the IBM System i Center in Rochester, Minnesota. The exceptional fault tolerance of the solution was achieved by using Vision Solutions (formerly Lakeview Technologies) MIMIX HA1.

SmartVista i is intended for financial organizations of any size that wish to establish a solid foundation for their card business growth. With its ability to add and incorporate new functions and requirements with minimal time and resources, SmartVista i helps bring down total cost of ownership and helps users maintain it at reasonable levels into the future.

The team that wrote this paper

This paper was produced in collaboration with BPC.

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1

About BPC

Founded in 1995 as Banking Production Centre, today, BPC is a recognized provider of electronic payment solutions for the global financial industry. The company is a part of the BPC Group, which, with its interests in financial services, energy and chemicals, delivers cutting-edge technology solutions and best international practices to rapidly growing industries.

The BPC flagship solution, the SmartVista Suite, is a comprehensive, state-of-the-art family of closely integrated software applications that address every payment processing need, from traditional ATM switching and card management to pervasive customer access to card accounts using the channel of their choice. SmartVista supports all existing international Electronic Funds Transfer (EFT) standards and technologies, including EMV (Europay, MasterCard, and Visa), and is open and extendable to cater readily to both emerging and local electronic payment mechanisms.

Built in compliance with open standards, SmartVista-based solutions offer significant business value while reducing the total cost of ownership versus traditional card processing systems that are available in the market today. Due to the success of its solutions, the BPC customer base has increased dramatically to include the largest and most progressive retail banks in Russia, the Commonwealth of Independent States (CIS), and Asia.

2

Modern Requirements for Card Processing Systems

The consequences of the development of the banking business that is related to issuing and acquiring payment cards and processing financial transactions include an increase in the functionality and performance requirements for card processing systems. The greater demand for speed and availability and the need to support new payment technologies has compelled banks to revise their approach to their IT infrastructure.

Until now, the architecture of IT solutions for card processors has limited their ability to meet the increasing demands for scalability, performance, and extensibility. The two major trends in the card processing solutions market are the use of so-called older platforms running on proprietary operating systems along with non-relational databases and the development of custom solutions on other platforms to support considerably smaller volumes of transactions, on the other. These trends have created serious obstacles to the further development of the card business with new technologies: chip cards, Internet payments, electronic commerce applications, and so forth.

In the search for innovative solutions capable of providing a single software and hardware platform that supports various functional areas of retail banking and becomes the foundation for its growth, priority is given to such criteria as reliability, high availability and scalability. This can be achieved using modern, open standard card processing solutions with built-in compliance with all latest industry standards and new technologies and by taking full advantage of the underlying hardware platform.

SmartVista i is an innovative and fully integrated solution for card processing and electronic payments. It combines the proven ideology of the SmartVista card processing system with the architectural advantages of IBM System i technology, ensuring fault-tolerance and high-performance capacity. SmartVista i is the result of a long-term, effective cooperation between BPC and IBM. The new solution meets the growing demands of banks and interbank processors around the globe for reliable and high performance solutions that support all modern payment technologies and delivery channels, ensuring 24x7x365 customer service.

2.1 System reliability, availability, and data integrity

Typically, the requirements for reliability are based on the processing demands of ATM or credit cards. The points of interaction (POI), such as POS terminals, ATMs, or kiosks, require faultless card processing operations that are performed by stable networks based on proven hardware platforms and powered by reliable software. When a card is declined or the system cannot process a request, the cost is very high, and the majority of the processors now must meet demands for the highest degree of failure tolerance and the complete automation of card processing operations and supporting processes.

Response time and steady operation are another business challenge that processing systems face today. Normally, the issuing financial institution or bank has about 10 seconds to respond to transactions in the country of that institution. Overseas bank and gateway transactions require more time. The consequence of unsatisfactory reliability or poor response-times is an overexpenditure for a financial institution if the other members of the ATM or POS network have the right to stand-in for the transaction originator that is incapable of completing the transaction in a specified time period. This consequence has serious repercussions.

A financial transaction that is initiated by the ATM or POS terminal user can include several stages and pass through several nodes before it is completed. Also, a successful transaction completes and is prepared for final settlement in real-time or in some form of batch processing. When failures and errors occur, the authorizing system of the host issuer must be able to reconstruct all transactions, without losing any of them.

The methods for meeting the response time, availability, and data integrity requirements that are imposed on financial processing systems go beyond fault tolerance: The system must also be permanently available.

2.2 Banking transaction categories supported by processing systems

Supporting direct transactions and the transactions that pass through shared networks extends payment system options. The operations available in the shared networks are not limited by the simple card processing, and include the following services:

- Debit and ATM network
- Surcharge-free programs
- Deposits, deposit sharing programs
- Gateway connections
- ATM driving
- PIN-secured debit, signature debit, and stored value card processing
- Card authorization, activation, and production
- Merchant acquirer and agent bank programs
- Bill payment services
- Risk management and fraud prevention services

Shared ATM networks increase the availability of services for customers, but they impose heavy demands on the payment systems and considerably increase the system workload. Most networks require stand-in authorization, which is used to authorize transactions when a card issuer or processor cannot do so.

To meet the availability demands of distributed networks and minimize the risks of fraud or transaction overcharging, the processing systems should minimize their downtime to the highest possible degree and stay online even during the maintenance and upgrades. The availability that is required by the banking industry is higher than 99%.

2.3 ATM and POS processing

ATM and POS processing follow similar paths through the network and associated systems. Typically, all transactions handled in the ATM and POS networks can be grouped in four categories:

- **On us**

  The transaction originated by the ATM or POS device that is owned by the bank is processed inside the bank.

- **Network on us**

  The transaction originates from a sharing network, in which both the bank and the ATM or POS-owning bank are within the same network.

- **Reciprocal transaction**

  The cardholder uses an ATM or POS owned by another bank, and the card issuer and the ATM or POS owners use different regional networks but the networks have a reciprocal-sharing agreement. A reciprocity agreement between regional networks is an arrangement whereby the two networks agree to pass information to one another in transactions involving members of each network. Typically, two switches are required to complete the transaction.

- **National bridge transactions**

  The cardholder uses an ATM or POS owned by a third-party bank, and the card issuer and ATM or POS owners use different regional networks, but the networks do not have a reciprocal sharing agreement. In this case, the card issuer and ATM owner must belong to the same national network and the regional networks serve as gateways to the national network. The transaction is routed from the ATM or POS regional network to the national network, and finally to the regional network of the authorizing bank. The transaction involves three switches, one from the initiating regional network, one from the national network, and one from the other regional network.

The operations that are performed by the regional and national network switching systems to a considerable degree resemble the processes that are implemented by the systems used within a financial institution. The switching systems conduct transactions from initiation to destination. The "switched" word is used to describe the process of passing the transaction from the host where the transaction originates to the network and then to the destination host. A typical path of the transaction within the network includes the following steps:

1. The host of the card-issuing institution accepts an ATM or POS transaction that is then either processed locally (on us) or switched to one of the regional networks (network on us).
2. The regional networks either switch the transaction to another institution host for processing (network on us) or switch the transaction to a national network for hand-off to another regional network (national bridge or reciprocal).
3. Responses are switched from the owning host of an ATM or POS (on us) to the ATM or POS or switched to a regional network (network on us).

4. The regional network either switches a host response to an ATM or POS transaction to the host of a member bank (network on us) or switches the response to a national network (national bridge or reciprocal).
5. The national network switches the response to another regional network for later switching to the card-issuer host.

In general, network switches switch transactions from host to host until a transaction response completes the original transaction request is completed or the request times out.

Today, many large card-issuing financial institutions belong to several major networks so that they can have a direct connection to those network switches. Because of these direct connections, more of their cardholder transactions fall into the *network on us* category. Using this approach, customers can save costs because the transactions involve fewer switches than reciprocal or national bridge transactions.

3

SmartVista Products and Solutions

SmartVista solutions are designed to support every aspect of the business processes that are related to plastic cards and electronic payments, whether on the acquirer or issuer side.

Depending on the business requirements of the customer organization and its place in the payment processing value chain, each implementation is composed of some or all of the closely integrated SmartVista products, with all or some of their features and components activated.

The core of the SmartVista Suite of products are SmartVista Front-End and SmartVista Back-Office systems. These systems deliver a fully functional solution for a card processing organization that deals with magnetic stripe cards or EMV-compliant chip cards, including card issuing and management, merchant and terminal management, acquirer-side and issuer-side authorization processing, transaction clearing and settlement, dispute resolution, interfaces with external card scheme operators and banking systems, and more. Originally designed to support EMV and run on modern platforms, SmartVista offers financial institutions a real opportunity to harness the power of cutting-edge card technologies.

SmartVista can handle both the issuer and acquirer sides of processing for members of international or local card schemes, such as Visa, MasterCard, American Express, Diners Club, JCB, China Union Pay, BancNet. It can also run a fully independent *on us* card scheme.

In addition to basic SmartVista functionality, BPC offers add-on products, modules, and integration options so that customers can choose more sophisticated ways of doing business that include enhanced loyalty management, delinquency management, customer scoring, and retail banking features. Customers can use these products, modules, and options to go beyond the classic card processing and management and take advantage of the emerging and fast-growing e-commerce and m-commerce models.

All SmartVista products can be installed either as a complete solution or separately as standalone solutions integrated with existing, traditional, or third-party systems.

3.1 SmartVista Suite

The SmartVista solution is based on three closely integrated software products, the SmartVista Front-End online transaction processing (OLTP) system, the SmartVista Back-Office card management system, and the SmartVista CardGen card production system that jointly cater to the full range of card processing and management functions. These cover the following key areas:

- Multi-channel service delivery whereby customers can initiate transactions and make queries using various devices and facilities such as ATMs, POSs, kiosks, call centers, e-commerce Web sites, mobile phones, and more
- ATM and POS network control, monitoring, and management
- Online acquirer-side authorization switching to the appropriate host or other system that can authenticate the card and verify the availability of funds
- Online issuer-side authorization processing with account limit and balance verification
- Interchange with payment networks (online for authorization and off-line for clearing and settlement and reports)
- Clearing and settlement between the customer and merchant with fees applied appropriately among all parties
- Exception, charge back, and dispute processing
- Integration with other line-of-business applications such as retail and core banking systems, customer relationship management (CRM), call-centers, and more
- Customer origination and applications processing
- Card, account, customer, and merchant management
- Product creation and management
- Card production and personalization
- Fraud prevention and monitoring
- Loyalty and affinity schemes
- Social programs and electronic government
- Sophisticated multiple account credit card support
- Delinquency management
- Fund transfers to third-party accounts (utility payments, mobile accounts, and so on)
- Internet banking
- E-Commerce

In the perennial dilemma of choosing between best-of-breed and integrated solutions, SmartVista has taken the best of both worlds. Its two main components, SmartVista Front-End and SmartVista Back-Office, are optimized to meet the different requirements that exist in real-time transaction processing environments and in the batch-oriented back-office domain.

3.1.1 SmartVista Front-End

SmartVista Front-End is a lean and mean real-time transaction engine that can be scaled up or out as needed through unlimited process parallelization capabilities and efficient communications infrastructure.

SmartVista Front-End handles all online real-time interactions and activities that are required to provide fast and error-free authorization processing at both the issuer and acquirer sides. Typically, it processes all transaction origination devices, online payment scheme interfaces, online host interfaces, Internet and wireless interfaces, and any other online interfaces.

The key functional areas that are supported by SmartVista Front-End include:

- Authorization requests capture, processing and routing
- Stand-in, host, and serial multi-host authorization
- ATM and POS network management and monitoring, including support for multifunctional self-service kiosks
- Online transaction monitoring using rule-based or statistics models to detect fraudulent transactions

3.1.2 SmartVista Back-Office

SmartVista Back-Office is built to focus on the flexibility and intelligence that are required to minimize errors and difficulties in the process of collecting and analyzing customer information and matching transactions and to offer maximum freedom and minimum time-to-market when configuring services and products.

SmartVista Back-Office provides off-line clearing and settlement with counterparties and payment networks; customer, card and merchant management; interfacing with the core banking and other IT systems; and comprehensive reporting, both within the organization and for external parties.

- The features and functions of SmartVista Back-Office cover the following main categories:
- Customer, card and merchant management, including fees, rate, and limit setup
- Clearing and settlement of financial transactions
- Dispute, charge back, and exception processing
- Fraud reporting and risk management
- Operational accounting (GL accounts maintenance) and reporting
- Comprehensive credit card functionality support
- Value-added services, such as co-brand cards, loyalty, and affinity schemes

3.1.3 SmartVista CardGen

SmartVista CardGen is a complete subsystem for magnetic and smart chip (EMV) card personalization. It provides direct interfaces to card production equipment and offers the facilities for embossing data preparation, chip personalization data preparation, card security management procedures, and more.

3.2 Solutions for various environments

In both completed and on-going implementations, SmartVista-based solutions provide the core platform for the following types of business:

- **Full-function retail bank with in-house card processing**

  This is an environment for principal members of international payment associations that offers a full range of the SmartVista Suite functionality, from traditional transaction switching and card management to pervasive customer access to their card accounts.

- **Switch**

  This configuration is for customers that would like to take full advantage of SmartVista Front-End to enhance their online real-time processing power while retaining their existing back-office card management environment.

- **Third-Party processor/member service provider (TPP/MSP)**

  As more and more banks outsource their processing environments to third parties, the SmartVista multi-institution capability makes it an ideal match for organizations that are providing TPP/MSP services to smaller banks that act as affiliate licensees or sponsored members of a payment scheme.

- **Agent organization**

  Also a full-function configuration, the SmartVista-based agent solution provides everything an associate/affiliate payment scheme member, independent selling organization (ISO), or a member's regional branch might need.

- **National payment network**

  SmartVista can be used as a technology foundation for a national or international payment network. It supports all functions featuring such payment processing system, including clearing and inter-bank settlement, message switching, routing and interfacing with member banks equipped with their own processing centers.

- **Merchant processor**

  A merchant acquiring network can be more effective if it is run as a core business. SmartVista offers the online functionality, terminal control and management features, and multi-institution capability that merchant processors require.

- **Payment gateway**

  SmartVista processing capabilities can be extended to a fully online environment where organizations acquire card payments over the Internet or GSM networks. This SmartVista solution works as a bridge between cardholders, issuing and acquiring banks and service providers to enable secure electronic payment processing.

3.3 Strengths of SmartVista solutions

SmartVista benefits include:

- Always the right size through modular design
- Freedom of integration through open standards and interfaces
- Flexibility through parameterization
- Scalability and availability through parallelization and distributed processing capabilities

SmartVista customers can always be sure that they can easily expand or extend their solution as the need arises by adding new functionality and increasing throughput capacity.

The SmartVista architecture can run multiple instances of computing and communication processes simultaneously for optimal load-balancing and maximum throughput. SmartVista fully utilizes the high availability and fault-tolerance options that are offered by the underlying operating systems, databases and certified hardware platforms.

SmartVista has been built and designed with the future in perspective. BPC continues to invest in product development and testing to expand functionality, extend the platform range, and achieve new performance benchmarks. In addition to the BPC research and development resources, BPC sponsors the software development laboratory at the Moscow Engineering Physics Institute, which is one of the leading technical universities in Russia, and also conducts joint activities with major platform partners.

It is the objective of BPC to provide customers with every opportunity to take full advantage of the excellent design of SmartVista, so the company has taken efforts to make sure that the services provided with and for SmartVista are on par with the quality of the product. BPC runs its projects based on PMI methodology in full compliance with ISO 9001:2000 quality standard, as attested by a certificate from SGS International Certification Services (SGS ICS). After the solution is installed, customers receive service-level-agreement (SLA)-based support, with 24x7 Help Desk, online service request entry and tracking facilities, remote access or onsite support, and dedicated support officers.

3.4 SmartVista operations

This section describes the way the SmartVista card processing solution operates (Figure 3-1) in simplified terms. The example refers to a bank that acts both as an issuer and acquirer.

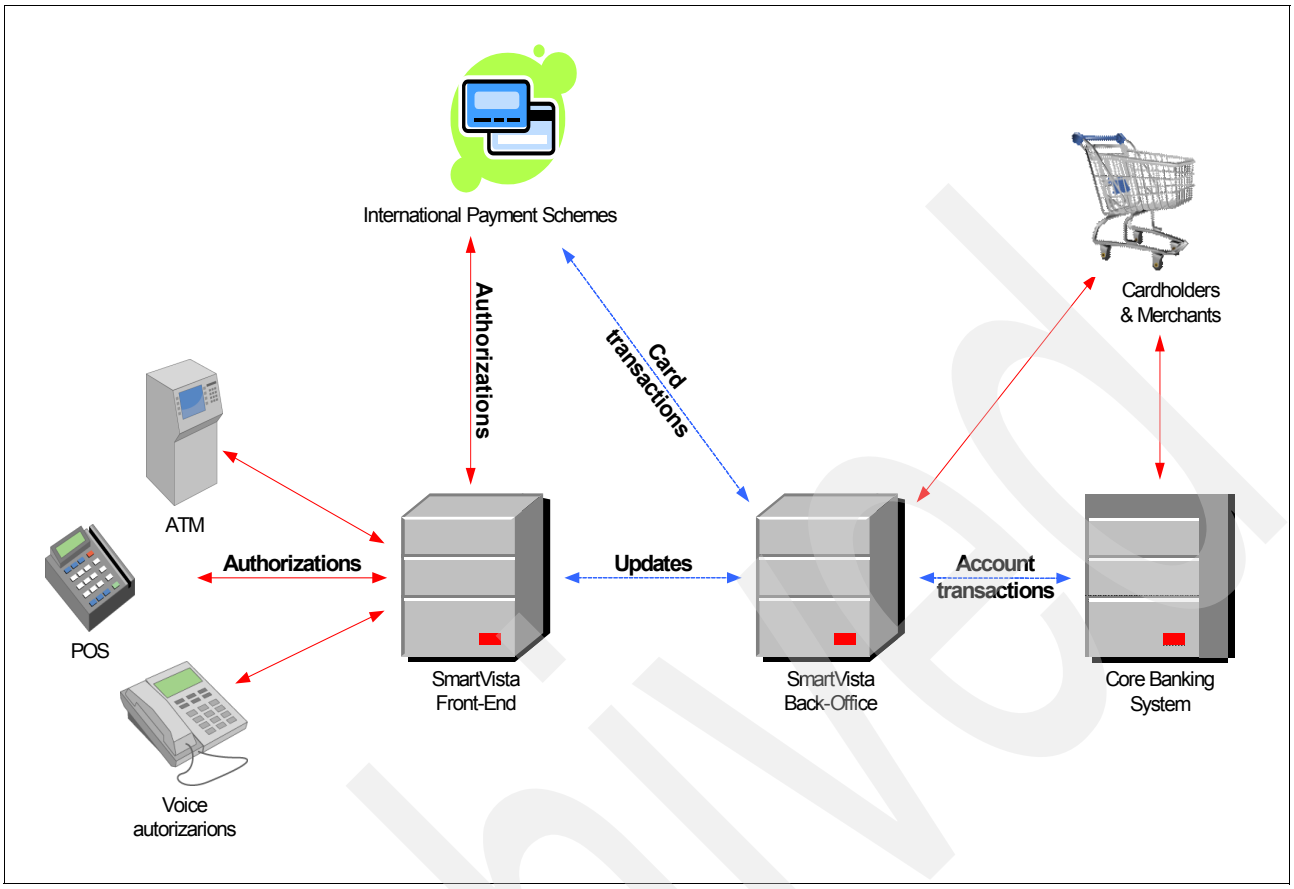

Figure 3-1 Operation flow of the SmartVista card processing solution

Like any card processing solution, SmartVista operates in an environment where it exchanges information with other systems, networks, devices, and people to ensure that card holders can use this instrument to pay for their purchases, and merchants can receive payment for the goods and services that they sell to the cardholders. The main categories of external participants in this interchange are:

- The core banking system of the bank that maintains all information about business with the customer, processes transactions that are not related to plastic cards, and performs consolidated account maintenance and settlement functions.
- Local or international payments organizations, or card schemes, such as Visa, MasterCard, and American Express, that facilitate the clearing of card payments.
- Merchant POIs, which include merchant electronic POS (EPOS) terminals, off-line voice authorization points for manual transactions, and Web-based Internet service points
- Bank POIs, which include Internet banking interfaces, and attended over-the-counter service points where cardholders can make cash withdrawals and other transactions
- Cardholders, which are the individuals entitled to use properly issued cards as a payment instrument, whether their cards have been issued by this bank or by any other member of the card schemes

Some of these interactions are performed in real time, such as authorization requests and responses, and others are performed using a regular, typically daily, exchange of files that are composed of messages in agreed-upon formats. This has determined the logical split of SmartVista. As we mentioned in 3.1.1, “SmartVista Front-End” on page 9), SmartVista Front-End is the system that deals primarily with the online realtime interactions. SmartVista

Back-Office is responsible for batch interchanges with both card schemes and the banking system and for the long-term maintenance of customer information related to their cards and card transactions (see 3.1.2, “SmartVista Back-Office” on page 9). This also means that SmartVista Front-End deals first and foremost with authorizations and all financial messages are the responsibility of SmartVista Back-Office. The only exceptions are Single Message System (SMS) transactions that are processed online without prior authorization. For these purposes, the SmartVista Front-End has some exception processing features built in to support the SMS clearing cycle.

The main interfaces required for the SmartVista card processing solution are:

- Online network interface (between SmartVista Front-End and the card scheme network)
- Device interfaces (online, between SmartVista Front-End and various POI devices)
- Host interface (online, between SmartVista Front-End and the host processor, if any)
- SmartVista Front-End and SmartVista Back-Office interface (off-line)
- Off-line network interface (between SmartVista Back-Office and the card scheme network, usually through a card network terminal)
- Banking system interface (off-line, between SmartVista Back-Office and the core banking system)

Another important principle that was taken into account during the design of the SmartVista solution involves keeping information under control. Therefore, SmartVista provides secure and auditable procedures for entering new data or changing the existing information. Different approaches are used for different types of data as follows:

- The most sensitive static customer information, such as new customers, cards or accounts, can only be entered in the form of an electronic document called customer application. It must pass a validation and approval process before the actual customer entries are added to the database.
- Authorized users with proper access control collect and update other types of static information that relate to the processing environment and product definitions using the SmartVista Graphical User Interface (GUI).
- Changes to the existing customer-related data that is required in a processing or customer service situation, such as card or account status change and address change, can be made dynamically. SmartVista GUI includes forms that authorized users can use to make such changes from their workstations, with an auditable transaction-style mechanism that applies these changes throughout the system.

3.4.1 Issuer processing

When the bank acts as an issuer, it provides payment services to its issuer card scheme customers, such as the people and organizations that hold cards issued by this bank. Figure 3-2 illustrates this process.

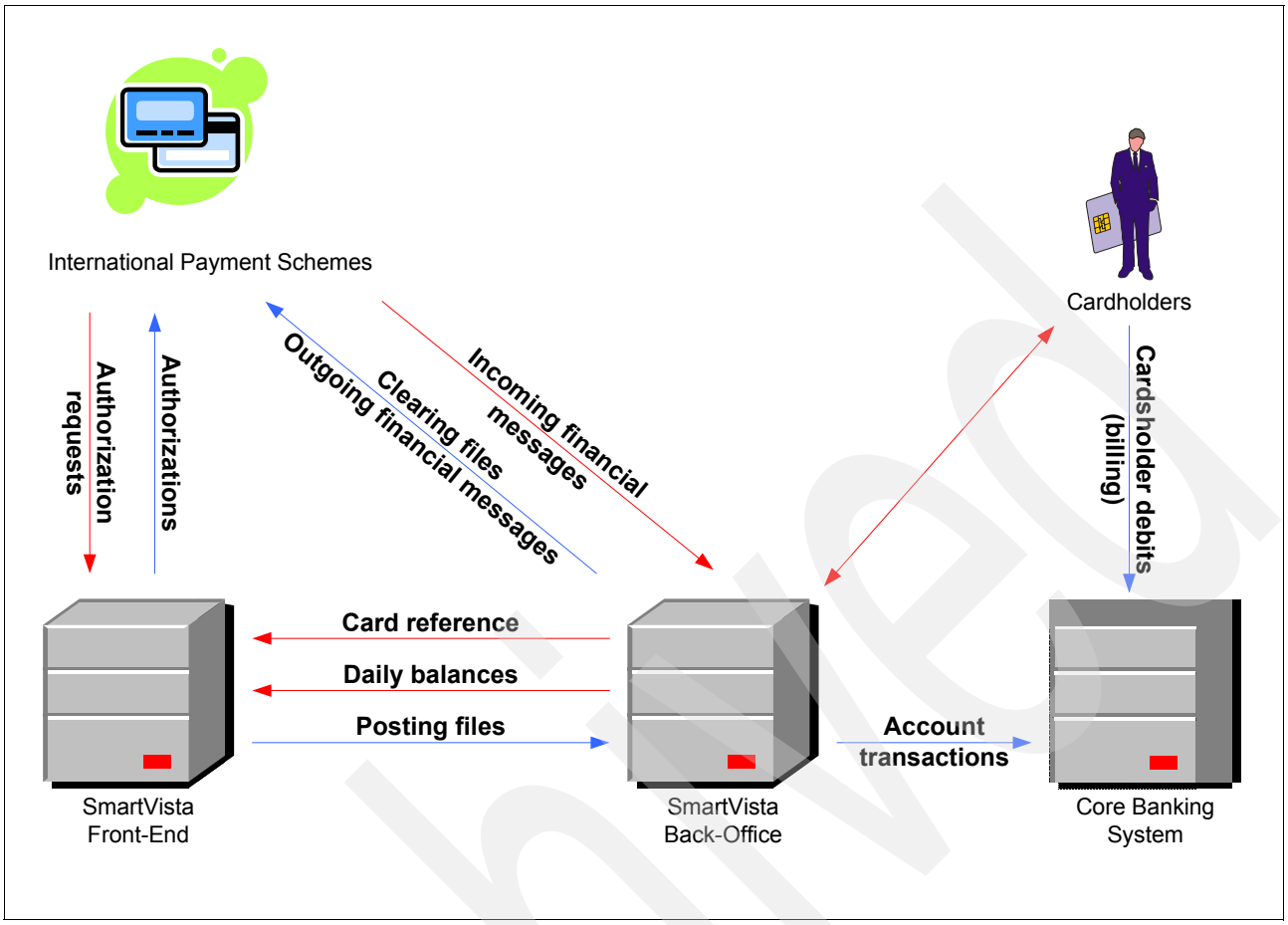

Figure 3-2 Operation flow of issuer processing

Customers can use their cards to pay for a product or service or to withdraw cash at any device or service point connected to any of the card scheme member banks acting as acquirers. First, an authorization request is sent from the service point and passed on by the acquirer through the card scheme to the cardholder issuer. This authorization checks the ability of the cardholder to pay and holds the required amount on their account with the issuer until the final settlement occurs. The authorization request is followed by a presentment, which is a financial message that urges the issuer to transfer the requested amount.

The only types of transactions that do not require authorization are:

- Those where the amount is below the floor limit (in this case, the issuer agrees to guarantee the payment in any event), including manual transactions (entered off-line by taking a card imprint and getting the cardholder to sign a slip, or voucher)
- Single Message System (SMS) transactions (where the authorization request is treated as a financial message)

SmartVista Front-End is continuously available for authorization processing. It receives authorization requests from the card schemes through the online network interface, and, if it is in stand-in authorization mode, checks the requested amount with the available balance on the card account that it holds in its database. If the balance allows, the authorization is granted, the amount is subtracted from the available balance, and an authorization message is generated for the posting file.

When it is in online (or host) authorization mode, SmartVista Front-End routes the request to the system that is responsible for online authorization processing, known as a host processor. SmartVista Front-End must receive a response before the authorization can take place. This might be a function of the core banking system to make sure that authorizations are always based on up-to-the-minute information about cardholder account balances. The o-line interface used for this type of communication is called the host interface.

Typically once a day (although it can be done more frequently), SmartVista Front-End uses the Front-End/Back-Office interface to send the posting file to SmartVista Back-Office, so that, later, the authorizations can be matched with the corresponding financial messages that will follow. The posting file also contains all financial and non-financial messages resulting from these authorizations.

To complete the two-way synchronization over the Front-End/ Back-Office Interface, two other types of batch files are regularly sent in the opposite direction: from SmartVista Back-Office to SmartVista Front-End: the daily balance file that updates the available balances and the card reference file that adds any changes to customer, card, and account information. Because SmartVista Front-End holds all information in its real-time relational database, these updates do not interrupt routine authorization processing; they populate the relevant database fields while they are not used for transaction processing.

For SmartVista Back-Office, all communication with other systems, from card schemes to the banking system, happens through file exchange, with the exception of its users, such as operators, account officers, dispute officers, and administrators. Any changes that they enter in the SmartVista GUI apply immediately but do not go beyond the Back-Office database.

As part of the daily interchange with card schemes through the off-line network interface, SmartVista Back-Office receives incoming clearing files that contain presentments and other financial messages that are allowed in the clearing cycle. These messages are matched with the authorizations received from SmartVista Front-End. If no problems arise, the transactions are written off to customer accounts and the relevant postings are generated and sent to the banking system as part of the outgoing banking system interface file.

If some of the incoming presentments are not acknowledged by the cardholder or cannot be validated against the issuer database, a dispute resolution process is started that follows the rules set out by the card scheme. It involves an exchange of financial and non-financial dispute messages, such as charge backs, retrieval requests, reversals, and so forth. SmartVista Back-Office simplifies the dispute officer work by keeping track of all the disputes and by providing maximum message automation. The dispute messages are transmitted to the card scheme as part of outgoing clearing files. After the dispute is resolved either to the advantage of the bank and customer or at a loss to either, the dispute amount is written off to either the customer account or the bank profit and loss column, and the resulting postings are sent through the outgoing banking system interface.

Any updates to customer account balances that originate outside the SmartVista, such as a deposit or withdrawal that the customer made in a branch without using their card or a payment order that arrived by Society for Worldwide Interbank Financial Telecommunication (SWIFT), are communicated to SmartVista Back-Office as entries in the incoming banking system interface file.

The off-line network interface is also used to receive other types of information from the card schemes, such as updated country and currency codes, BIN tables, hot card lists, and so forth. It also sends back all kinds of mandatory reports.

3.4.2 Acquirer processing

When a bank acts as an acquirer, it provides its acquirer customers, such as merchants and its own retail branches, with a facility to accept plastic cards at their POIs (Figure 3-3). The bank must to set up its own internal merchant structure to include its retail branches and POI's, such as teller desks and ATMs.

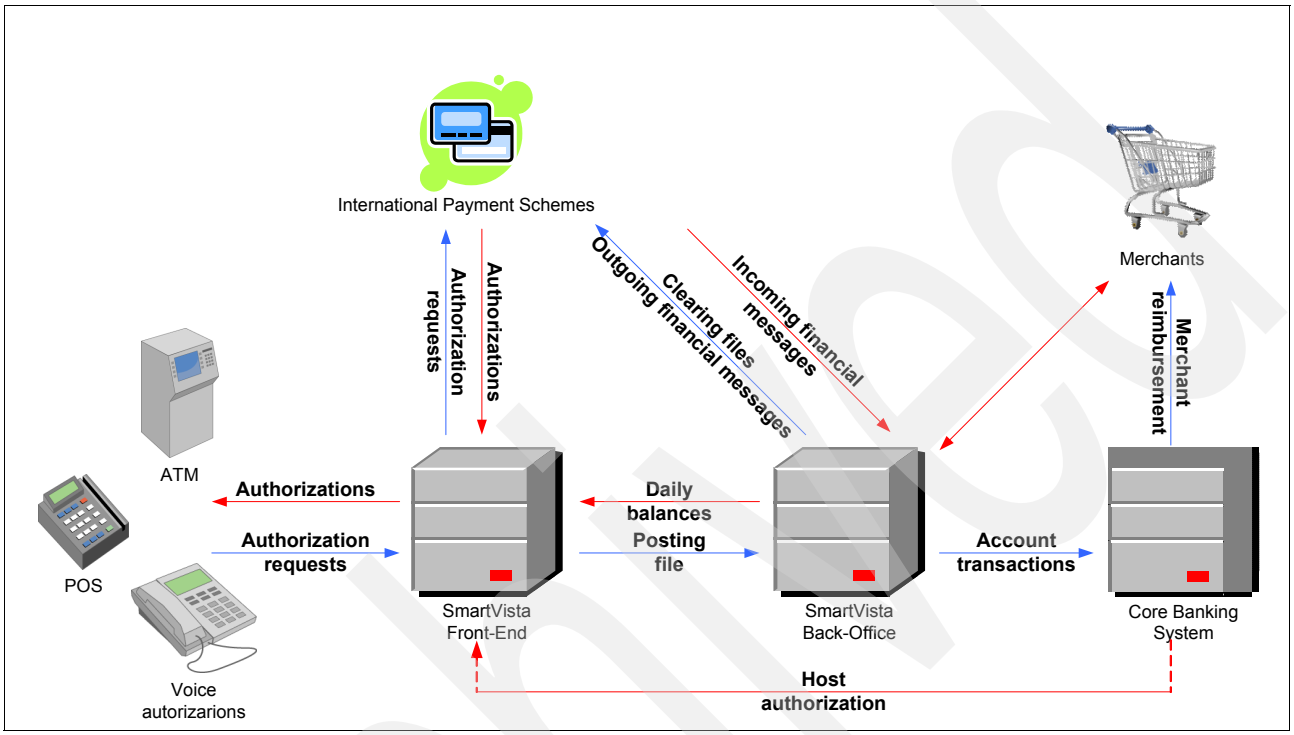

Figure 3-3 Operation flow of acquirer processing

When it is operating in the acquirer mode, SmartVista Front-End continuously receives authorization requests directly from the POIs, executes PIN verification where required, passes the authorization requests on to card schemes, receives issuer authorization messages from the card schemes, and forwards them to the POI. It also provides facilities for online remote control of ATM and POS devices, including fault and status monitoring. All processed transactions are included in the posting file and sent to SmartVista Back-Office.

Based on the authorizations received, SmartVista Back-Office generates presentments and passes them to the card scheme as part of the outgoing clearing file and calculates the Merchant Service Charge (MSC).

Otherwise, the information exchange between the SmartVista components and external systems is similar to the one described in 3.4.1, “Issuer processing” on page 13, except that now the transaction flow runs in the opposite direction.

For final settlement with the merchant based on their merchant agreement, the relevant postings are generated and sent through the outgoing banking system interface either upon receipt of funds from the cardholder's issuer, or within a specified period of time after the authorization, depending on the rules of the merchant contract.

3.4.3 Us-on-us processing

When the same bank acts as both the issuer and acquirer, issuer bank customers can pay at the issuer merchant customer POIs. This situation is referred to as us-on-us ("our cards used on our devices"), as opposed to us-on-them ("our cards used on other bank's devices") and them-on-us ("other bank's cards used on our devices"). This means that the bank can close the clearing cycle without exchanging any messages with the payment scheme network.

SmartVista is fully equipped for complete us-on-us processing, where authorization and financial messages go straight from the acquirer to the issuer side of the solution. All other messages between the bank and the card scheme are sent and received through the off-line network interface in the usual way. Obviously, this processing method first must be approved by the card scheme that will clear the transactions, unless SmartVista is used as a processing center solution for a private or local card scheme.

4

SmartVista i: SmartVista on the IBM System i Platform

In November 2006, BPC announced that it had joined its efforts with IBM and Lakeview Technology (now Vision Solutions), the information availability company, to port the BPC SmartVista card processing system to the IBM System i platform. As the result of extensive development and testing, BPC can now offer financial institutions around the globe a complete retail banking solution with superior reliability. This solution is SmartVista i.

4.1 SmartVista i processing solution

In the beginning of 2006, IBM and BPC began developing a brand new processing solution based on the System i software and hardware platform and SmartVista Front-End. This innovative and fully integrated solution for payment cards processing and electronic payments, called SmartVista i, has combined the proven ideology of the SmartVista Front-End card processing system with the architectural advantages of System i server technology, ensuring fault-tolerance and high-performance capacity. SmartVista i started as a project for developing the first Russian secure payment infrastructure based on the Secure Electronic Transaction (SET) standard. SmartVista i meets the growing demand for reliable and high performance solutions that support all modern payment technologies and delivery channels, ensuring 24x7x365 customer service.

4.1.1 SmartVista technical and physical architecture on System i

IBM System i servers have proved to be reliable, high-performance, cost-effective systems that are safe from hackers and viruses. The System i hardware platform ensures performance and reliability, creating an environment for the deployment of various business applications from basic financial applications and payment systems to internet banking. In its turn, the IBM i5/OS® operating system provides the environment for integrating the information resources of banks and non-financial organizations, which helps reduce the total cost of ownership (TCO) of IT resources and helps increase their efficiency and fault-tolerance.

The System i software/hardware platform is based on open standards so that banks and financial institutions can use their existing system resources instead of buying a new server for each application. The platform concurrently supports applications running on i5/OS, Microsoft Windows, Linux, and IBM AIX 5L environments. System i integrates the DB2® database management system, security and performance features, LAN and Internet connectivity, backup and restore functionality, report generation, and file and print management functions. DBMS integration in the operating system results in high performance, reliability, and management simplicity.

The System i platform is the environment for bank information resources integration, which can help reduce the number of servers and consequently the staff that supports the bank IT infrastructure. When integrated with the SmartVista processing system, System i fully displays its advantages as a reliable, robust platform that can run a software application that supports large volumes of payment card transactions, and to ensure its continuous availability.

BPC and IBM involved Vision Solutions to ensure the fault-tolerance of the new solution. Vision Solutions, Inc. provides high availability, disaster recovery and data management solutions for the System i and System p™ markets. Vision products also help ensure business continuity, increase productivity, reduce operating costs, and satisfy compliance requirements. The Vision Solutions approach to building a reliable and secure enterprise-wide solution was selected because it can eliminate both planned and unplanned downtime for greater productivity and continuous availability. Its advantages are:

- Interoperability with various operational systems and databases
- Model-based setup and configuration for information capture, replication, and transformation information
- The sharing of information whenever and wherever it is needed
- The flexibility to work with any complex IT system topology
- The protection of IT systems, applications and databases from any damages in real time

These solutions work with all iSeries communication protocols, support replication (including keyed one) and switching topology, and handle the most demanding environments, including clustering, iASP, cross-site mirroring, and two or three-tier applications.

4.1.2 SmartVista porting to System i

The project for porting SmartVista to the System i native environment involved full adaptation of the SmartVista Front-End processing system to the System i platform, using the i5/OS operating system and the integrated DB2 database management system. It included server process reengineering and porting the database structure, objects, and configuration data into the System i environment. SmartVista i development also involved reengineering the user interface in compliance with the three-layer thin-client architecture, using IBM WebSphere as an application server.

SmartVista i was also integrated with MIMIX HA1 software from Vision Solutions; basic configuration included a two-node active-active replication mode.

The porting team used the Qshell extension and ILE environment for adapting our compiling and building techniques to the i5/OS environment.

During the porting process, we learned that:

- When you work with shared memory segments, you can use TERASPACE(*YES) compiler option.
- Use the CRTSQLCI compiler command to make C-source with Embedded SQL statements.
- Instead of using archive libraries (*.a) you can use CRTBNDDIR compiler command to create a binding of different object; it can be equivalent to creating archives.

SmartVista uses Embedded SQL statements in its source code because the only change required is the managing mechanism for database sessions. Additionally, Embedded SQL is believed to be the fastest way to access the database from the binary file that originates from the C language. Using short table names is recommended when accessing the database directly because using long ones resulted in performance degradation during testing.

For OLTP systems such as SmartVista that deal with multiple device connections, you must make sure that the system is capable of creating enough socket listeners to accept incoming connections. The porting team changed this value from default to what was required.

Because there is no **`fork()`** function implemented in i5/OS, you must use other techniques to create and control child processes even if it means designing and implementing them from scratch. For this purpose, the porting team used a single control process that can bear and control its child processes through a dedicated shared memory segment.

4.2 How the System i platform addresses the demands for highly available processing

The principal reasons for selecting a hardware platform for a processing solution are based on the requirements for high availability, security, manageability and scalability that is imposed by the retail banking business. The SmartVista i solution meets the requirements of banks and processors of any size and complexity with fast response times, reliable data protection, high levels of data integrity, and hot recovery from any failure.

4.2.1 An effective approach to building the banking solutions

System i can run multiple operating systems and application environments simultaneously. It offers a broad choice of available applications and few restrictions when consolidating a diverse network. System i supports applications running on i5/OS, Microsoft® Windows (via Integrated xSeries® Adapter or Integrated xSeries Server), Linux, IBM AIX 5L, Java™, WebSphere, WebSphere Portal, and Lotus® Domino® environments all at the same time and all on one highly reliable system. This approach is simpler to manage and more cost effective than creating a network of individual servers to provide the same capability. Banks can adopt a design strategy for running their core banking solutions on i5/OS, for example, and then run other solutions, called point solutions, on the operating system that the solution requires, while tightly integrating it with the core solution.

The other advantage of System i is that it is possible to build point solutions that focus on very specific target groups. Many point solutions (for example, payment systems) are also available for System i that, because of its design, can integrate tightly with the core banking solution. These solutions optimize the payments process infrastructure, such as checks, bank cards, and wholesale payments and can help reduce costs, eliminate redundancies, protect against fraud, and satisfy regulatory requirements.

4.2.2 Availability

Continuous availability goes beyond hardware fault tolerance; it is achieved by a combination of hardware, application code, and good system management practices.

On a server basis, System i can maintain very high availability because of the fault-tolerance features built into server hardware as follows:

- On the power subsystem level, the fault tolerance is provided by the redundancy of all power system basic units such as power supplies, cooling fans, and line cords. Therefore, power can be supplied from more than one source, with one source acting as a backup in the event of a disruption to the alternate power source.
- On the disk subsystem level, the fault tolerance is based on the device data protection and concurrent maintenance of the RAID-5 system.
- On the I/O subsystem level, hot pluggable PCI cards, dynamic hardware resource reallocation redundant HSL loops, and intelligent I/O processors reset contribute to avoiding the system outage.
- On the system memory level, the Chipkill technology provides the means for the system to remain active should a part of the main storage fail.
- On the hardware service level, System i uses hardware failure notifications to reduce the time that is required to detect failure detection and handle faults.
- On the IT infrastructure level, with the System i architecture, you can use different approaches to provide high-availability solutions, increase the Recovery Time Objective (RTO) and Recovery Point Objective (RPO) factors, and reduce the planned downtime.

The basic level of data integrity and fault tolerance can be provided by applying the following strategies based on the System i advanced techniques for single-server solutions:

- Performing periodic data backups according to a backup schedule that is based on the estimates of documented SLAs between business units & IT
- Using off-site data storage to ensure the safety of data backup copies
- Optimizing RAID-5 with the flexibility to exploit built-in system-level i5/OS mirroring for parallel reads/writes, and journaling.

The advanced multi-server solution join multiple dedicated servers in load balanced or clustered configurations, facilitating the system expansion and providing very high levels of system availability. The available solutions are based on storage area network (SAN) disk copy services, switched IASP clusters with managed backup and recovery, the logical replication cluster, or combinations of these techniques.

The tight integration of the database with the operating system prevents additional system weaknesses, and increases the overall system availability.

4.2.3 Clustering

Clustering techniques focus on keeping critical business applications and data up and running during a server failure or shutdown. It eliminates both unexpected IT outages and the planned downtime required for routine system maintenance. Using the high availability clustering solutions that are enforced by advanced replication and "true" continuous data protection (CDP) capabilities, you can maintain an extremely high degree of data integrity and apply hot fixes to accidental data corruption. The solutions available from the clustering software providers ensure an easy, automated way to provide the highest degree of reliability to the databases and applications.

For SmartVista i, the clustering solutions ensure the fault tolerance of databases and applications and high system performance under a heavy load.

With the advanced System i and MIMIX data replication features, which are data groups, switching, and journaling, it is possible to use the most effective data replication and clustering techniques for SmartVista i.

The integration of MIMIX data replication and clustering techniques with SmartVista i provide additional advantages. They make full use of the IBM advanced journaling technology to protect the data and objects with a very high level of efficiency so that the best solutions can be implemented in a variety of IT environments, including cross-platforms, complex data structures and data transformations, and high performance requirements. It easily scales the replication process so the backup server stays current even during peak processing, and provides technology to maintain the integrity of remote journaling data transport functions and solve failed communication issues.

4.2.4 Security

SmartVista is based on a solid yet flexible security model that covers every aspect of information security from data encryption in the network communications to front-end pervasive role-based user access control that can be configured down to individual user and individual customer record. Porting SmartVista to the System i platform facilitated further security enhancements based on the IBM approaches to the support of overall IT system security strategy. For example, from its inception, System i architecture has been object-based. The stringent rules for interaction between objects prevent one object from posing as another to acquire unauthorized access. The computer security industry has identified fewer threats to IBM i5/OS than to Windows or UNIX® operating systems.

IBM System i security enhancements include:

- Hardware storage protection to help prevent unauthorized programs from accessing system objects
- Intrusion detection to help automate the monitoring of intrusion events, such as scanning for open TCP/IP ports

- New auditing features to strengthen the access control
- Additional encryption capabilities to help safeguard and ensure the integrity of critical data

4.2.5 Manageability

Easy system maintenance and the availability of reliable, easy-to-use, and handy system management tools are important requirements for the complex solutions where defects and errors are very costly. SmartVista i includes the management scripts for a system administrator that is experienced in UNIX systems management and a user interface based on the IBM WebSphere three-tier architecture.

System i provides advanced manageability tools, including fault detection, automatic switching to backups where available (Chipkill memory, ECC cache, CP, Service Processor, system bus, Multipath I/O), plug and play and hot swap I/O, capacity upgrade on demand, and many others. The system management solutions that are available from IBM (IBM Tivoli®) can be also used to make the system management more effective.

4.3 SmartVista i features and functions

This section highlights the features and functions of SmartVista i.

4.3.1 Core issuing

As a solid foundation for value-added and forward-looking services and features, SmartVista i offers a comprehensive set of core card issuing functionality that covers the business needs of traditional issuers, from online authorization to transaction filtering.

SmartVista i performs online pre-authorization, authorization, and Single Message Settlement (SMS) functions against its own database, where information about cards, accounts, transactions, limits, fees, rates, and so forth is maintained in real time between batch synchronization sessions with SmartVista Back-Office or other similar systems.

SmartVista Back-Office covers all off-line functions, such as card, account, customer and product management functions and the processing of clearing and settlement messages for cardholders' transactions, including their reconciliation with authorization records, statement production and report generation.

Customer origination functions, including the capture and processing of customer applications for new cards, accounts and products, or for any changes in the current service, are provided by SmartVista Back-Office.

SmartVista i performs all online functions for non-stop processing of transactions that are initiated by the holders of cards issued by the financial institution that is running SmartVista.

Host versus stand-in authorization modes

SmartVista i supports two authorization modes:

- Host authorization (by an external host system using the SmartVista On-Line Host Interface)
- Stand-in authorization (standalone, using SmartVista i database)

The authorization mode is set by card BIN, which is checked for every transaction requested.

Positive version negative authorization methods

In stand-in mode, SmartVista i supports two groups of authorization methods:

- Positive authorization (whether the account balance, card/account limits, or both allow the transaction)
- Negative authorization (whether the card is stop listed and if the transaction number and cash withdrawal transaction limits are not exceeded).

The authorization methods are identified individually for all BINs that are used to issue cards.

Transaction filtering

SmartVista i offers a transaction filtering capability for the automatic rejection of authorization requests matching a certain combination of predefined criteria.

In an issuer-side processing situation, filters can be set for card scheme, transaction type, merchant country code, acquiring bank ID, terminal type, point of sale name, and maximum transaction amount.

Online card/account management

To ensure non-stop transaction processing, SmartVista i relies on its online database, which is optimized for maximum throughput and performance. The SmartVista i database holds information about all SmartVista customers, cards, and accounts with the same many-to-many relationships as those in the SmartVista Back-Office or other back-office system databases, including the latest data synchronization and any changes made in the front-end system before they are synchronized back to the back office.

To ensure accurate and flexible online card/account processing, SmartVista i supports several balances and amounts for each card and account, such as ledger balance, available balance, and held amount, so that customers can fully utilize the purchasing power of their cards without overusing them.

Online fees

SmartVista i can hold the rules for charging transaction processing fees during the clearing and settlement phase. Based on these rules, these projected fees are included in the authorization amounts for more accurate funds availability control.

SmartVista i supports more than 12 interest and fee accrual algorithms with user-defined fee structures (flat, percentage, tiered percentage, threshold percentage, minimum or maximum to pay, or any meaningful combination thereof). Transaction fees can be defined based on card scheme, transaction type, acquiring financial institution ID, acquirer country code, acceptance device type, transaction amount, transaction currency, clearing currency, transaction conditions (such as PIN verified, PIN non-verified, EMV, and card-not-presents), and other parameters.

4.3.2 Core acquiring

SmartVista offers a comprehensive set of core online and off-line card acquisition and terminal/merchant management functionality, from ATM switching to financial clearing with international payment associations, merchant management and report generation. Online functions are performed by SmartVista i, which has direct ATM and Terminal (POS, voice, e-commerce and Internet banking) for online transaction processing and terminal management, including centralized ATM monitoring and ATM scenario management. SmartVista i is also responsible for batch functions that are related to ATM and merchant management, such as end-of-day processing and reporting.

The security of interactions with online systems and devices is assured by the use of third-party hardware security modules; however, no additional software is required to control them. SmartVista i includes all the features that are required for PIN translation and encryption key management.

Offline and batch functions, such as merchant management, clearing and settlement with card schemes, exchange of posting files with a banking system and report generation, are provided by SmartVista Back-Office or other back office systems.

SmartVista i and SmartVista Back-Office are fully integrated in terms of merchant and terminal management, so that all administrative activities (for example, adding a merchant or changing its entity structure, limits or attributes) can be performed centrally and then synchronized to the SmartVista i system over the front-end interface. After synchronization, SmartVista i has all static data required for processing, including all terminal details and attributes, such as protocol and communication data. This ensures the smooth operation of the SmartVista solution as a single system.

Merchant/terminal control and management can also be done from SmartVista i administration forms if the customer business case does not warrant the installation of a full-fledged SmartVista solution or in the event of emergency.

SmartVista i performs all the online functions that are required for non-stop processing of transactions that are acquired by a financial institution running SmartVista from its own ATM network, from a merchant POS terminal, or from an e-commerce or Internet banking Web site.

Authorization switching

SmartVista i communication and transaction routing subsystems receive authorization requests from all supported terminals and delivery channels, and, after front-end processing and filtering, send them to the required card scheme network, or, in the case of on-us transactions, to the issuer-side front-end authorization system. After receiving the authorization response, they send it back to the terminal so that the transaction can be completed or rejected, receive the completion confirmation from the terminal, and pass it to the issuer. This process involves multiple protocol conversion to make sure that transaction details, including the encrypted PIN block, are exchanged correctly all the way between the terminal and the issuer.

Transaction filtering

SmartVista i offers a transaction filtering capability, so that authorization requests matching a certain combination of predefined criteria, can be automatically rejected, even before being passed to the issuer.

In an acquirer-side processing situation, filters can be set for terminal activity limits (number of transactions, daily turnover, maximum transaction amount) and security details checked (CVV, PIN entry, full track 2, e-commerce details).

ATM support

SmartVista i ATM support consists of full-function communication with most of the ATMs in the market today for transaction acquiring, monitoring, control and management. The entire ATM network can operate smoothly and efficiently, minimizing the need for in-field service. The system has tools to build and distribute ATM scenarios so that the acquirer can use its ATMs to offer whatever services and transaction types its business requires and to deliver any branding or marketing message it needs.

ATM interface

The SmartVista i component that is directly responsible for communication with ATMs is the ATM Interface. It provides connectivity to the devices using a broad variety of protocols and analyzes and forwards all messages that are received from ATMs.

ATM transaction acquiring

SmartVista i supports most ATM application protocols. These include NDC+, Diebold 912/DDC, and generic ISO 8583.

ATM monitoring

SmartVista i keeps full track of events, warnings, and alarms generated by the ATM devices in the network and stores them in the database. Operators can then monitor the device status using the SmartVista i User Interface online forms.

ATM counter synchronization

SmartVista i maintains values of ATM counters based on transactions logged for each ATM. Whenever an event is detected that might affect the consistency between the ATM counter readings and the corresponding values in the SmartVista database, a software process is triggered to interrogate the ATM and synchronize the counters. As a result, SmartVista database has accurate and up-to-date information about the dispenser status and the amount of cash in the cassettes.

ATM control and management

The SmartVista i user interface provides online forms that operators can use to control and manage the ATM network remotely by issuing commands. ATMs can be assigned to logical groups so that they can be controlled and managed with a single command.

SmartVista supports a special class of maintenance transactions that can be initiated locally by field support to reflect such activities as bank note and printer tape loading. These PIN-based transactions can only be initiated with the help of a special supervisor plastic card that restricts its use to a predefined group of ATMs.

POS support

SmartVista i offers complete functionality to acquire transactions generated at POS terminals installed at merchant locations, to provide voice authorization of slip-based transactions from the acquirer call center, and to manage the POS network.

POS interface

The SmartVista i component directly responsible for the interaction with POS terminals and the processing of POS transactions is the POS Interface. Both direct and dial-in connection methods are allowed.

Using the Trickle Feed option, POS devices can authorize a transaction off-line when the transaction amount is below floor limit, accumulate such authorization messages, and send them to the host during the next communication session or in between current online messages.

POS transaction acquiring

SmartVista i supports all of the most common POS application protocols, including Visa I/II (J and K) and ISO 8583.

POS terminal configurations are stored in the SmartVista i database and include all the details that are required to identify the merchant, merchant outlet and terminal to SmartVista and the Card Networks and to specify the current business day, currency, and so forth.

POS management

The SmartVista user interface provides online forms for managing and controlling actions on the POS terminals. POS terminals can be made part of Communication Groups for group management.

Voice authorization

SmartVista offers an interface to the acquirer's call center so that merchant transactions can be authorized by phone in strict compliance with card association rules and policies.

EPOS support

All SmartVista i application functions for POS devices are also supported for online delivery channels, such as EPOS, e-commerce systems, Internet shopping interfaces, and so forth. The difference lies in message formatting and security mechanisms, which are separated from the physical communication interfaces. SmartVista i includes e-POS interfaces that are based on SSL, SET and proprietary security methods.

PIN verification and key management

To ensure secure PIN translation and message authentication between SmartVista i and terminal devices, such as POS and ATMs, SmartVista relies on Hardware Security Modules (HSM).

Online merchant management

To ensure non-stop transaction processing, SmartVista i relies on its online database, which is optimized for maximum throughput and performance. The SmartVista i database holds information about all merchants, terminals, and accounts, with the same five-tier merchant hierarchy as in the SmartVista Back-Office database, as of the latest data synchronization plus any changes made in the SmartVista Front-End system before they are synchronized back to SmartVista Back-Office. This also applies to all the information about merchant service charges, fees, limits, exchange rates and other items needed for online acquirer-side processing.

4.4 Achieving high availability on System i

Tight integration of System i with clustering software makes it possible to deliver a SmartVista i solution that is focused on system availability and high performance. The automatic failover provides availability. The advanced features of the clustering software make it possible to:

- Build flexible environments to fail over individual applications or an entire server
- Provide fast, simple switching between the production and recovery nodes to address planned downtime
- Comply with regulatory mandates and SLAs.

The planned downtime, which includes database reorganization, installing the software patches, hardware and software updates, and servers reboot, is the critical parameter for large IT systems; it can exceed the unplanned downtime several times. The high availability solutions are focused on cutting down the overall time needed for all the service, maintenance, and repair works.

One of the most effective solutions for ensuring business continuity and boosting the system productivity is MIMIX ha1 for i5/OS. MIMIX protects software systems, applications and databases in real time with minimal management. MIMIX high availability solutions are based on the MIMIX ha1 and cluster1 software, which offers a new and completely integrated

clustering solution for the availability of applications and data and centralized cluster management.

SmartVista uses MIMIX clustering software to build clusters that ensure the best possible recovery times in case of any critical failure or system crush. Typical configurations are based on two-node clusters where the nodes are switched when a critical error is detected on one of the nodes. The switching scheme depends on the cluster configuration.

For SmartVista, it is possible to choose active-passive, active-active, or disaster recovery (DR) configurations.

4.4.1 Active-passive SmartVista configuration

An active-passive configuration is a configuration with two server nodes with one node acting as a production serve and the other acting as the backup server, which takes over the function of the production in case of failover (Figure 4-1). The typical recovery scenarios switch the communications in the complex IT networks to the backup server, perform necessary data replication, and enable the critical applications running on the backup server when the cluster software detects a production server failure. For this, the continuous heartbeat monitoring is performed on the production server. Using the up-to-date replication techniques, you can switch the individual application or the entire server.

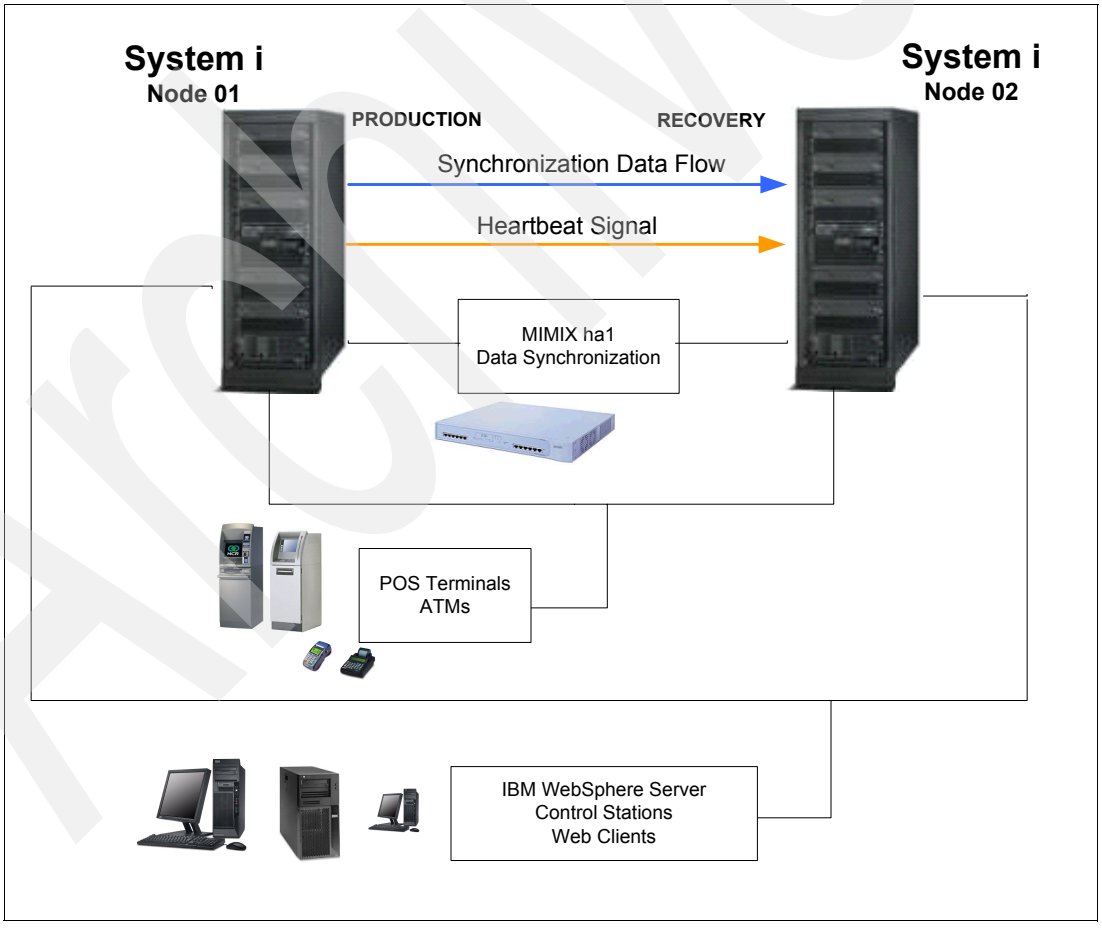

Figure 4-1 Example of active-passive SmartVista configuration

4.4.2 Active-active SmartVista configuration

Unlike many other clustered environments, a clustered SmartVista i server can have both servers in the cluster simultaneously active. This is called an active-active cluster configuration (Figure 4-2). In active-active configurations, the shared cluster resources, applications, and data are simultaneously available to all servers in the cluster. Consequently, active-active clusters support load balancing and high availability. If a server fails, the shared resources on that node failover to one of the remaining node servers and users can continue to access these resources without interruption.

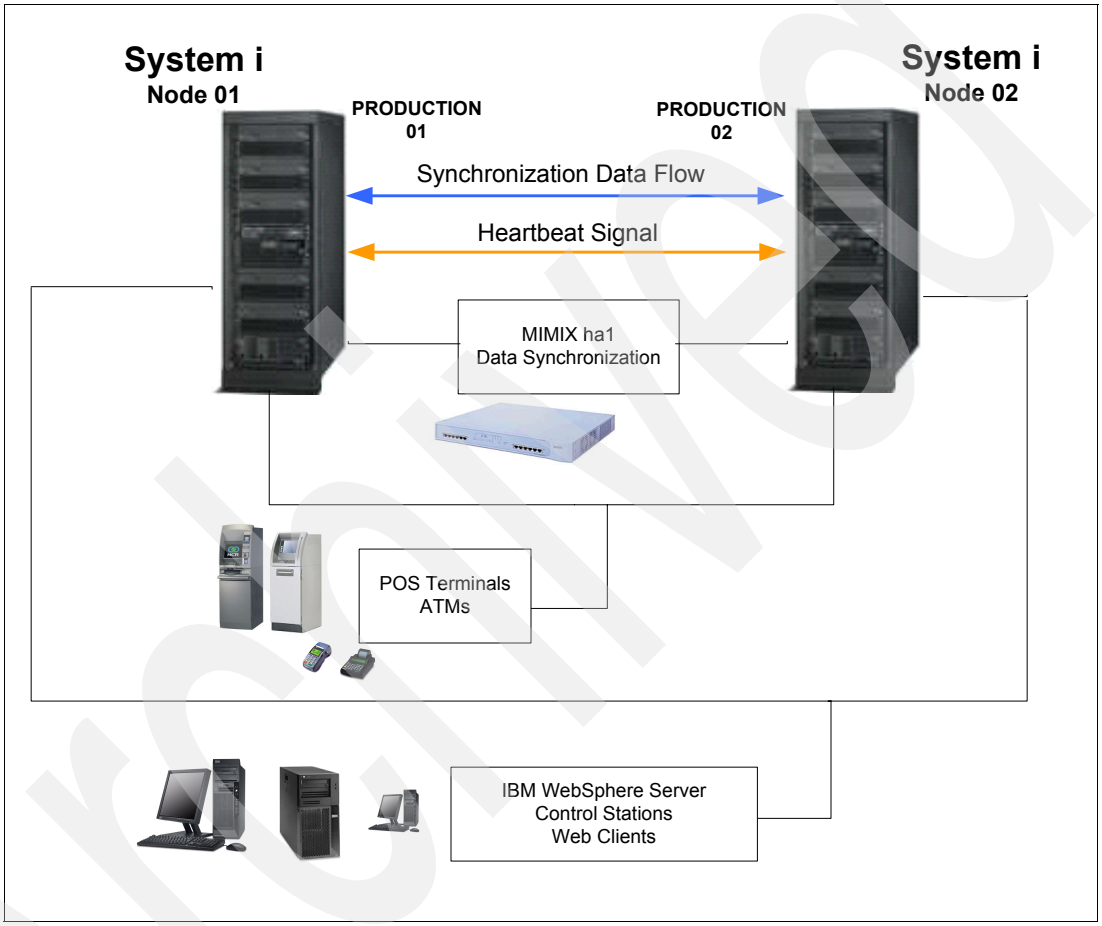

Figure 4-2 Example of active-active SmartVista configuration

Server clusters using active-active configuration ensure that every node in the cluster maintains its own workload. This helps achieve greater scalability in addition to maximizing the overall system performance. Thus, every server in the cluster is available to do real work, and every server in the cluster is also available to recover the resources, data, and processing of any other node in the cluster. There is no need to have a wasted, idle server waiting for a failure. However, active-active cluster servers must be sized appropriately to handle the load of two servers (in the event of a failover). Another advance is the integration of the clustering and replication MIMIX techniques. The systems can be configured to optimize the productivity and computational power and ensure the data integrity and high system availability.

The availability of both integration and clustering techniques in a single solution make it possible to avoid the data collisions for the active-active SmartVista i cluster configurations. Basic solutions using active-active configurations do not eliminate the risk of data collisions,

which can occur when the two sessions try to update the same data on the node simultaneously. Many processing systems do not make use of the active-active cluster configuration advantages because there is a risk of financial losses that can be occur, for example, if more than one authorized card holder tries to access the same account. SmartVista i is the processing solution that eliminates the risk of such collisions. Through the combined efforts of BPC and Vision specialists, SmartVista can seamlessly process such transactions and avoid these collisions without any data discrepancy or performance decrease. This makes SmartVista active-active processing/replication mode one of the fastest and highly available solutions for card processing centers.

4.4.3 Disaster recovery SmartVista configuration

The disaster recovery software and data protection techniques that are available from MIMIX improve the business continuity that is required to avoid data loss or prolonged system downtime in situations where both active-active or active-passive cluster servers are unavailable of destroyed. This can happen, for example, in a natural disaster.

This approach to the system availability improvement is based on restoring the failed server configuration, data, and processes on a remote server. Basically, the data in this case is transferred by a low-bandwidth long distance communication channel or restored from a backup tape, which takes several minutes (Figure 4-3).

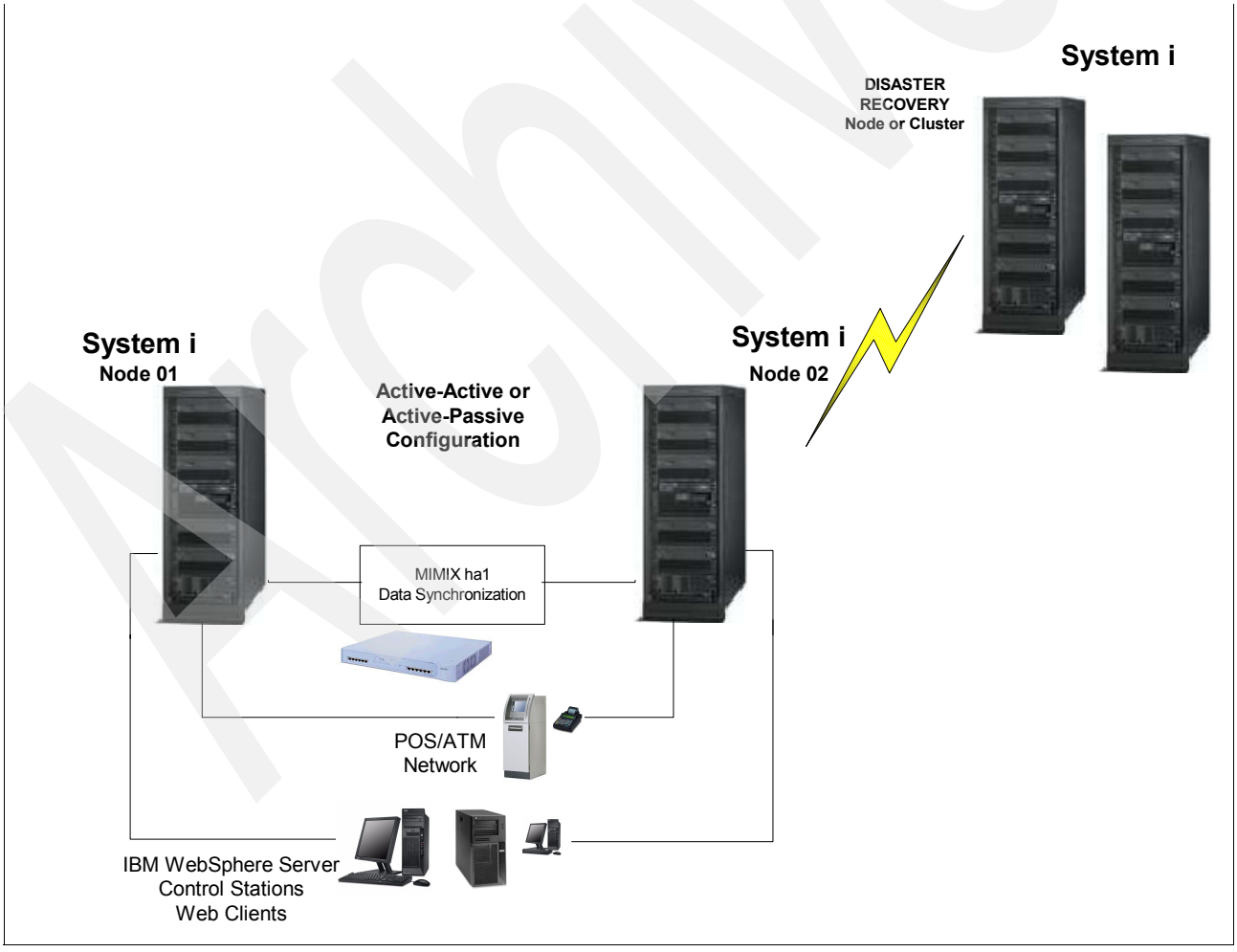

Figure 4-3 Example of disaster recovery SmartVista configuration

4.5 Testing the system performance

The final stage of the SmartVista i development project was a series of benchmarking tests of the new solution on two sites: in the Moscow IBM laboratory and in the IBM System i center in Rochester (Minnesota, USA). Using IBM laboratory resources, the testing team created a configuration similar to SmartVista production run in the largest processing centers (Figure 4-4). During the tests, a mix of transactions was generated from different devices, including ATMs, POS, and EPOS-terminals. Funds withdrawal and transfer, balance inquiry, retail purchases, and other types of transactions were emulated. The system configuration used during the tests modeled the production operation of a multi-branch financial organization, acting as MSP/TPP, or of a processing center of national scale.

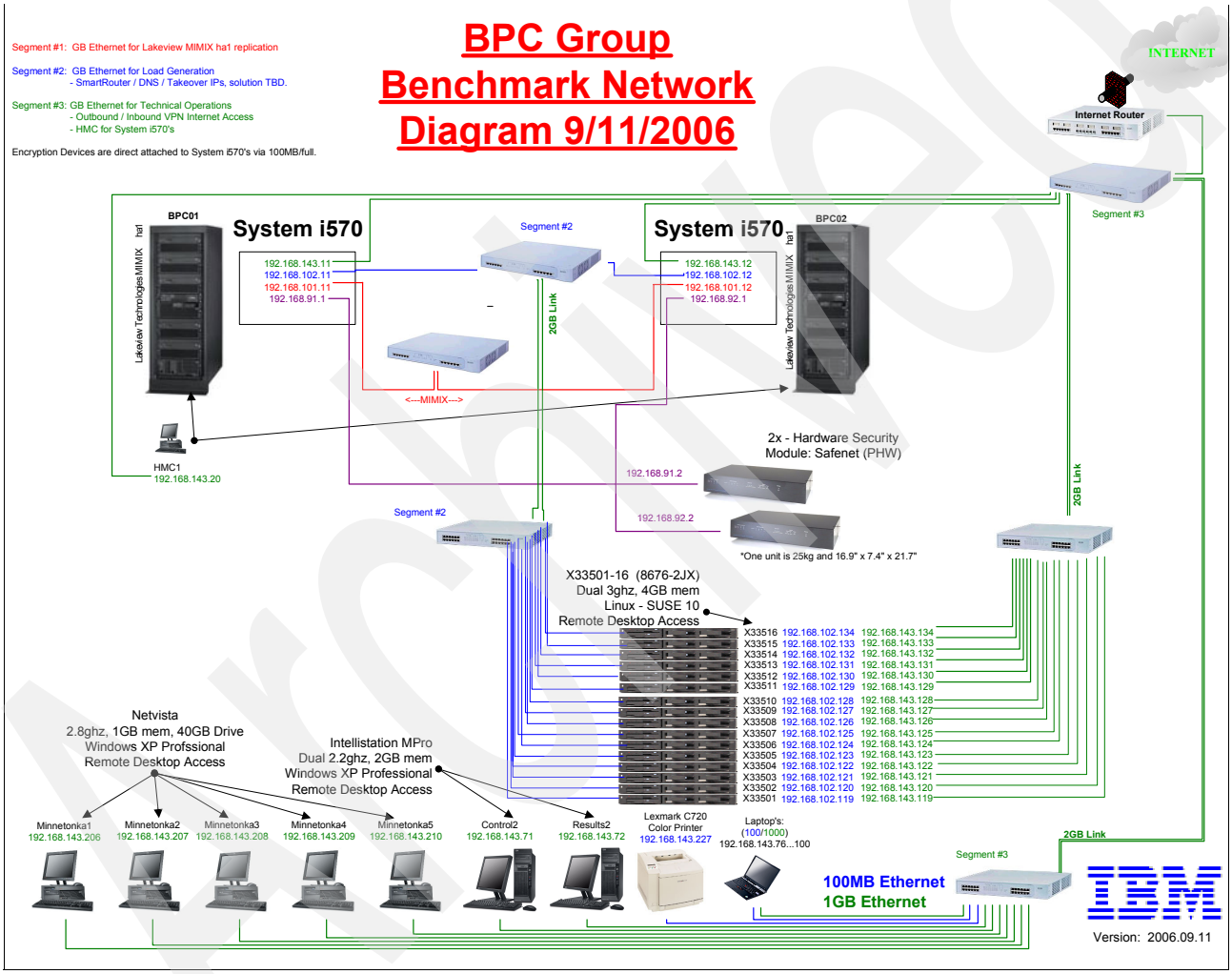

Figure 4-4 Benchmark network diagram

The testing was performed using the following hardware:

- Two IBM iSeries 570 servers (16 CPUs Power 5+ 2.2 GHz, 128 GB RAM, 90 hard disks with total capacity of 4 TB, i5 V5R4) with MIMIX ha1 software installed on both i5 servers
- Sixteen IBM xSeries servers, model 335 (2 XEON CPUs 3.6 GHz, 4 GB RAM, SuSe Linux 10) for load generation.
- Two Hardware Security Modules Safenet ProtectHost White PL1200, 6 PC (Pentium® IV 2.8 GHz, 1 GB RAM, Microsoft Windows XP, Service Pack 2)

Various system downtimes and planned outages were emulated during the tests to check the the fault-tolerance of the system. The cluster built with the Vision Solutions clustering solution ensured continuous server availability with permanent data replication between them. When one server stopped running, the other picked up the entire workload within several minutes. The tests performed on both sites included both active-active and active-passive switching mode. The manual and automatic switching were applied to switch the processing to the backup server.

4.5.1 Failover and switchover scenario results

The BPC, IBM, and Vision teams prepared and tested a set of failover and switchover scenarios emulating both planned and unplanned switching between nodes in real life:

- Distress message failover
- Maintenance switch for:
  - Primary system failure
  - Backup system failure
- Heartbeat timeout for:
  - Communication failure
  - i5/OS failure

Table 4-1shows the results.

Table 4-1 Failover and switching test results

Replication mode	Switching time
Active-passive	1 min 25 sec
Active-active	1 min 40 sec

Among the actions that are known for emulating failover behavior, some new ones, such as issuing the `endsbs *all` command on a node while testing the distress message scenario and main store dump on a node while testing the heartbeat timeout scenario, were used.

4.5.2 Single node performance benchmark results

One of the challenges for the BPC team was a single node performance benchmark that used all available techniques for tweaking the system. One of the critical parameters for the system on i5/OS is Commercial Processing Workload (CPW) per transaction. Thanks to help from the IBM team at the Rochester labs, the BPC team obtained a CPW/transaction value that was two times smaller than the results before the testing. SmartVista also supports static data caching and the changing of data immediately after receiving an incoming request from the management processes. Therefore, several caching possibilities were used for multiple runs with terminal emulators to see what would happen when we scaled the load from low to higher values. Table 4-2 shows the main results.

Table 4-2 Results of scaling the load from low to higher values

CPUs	RAM, GB	Min TPS	Avg TPS	Max TPS
8	32	682	1030	1260
8	64	825	1115	1290
16	64	1337	1928	2163
16	128	1231	2011	2370

Table 4-2 on page 33 demonstrates that the i5/OS architecture and the load balancing mechanisms create an almost linear dependency between the CPW and transaction per second (TPS) values. Moreover, RAM size is not a critical parameter for the application and adding more memory to the system does not increase performance. However, doubling CPU power on the system is likely to double the application performance (Figure 4-5).

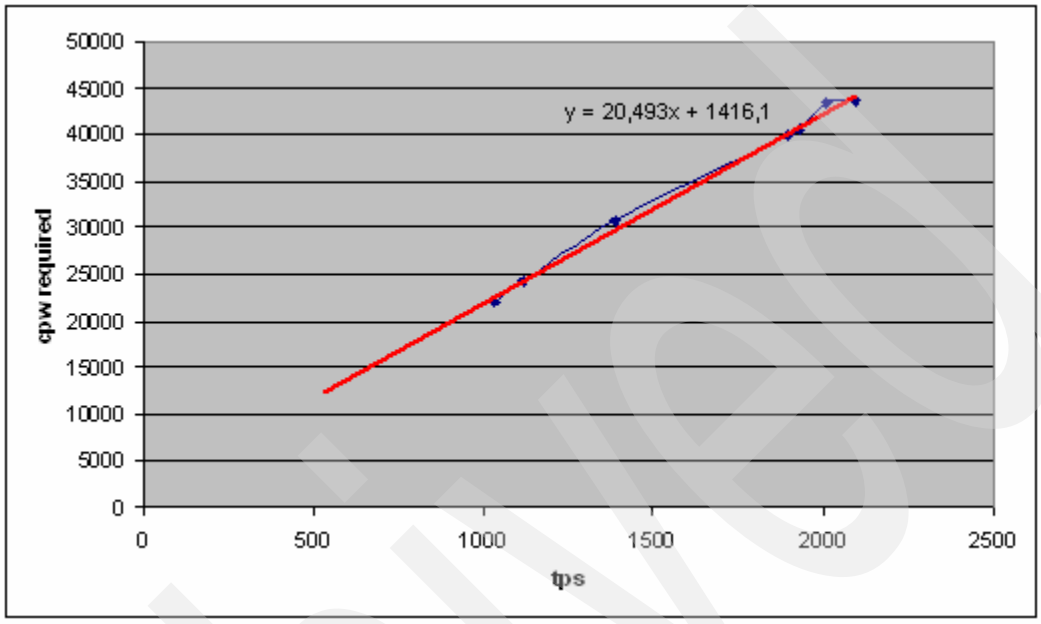

Figure 4-5 Single node performance benchmark results

The SmartVista i testing in the IBM Rochester benchmarking center demonstrates the high performance and fault-tolerance of the solution during the processing of large volumes of financial transactions. The combination of SmartVista functional advantages with the platform reliability and robustness of System i helped create a new high performance solution for payment card processing and electronic payments that designed for financial organizations of any size and can provide them with a solid foundation for card business growth.

SmartVista i

High-performance payment processing solution on IBM System i

Redpaper™

Availability and scalability solution for banks and interbank processors

Reduced TCO using an integrated System i platform

Real alternative for replacing existing systems

SmartVista i is an evolution of the BPC SmartVista card processing solution, adapted to run on the System i platform. Combining the comprehensive card processing functionality, modular design, and flexibility of the BPC SmartVista software application with the robustness and fault-tolerance of the IBM System i platform, SmartVista i offers continuous availability, high performance, and scalability.

SmartVista i is a result of extensive collaboration between BPC and IBM experts from Russia, the United Kingdom, and the U.S. Built around the growing demands of banks and interbank processors in both mature and emerging markets, SmartVista i represents a reliable and high-performance electronic payment system that takes into account all current payment technologies and ever increasing delivery channels. For this paper, we used high volumes of financial transactions to record SmartVista i performance ratings during benchmark testing at the IBM System i Center in Rochester, Minnesota. The exceptional fault tolerance of the solution was achieved by using Vision Solutions (formerly Lakeview Technologies) MIMIX HA1.

SmartVista i is intended for financial organizations of any size that wish to establish a solid foundation for their card business growth. With its ability to add and incorporate new functions and requirements with minimal time and resources, SmartVista i helps bring down total cost of ownership and helps users maintain it at reasonable levels into the future.

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