An IBM White Paper

IBM i

A platform for innovators, by innovators

An executive guide to the strategy and roadmap for the IBM i integrated operating environment for Power Systems.

Fully updated for IBM i 7.4 and Db2 Mirror for i

IBM

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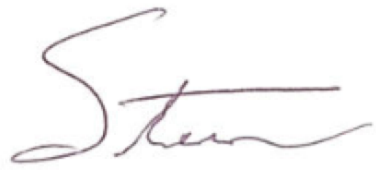
Dear Clients and Business Partners,

IBM is a leading innovator in server and storage solutions, with outstanding performance, resiliency, and security capabilities that scale based on clients' needs. Within our IBM Cognitive Systems portfolio, IBM i is the integrated operating environment for our IBM Power Systems™ servers. We continue to celebrate our amazing clients transforming their businesses with AI, IoT, open source and more using IBM i.

With its integrated Db2® database architecture, IBM i provides a cost-efficient, highly resilient and secure foundation for running a wide variety of popular industry applications. I am delighted to take this opportunity to reaffirm our ongoing commitment to IBM i, and thank you for the trust that you have placed in our IBM Systems solutions. IBM i is a critical component to our overall Cognitive Systems portfolio of products.

This white paper is designed to help IT executives understand IBM's strategy and roadmap for the IBM i operating environment. This is an ideal time to update you on our strategy, as we announced IBM i 7.4 just last year. It is the latest release of the operating system with many new capabilities including Db2 Mirror, a breakthrough database resiliency offering. You will also find details behind our strategies for exploiting a multi-cloud environment and integrating your applications with new AI solutions.

Thank you again for your business and I trust that you will find this white paper valuable as together we invest in the future of IBM i.



Steve Sibley
Vice President, Power Systems Offering Management
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Executive summary

Reinventing the future

Digital technologies have redefined how people live. Technology is already changing traditional industry structures and economics and is reinterpreting what it means to be a customer and a citizen. To thrive in a rapidly changing business environment, organizations will need to focus in new areas, build new expertise and devise new ways of working in order to offer customers compelling new experiences. Leaders advance this process by embracing digital transformation. They envision possibilities, create pilots, deepen capabilities and orchestrate new ecosystems.

Overview

This paper provides the details for the strategy regarding the IBM i integrated operating environment for Power Systems. Beginning with a high-level examination of the three focus areas of the strategy, followed by a look at the nature of business in the age of ongoing digital transformation, the rest of the paper focuses in specifically on IBM i. Areas covered in depth include the standing of IBM i in the marketplace, the key pillars of the IBM i architecture, the roadmaps to the future of IBM i and the diverse portfolio of IBM i products. The paper concludes with a list of resources useful to the IBM i community and links to explore for further information.

A strategy for continuing innovation

Businesses today are undertaking significant digital transformations: rethinking what customers value most and creating operating models that take advantage of new possibilities for competitive differentiation. The challenge for business is how fast and how far to go. IBM recognizes this challenge, and wants IBM i to help clients negotiate the difficult waters of transformation. That is why the IBM strategy for the IBM i portfolio emphasizes the expectation that digital transformation is a part of IT. That strategy is built on three focus areas:

1. Solutions as the top priority
2. Open for choice
3. Integrated value

This approach allows IBM to continuously innovate and evolve the IBM i portfolio, providing clients and partners with a platform that allows them to do the same. IBM is expanding innovation in areas such as analytics, virtualization, and hybrid multi-cloud. The strategy is inclusive of what many clients are examining for the future, such as AI, machine learning, the Internet of Things (IoT) and other forms of cognitive computing.

Solutions as the top priority

Solving business problems while minimizing the need for a high level of technical expertise is fast becoming the focus of all companies. However, successful business solutions require many new technologies. The popularity of IBM i is due in part to the fact that it provides a reliable, integrated platform on which business solutions can be deployed without a need for excessive IT resources.

IBM works with Independent Software Vendors (ISVs) to understand the advances in software technology necessary to deliver current and future value. IBM then invests in database enhancements, programming languages, software development tools and software delivery methods to continue to provide a state-of-the-art environment for the development of state-of-the-art business applications. This allows all developers, not just ISVs, to reinvent applications to meet business and customer needs.

Open for choice

Transformation seldom has one path. Organizations can choose multiple paths as they move from their current environment. Their choice is based on many factors, especially requirements founded on business strategy. IBM i has integrated open technology for more than 20 years, and in recent years the number of available technologies on IBM i has grown exponentially. This remains a focus area in the IBM i strategy precisely because providing these options is of clear value to our clients, allowing them to continue innovating with the technology that fits their needs.

In the realm of open source, some choices are possible through enhancements to existing, powerful languages. Many of the open source languages that are now part of the IBM i catalog started as solution enablers. Other options are available from the broad open source community. Often, IBM developers and partner developers were actively engaged in the open source communities, participating in the advancement of those languages (Node.js is one such example). When it became clear that a language would provide value to the IBM i community, the IBM i development team migrated it to IBM i.

Bringing new, young talent to IBM i clients is another important aspect of this part of the IBM i strategy. Most new developers learn open source languages and tools during their education. By ensuring that those industry standard environments are available on IBM i, IBM has enabled clients to find fresh new talented programmers, hire them and have them be productive immediately.

Over the last few years, clients have reported that this strategy has been extremely effective. Evidence of the success of the program is demonstrated in the growth of the IBM i Fresh Faces community. Each year, a new group of Fresh Faces is recognized in the June issue of IBM Systems Magazine.

Integrated value

As IT evolves, solutions are becoming more dependent on multiple components assembled together. As in any environment, not just IBM i, when each new technology evolves there is a period of time during which companies need to evaluate its potential and determine whether this technology is of value to their business. If these factors are true, then it will eventually become an expected component of an overall solution. IBM integrates many of those new technologies into the suite of IBM i products, factoring them into the architecture and simplifying their use. This allows IBM i clients to use the technologies with minimal impact to their business.

This level of continuous integration also benefits the solution providers in the IBM i ecosystem, allowing them to build their business solutions on top of the latest technologies. This provides the ISVs with the ability to grow and evolve their solutions to include these new technologies as well.

Business in the age of digital transformation

New challenges bring new approaches

Business leaders have long used information technology to improve productivity and efficiency, reach new markets and optimize supply chains. What's new is that customer expectations have also changed. Whether at work or in their personal lives, users today expect speed, availability and continual access from their technology.

Relentless technological innovation impacts industries across multiple fronts. With the speed of this transformation accelerating, IT departments are expected to drive innovation and growth, and to do so with declining IT budgets. As a result, more than ever, IT choices matter and IT infrastructure matters.

Combining multiple technologies, including cloud, cognitive, mobile and IoT, digital transformation rethinks customer and partner relationships from a need-, use- or aspiration-first perspective. Digital transformation helps organizations create unique, compelling experiences for their customers, partners, employees and other stakeholders. These benefits arise regardless of whether enablement or fulfillment of the experience involves direct provision of products or services, or orchestration of products or services from partner organizations by way of a business ecosystem. The most successful businesses have transformed to establish a platform of engagement for their customers, acting as enabler, conduit and partner.

How can businesses best respond to digital transformation? How can they take advantage of the opportunity to innovate, differentiate and grow? And how can they do all of this cost-efficiently, leveraging and optimizing the newest information technologies as part of their overall physical operations?

Businesses with a cohesive strategy for integrating digital and physical elements can successfully transform business models, setting new directions for entire industries. These leading companies focus on two complementary activities: reshaping customer value propositions and reconfiguring operating models using digital technologies for greater customer and partner interaction and collaboration. To do so, they are building a new set of capabilities that allows them to progress along both dimensions.

Organizations transforming with IBM i

For more than 30 years, IBM i has been used by organizations in every industry—from entertainment to retail, manufacturing to financial services, non-profits to worldwide distribution. Today, these companies continue to trust IBM i to run their most critical business applications and provide security for their most sensitive data, as they work to drive digital transformation and innovation.

The story of the IBM i client JORI provides an excellent example of several parts of the IBM i strategy, as well serving as an example of the value that clients expect from IBM i. JORI wanted to move its custom furniture manufacturing into a new era by providing clients a chance to see 3D simulations of furniture before it was purchased or even built. As its business processes were running on IBM i, it engaged a local IBM Business Partner with a young developer who knew open source software. The developer used that open source knowledge to build a solution on IBM i, a platform with which he was not yet familiar. The partner integrated this new code with the existing manufacturing and business software, and JORI created innovation without disruption to its business.[1]

JORI is just one example of IBM i innovation at work. When Caixa Geral de Depositos France wanted to integrate machine learning into its existing core banking software, which runs on IBM i, the company and its partners used a hybrid cloud approach, taking advantage of the integrated capabilities of IBM i to consume services available on IBM Cloud.[2]

Finally, global brand Carhartt is an IBM i client that takes advantage of all of the operating systems available on IBM Power Systems. Its total cost of ownership story demonstrates that it not only benefits from the attributes of IBM i that are discussed at length in this paper, but also from the offerings available on Power for consolidating workloads.[3]

These are only three examples of clients who recognize the value of IBM i—and working with partners—to take advantage of the operating system's integrated capabilities and extend the value of their IT infrastructure, using modern technologies to their advantage. They are not alone.

Each year, IBM Business Partner, HelpSystems, conducts a survey of the IBM i community. And every year, among the many useful insights they gather, they ask the community if the return on investment of IBM i is superior to other operating systems. Overwhelmingly, the answer is "Yes."[4]

IBM i: a platform for innovators, by innovators

As technology continues to evolve, it is pushing businesses to do more. IBM i users are building applications that are a blend of technologies from traditional business solutions integrating with open-source solutions, either running on IBM i itself or deployed on Linux on Power. IBM i clients have a clear advantage in their ability to extend business solution choices in any of these modes. It's all about providing technical flexibility to help solve business problems and extend value.

IBM i users are also integrating their business applications with analytics engines, inferencing technologies, mobile interfaces, and all manner of IoT capabilities. Such technologies are exploding in use and creating new demands for core business applications. Implementing business applications using the IBM i operating system on IBM Power Systems servers helps companies outpace their competitors, differentiate their offerings from the competition and turn operational costs into investment opportunities.

At its core, then, the IBM i operating system is a platform designed to adapt to the needs of business computing, with the expectation that both business and computing will change over time. IBM i is designed to adapt to whatever changes arise, and that has allowed IBM to invest in making IBM i a platform that provides a strong foundation for continuing innovation—both for IBM and for clients. Its defining characteristic, the "integration" represented by the "i" in IBM i, allows clients to get more value from advanced technology with fewer resources and higher reliability.

IBM i in the marketplace

Traditionally, IBM i has been used in industries such as wholesale distribution, retail distribution, manufacturing, local government and school administration. Today, the fastest growth comes from financial industries like banking and insurance, as well as in retail and healthcare. The latest evolutions of IBM i and Power Systems servers have changed the breadth of applications and infrastructure available to solve today's business problems for companies of all sizes and in all industries.

The current trend of digital transformation is taking IBM i usage into new technology integration areas. For example, companies running their core applications on IBM i are beginning to explore new visual recognition or non-traditional data searches to enhance their applications.

Global growth

IBM i enjoys a strong base of clients in the traditional markets of North America, Western Europe and Japan, accounting for more than 80 percent of IBM i sales annually. Over the last few years, IBM i has seen ongoing growth in emerging markets such as Latin America, Eastern Europe and the ASEAN region, especially in the banking and distribution sectors. While China tends to be a growth market dominated by UNIX, IBM i continues its strong presence there, especially in the banking and financial services sectors.

The IBM i market has a dual nature: an extensive small and midsized client community alongside a strong select group of users in large enterprises. The majority (approximately 70 percent) of IBM i users are small and midsized enterprises, with 30 percent being large enterprises with 1,000+ employees.

IBM i use in small and midsized companies

Many thousands of companies around the world rely on IBM i because they want a more resilient, more secure and more cost-efficient alternative to Windows technology-based servers for their most important business data and applications.

Midsized companies in particular have two key requirements: one, to maximize their IT investments and, two, to exploit these investments as the company's requirements grow. Unlike Windows technology-based servers, the IBM i operating environment is almost always used to run multiple business applications and databases securely and efficiently on the same server. As a result, clients report that they have fewer servers to manage with IBM i compared to Windows. That helps a company better utilize its IT assets today, while avoiding the costs of deploying and managing a new server every time the business needs to deploy another application. This easy deployment, upgrading and management gives IBM i a significant advantage when evaluating TCO.

IBM i use in large enterprises

Dramatic advances in both server virtualization technology and storage architecture have been made in recent years. Large enterprise clients are taking advantage of these in their IBM i implementations. They see significant cost savings by consolidating their distributed servers back into the data center. Today, large enterprises typically run IBM i for high-volume transaction processing on fewer, highly virtualized systems.

Additionally, in today's implementations of storage, the trend for large enterprise clients is to balance the use of traditional internal storage with a growing use of SANs, such as IBM DS8000® and Storwize® V7000. Flash storage can also be attached directly to IBM i or through a SAN. The trend toward using external storage has enabled IBM i users to leverage mainstream technologies for storage and associated software like IBM PowerHA®, FlashCopy®, Metro Mirror and Global Mirror.

Cloud and IBM i

Cloud is changing the computing landscape. Cloud technologies have allowed companies to make business decisions about how and where to run their compute environments. Today, some companies have no in-house infrastructure and run completely in the cloud. Infrastructure-as-a-Service providers take many forms and are offered by IBM as well as strategic cloud partners. Many ISVs have had cloud implementations of their software solution (Software-as-a-Service or SAAS) for many years. This lets their clients manage the business applications without needing to manage the system.

IBM has a multi-cloud strategy for IBM i. Not only will the IBM Cloud™ strategy continue to look to ISVs for SaaS, and to partners to provide IaaS, Platform-as-a-Service (PaaS) and Disaster-Recovery-as-a-Service (DRaaS), but in early 2019, IBM announced that IBM i would be available in the IBM Cloud. This will enable companies to choose a single-vendor for their cloud solutions, working with IBM as the provider of both their cloud technology and their operating system.

Community

IBM i has a very strong and passionate community of users, which IBM applauds, encourages and helps promote. A common thread running through this broad group of IBM i users is their appreciation for, and commitment to, the IBM i platform. Clients are often very willing to share their stories, and these stories demonstrate how IBM i makes it possible for these clients to use the most up-to-date technology to bring value to their customers.

IBM i Large Users Group, better known as LUG, is an independent organization that meets with IBM three times a year in Rochester, Minnesota. Members include many of the largest IBM i users in the world. The LUG acts in an advisory capacity to the IBM team, providing feedback and input on the IBM i and IBM Power Systems strategies.

The COMMON organization of international user groups has been in existence for more than 50 years. There are COMMON organizations in North America, including Canada, Mexico, the United States and various countries in the Caribbean. COMMON Europe has 14 member country organizations representing the cultures and languages of Europe. IBM Japan Users Association is the name of the IBM i User Community organization in Japan.

There are other user community organizations in other parts of the world.

IBM meets regularly with the COMMON Americas Advisory Council (CAAC) and COMMON Europe Advisory Council (CEAC) to understand and prioritize requests for future enhancements to IBM i. Both the CAAC and the CEAC meet face to face twice a year and hold regular monthly calls.

Additionally, an extensive network of local user groups, ISV user groups, LinkedIn groups and Facebook communities are dedicated to IBM i. The IBM i team works with these groups to gather feedback and review requirements for the platform.

Key pillars of IBM i

Overview: IBM i architecture

The adaptability of IBM i is guaranteed by an architecture that provides unique dependability, security, flexibility and integration, all of which lead to a significant total cost of ownership advantage. The pillars of this architecture make IBM i unique in the industry. They include:

1. Db2 for i and single level storage
2. Security and integrity
3. Open source runtime and integration of technology
4. Multi-workload virtualization
5. Investment protection

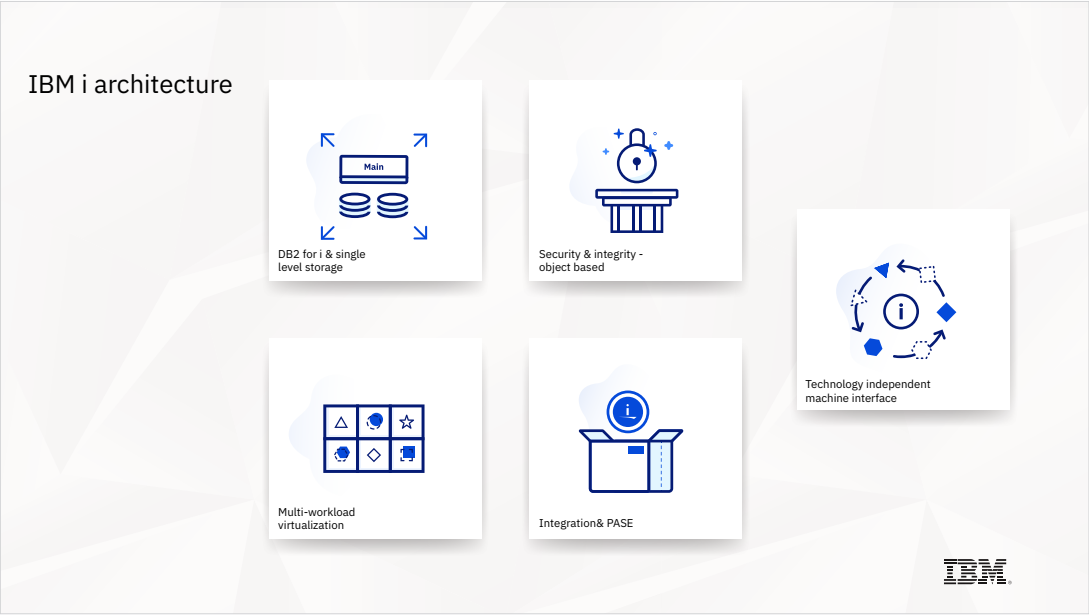


Figure 1 — IBM i architecture

Each of these pillars provides clear differentiators from other operating systems and together create the unique foundation for continuing innovation that exists today in IBM i 7.4.

1. Db2 for i and single level storage

IBM i is unique among operating systems in how it treats data. Transactional workloads—the workloads that run the core business, such as financials, inventory control and so on—are best served by relational databases. Most operating systems today deliver only a generic file system. Customers must then acquire, install and manage a relational database. This is not the case with IBM i.

IBM i includes a fully relational, SQL-compliant database, Db2 for i, as an integrated piece of its architecture. In addition to being integrated, Db2 for i also automates many of the tasks typically performed by database administrators and storage administrators on other platforms. An example of this is rebalancing indexes over database tables. This is done in partnership with another unique part of IBM i, the single level storage architecture. The storage location for each piece of data is determined by the operating system, automating the analysis and placement of data to ensure high performance.

2. Security and integrity

IBM i has several attributes that provide levels of integrity and data safety beyond other operating systems, but chief among them is the object based architecture and hardware storage protection.

Object based architecture means that every "thing" in IBM i comes with a predefined set of uses. For example, program objects have a predefined "use" that says programs may be executed, but files cannot. Security, built on top of the object-based architecture, guarantees that each "thing" in IBM i can only be used as its object type allows and nothing more. This key architectural design protects IBM i from "Trojan horse" attacks that plague other environments. A Trojan horse virus depends on a malicious piece of code masquerading as something else. For example, a program that deletes important information might appear to the user to be a photo or movie, but when that "file" is activated the malicious program runs. This cannot happen with IBM i objects. A program cannot masquerade as something else.

Viruses, by contrast, often reach into existing programs and change the processor instructions. To accomplish this, the virus takes a pointer to some memory location and changes it to point somewhere else where it can insert unwanted instructions. IBM i, in conjunction with the POWER® processors, prevent this from happening. The unique single level storage architecture also allows enforcement of pointer manipulation so code from outside the operating system cannot change processor instructions.

These security and integrity features, along with many others, are not just added on to the operating system; they are built in by design.

3. Open source runtime and integration of technology

The two preceding sections should have already made clear that the database and the security infrastructure of IBM i are integrated, but the integration of technology in IBM i goes far beyond that.

Over time, applications have required larger numbers of increasingly complex technologies to accomplish their tasks. IBM i integrates that technology—often described as middleware—into the operating system and its related integrated offerings, without requiring clients to purchase additional software.

Web servers, application servers, program integrity tools, digital certificate management, auditing capabilities, and directory and user identity services are all part of IBM i—built, tested and delivered together. Additionally, as these technologies have evolved over time, IBM includes the latest and greatest into the IBM i portfolio.

An integral element of IBM i is the IBM Portable Application Solutions Environment for i (PASE). Technologically, PASE takes advantage of the capability of the POWER processors to run multiple flavors of operating systems at the same time, including IBM i and flavors of UNIX (AIX® and Linux). Using this POWER capability, IBM i has an AIX kernel embedded. It is the PASE environment that allows software, compiled for AIX, to be used directly by, and within, IBM i.

One of the most important uses of PASE within IBM i, however, is to bring open source components to the

platform. Most open source development targets UNIX-flavored operating environments, so finding or creating open source software that is ready to run in PASE requires very little work. This dramatically increases the number of solutions and software components available to IBM i.

4. Multi-workload virtualization

Since the late 1990s, most businesses need their servers to do more than one thing. IBM i, from the very beginning, was designed to allow a client to run an Enterprise Resource Planning (ERP) solution on the same IBM i instance where payroll software, Customer Relationship Management (CRM) application and the web server are also running. The result was one server and one instance of the IBM i portfolio of products and multiple applications all running in one place.

However, IBM i is also designed to allow the running of the same software for multiple clients at the same time on the same machine. Using the built-in work management subsystem capabilities in conjunction with the inherent security capabilities of Db2 for i, IBM i can provide isolation of workload. No client needs to ever interact with the data of the others. Using these built-in techniques long before “cloud” technology was widespread, ISVs that wrote solutions on IBM i were able to service multiple clients remotely, on one instance of IBM i.

This level of virtualization means fewer systems need to be purchased and fewer licenses and support contracts need to be bought, making IBM i a platform designed to give clients multi-workload management that drives a low total cost of ownership.

5. Investment protection

Is it possible to imagine writing a business solution once and never again having to recompile it? IBM i clients don’t have to imagine it. This is what they’ve come to depend on through more than three decades. Application code that was written and compiled in the 1980s, which originally ran on a 48-bit, single-threaded processor, still runs today, unchanged, on the latest POWER9™ multi-core, multi-threaded processors, and clients were not required to change the software or even need a recompile.

This unmatched forward compatibility is enabled through another unique architectural pillar of IBM i: the Technology Independent Machine Interface (TIMI). When a software program is compiled on IBM i, it is not compiled to specific processor instructions, as it would be on other operating systems. Instead, it is compiled to an intermediate set of instructions called MI instructions. This intermediate layer remains constant even when the layers of technology below them change. For example, as clients today move to POWER9 hardware, there is no need to recompile or retranslate application code. IBM i provides the translation of the existing MI instructions to the most current processor architecture.

An additional benefit to this unique technology is that IBM i can, and does, improve performance of user software over time, as the operating system engineers take advantage of the advancing capabilities of the POWER servers.

The architecture of IBM i has always been ahead of its time. In 1988, the architects put these key pillars in place with a vision of where computing might go in the future. As chip design, security, virtualization, mobile computing and now AI have added sophistication to computing, the architecture of IBM i has allowed companies to grow and evolve knowing that IBM i has grown with them, providing the latest advancements while protecting critical business functions.

The future of IBM i: roadmaps

There are two roadmaps for IBM i: the IBM i product roadmap and the IBM i support roadmap. These two pieces of information are critical when understanding the investment that IBM makes in the IBM portfolio of products and the significant length of time in the lifespan of each release.

The IBM i product roadmap

In the product roadmap, IBM documents the strategic delivery of IBM i features by two related mechanisms. First, IBM delivers major IBM i releases every two to four years. The roadmap (Figure 2, below) shows the most recent release, IBM i 7.4, in the center. On the left are the two previous major releases, and on the right are two future major releases. IBM has been delivering on this roadmap for more than a decade, and continues to follow through on its commitment to ongoing innovation.

Every major release provides extensive enhancements and new functions—too many to enumerate in detail. However, a brief overview of the major releases makes clear the extensive development that goes into each one.

The most recent major release, IBM i 7.4, introduced many new features. The most notable is the new program product called IBM Db2 Mirror for i. This product enhances the capability of IBM i to provide continuous availability of applications. Clients who require platforms that are always available can now use high-speed connections, the latest POWER servers and IBM i 7.4 to achieve that result.

IBM i 7.3 introduced Db2 support of integrated analytics capabilities, including the ability to keep historical business data integrated into active current data. This simplified the ability to analyze the past when making decisions about the future. Additionally, IBM i 7.3 contained a new security capability of IBM i called Authority Collection. Authority Collection monitors how application users are using the data and application objects. Clients are able to monitor the success of their security policies and to prove to auditors that those policies are protecting business data.

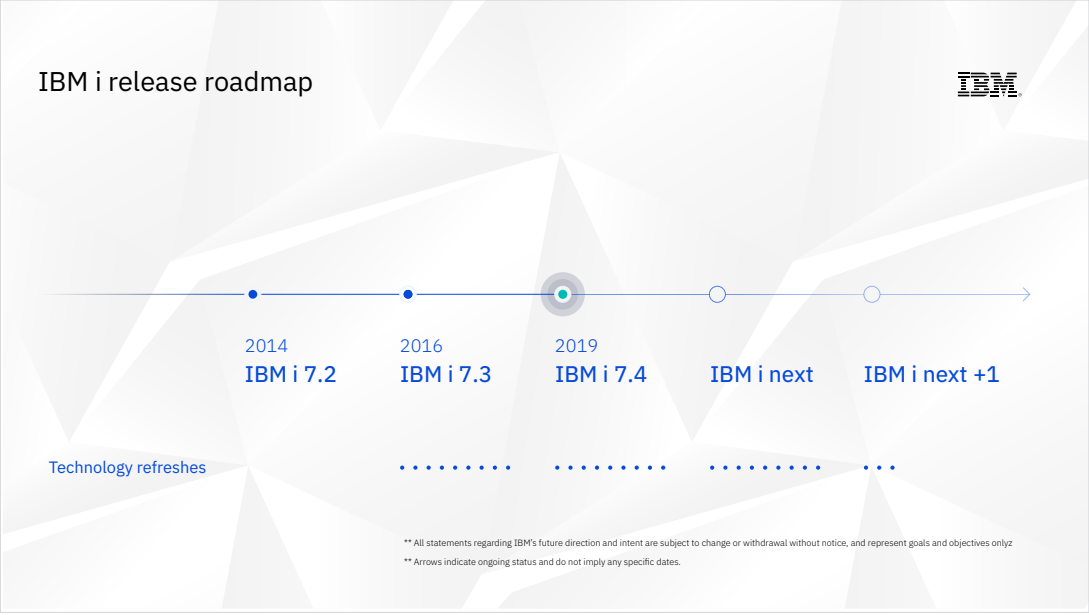


Figure 2 — IBM i product roadmap

IBM i 7.2 featured Db2 Row and Column Access Control, an integrated and automated way to allow clients to secure business data. IBM i 7.2 provided many new open source language environments and updated RPG to be free format.

Another strategic aspect of the IBM i product roadmap is the ongoing delivery of new capabilities in between major releases. Since 2010, IBM has delivered IBM i enhancements several times each year, including semi-annual Technology Refreshes (TRs). These TRs deliver significant updates related to the IBM i suite of products and the enablement of Power Systems server technology, including virtualization, I/O and storage capabilities. Many of the services required for IBM i to participate in cloud have been enabled by capabilities added between releases. The TR delivery vehicle is a clear demonstration of the ongoing continuing innovation IBM delivers in IBM i.

IBM i is the integrated operating system and it has many components. In each new release and TR, the breadth of components delivering new features and function is significant. IBM invests heavily in evolving IBM i to meet the needs of the industry and, most importantly, to meet the needs of the community of clients. The regular drumbeat of major releases and TRs demonstrates that ongoing commitment.

While IBM does not reveal information about the content or the dates of future releases, the roadmap clearly illustrates that additional releases are planned.

The IBM i support roadmap

IBM i clients value the high-quality, long-lasting, reliable support available for the operating system and related program products. Historically, clients cite support as one of the areas with which they are very satisfied.

The IBM i support roadmap shows two important parts of that support. First, each IBM i release has a dependable period of base support. Based on historical precedent, the IBM i strategy is to deliver this base support for approximately seven years after a release becomes generally available. For clients who require a longer time to move to the current releases, based on historical precedent, IBM offers an extended support period, typically for three more years. Together, this provides approximately 10 years between when a release is announced and when it goes to end of life.

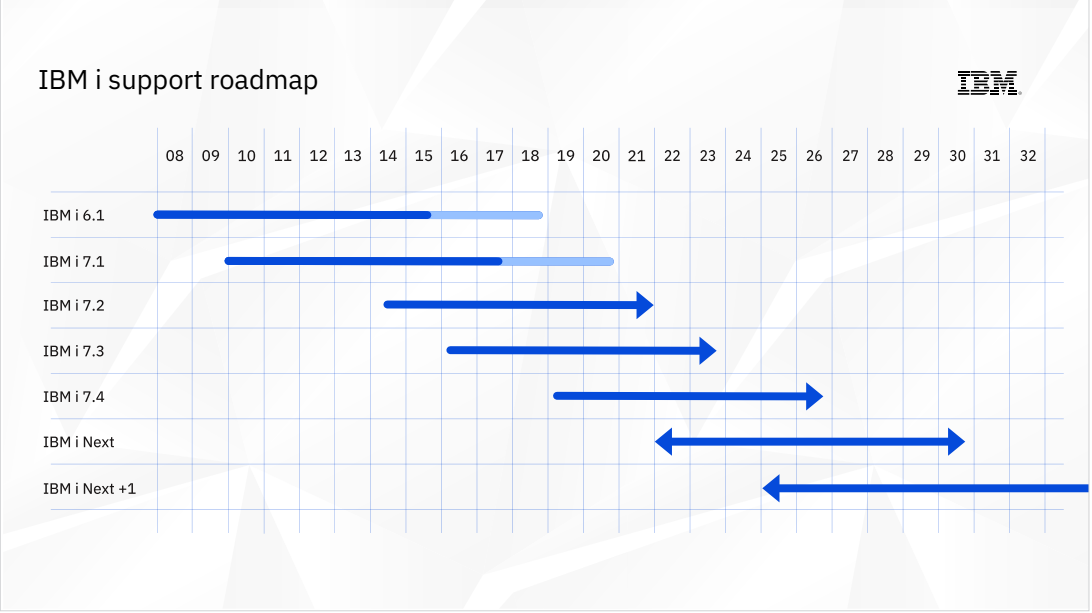


Figure 3 — IBM i support roadmap

The second point of the IBM i support roadmap is that it provides some guidance regarding the unannounced releases from the product roadmap. Using the 10-year lifespan support strategy, it is possible to forecast future release and support. For example, IBM i 7.4 just debuted in 2019. Using the "7+3" support strategy, it is possible to predict that it will remain under regular and extended support until around 2029. As there are other unannounced releases on the product roadmap, predictions can go well into the 2030s.

IBM i product portfolio

As previously described, the strategic direction for IBM i and the portfolio of associated products is focused on three tenets:

1. **Solutions as the top priority**—providing modern business solutions by integration with the most modern technologies such as AI, cognitive, cloud and IoT
2. **Open for choice**—opening up the IBM i operating system to include open source components, thereby allowing new or existing applications to integrate with countless forms of cutting-edge technologies, including applications running on AIX and/or Linux
3. **Integrated value**—providing many new functions within the parameters of IBM i integration without compromising security, reliability and availability

With the continuous evolution of the underlying POWER technology and its increasingly powerful hardware, IBM i must accommodate those technology changes and exploit the new capabilities. This is true not only of the processors and memory advancements, but also of the various peripherals that can attach to IBM Power Systems, such as external storage devices.

Supporting these key tenets are strategies around each major functional area in the operating system, including:

- Database
- Business analytics and optimization
- Cognitive computing
- Application modernization
- Open source
- Mobile computing and mobile access
- Server virtualization and cloud technologies
- Resiliency and high availability
- Systems management
- IBM Power Systems servers
- Systems storage
- Data transfer
- Database

Database

A full implementation of Db2 for i is integrated into the IBM i operating system. IBM Db2 for i encompasses both native database record level access and standards based SQL. Db2 for i, like the IBM i operating system, was built from the ground up to meet the needs and expectations of business computing. The superior architecture of the database yields business value in the form of flexibility, scalability, security, ease of use and rock solid stability. Historically, this has also meant that many companies can rely upon IBM i to run their business with little to no investment in DBA staff, lowering the total cost of ownership.

The many capabilities and enhancements provided in Db2 for i have enabled clients to embrace both data-centric and analytics technologies. By handing over the responsibility of processing to Db2 for i, clients are able to focus on solving the next wave of business requirements while still continuing to satisfy their performance and scaling expectations. Whether clients are modernizing from DDS to SQL DDL, renovating their SQL DDL to accommodate very large data, becoming skilled at set-at-a-time SQL query composition, protecting business-critical data with database rules, or revamping what it means to be a database engineer, Db2 for i has the right tool for the task.

While "in-memory" database technology seems to be a new concept in the industry, IBM i architecture has had in-memory database since 1988. Single level storage on IBM i means that the system treats memory and disk as one address space, as if it was all memory. With the current releases, the in-memory capabilities on IBM i have taken a leap ahead of other implementations by allowing clients to pick and choose not only the tables and indexes to place in memory, but also which subsets of tables and indexes to include. Through the use of media and memory preferences, an IBM i client has granular control of which data is positioned the closest to their POWER processors.

Business analytics and optimization

Studies show that organizations that apply analytics outperform their peers. And those with a high "Analytics Quotient"—that is, a broad-based, analytics-driven culture—perform, on average, three times better. Business analytics helps organizations to recognize subtle trends and patterns, allowing them to anticipate and shape events and improve outcomes. Not only is it then possible to drive more top-line growth and control costs, but risks are also more easily identified up front, allowing correction before derailing business plans.

IBM business analytics software enables organizations to apply analytics to decision-making anytime, anywhere. IBM i clients can better analyze their data to reduce costs and improve service across their business with Db2 Web Query for IBM i. IBM, in cooperation with Information Builders, offers a full suite of query, reporting, OLAP and dashboard technologies to meet a wide variety of business intelligence solutions. With Db2 Web Query, clients operate at the speed of thought, while avoiding the complications of offloading data to another system.

In IBM i 7.4, the addition of the open source language R and the data science capabilities of Python have provided programmatic ability to build analytics over IBM i data.

Cognitive computing

Cognitive computing is quickly emerging as a transformative technology that enables organizations to gain business advantage. Also referred to as AI, cognitive technology augments human expertise to unlock new intelligence from vast quantities of data and to develop deep, predictive insights at scale. This shift to systems that can reason and learn is especially germane to the bottom line. The cognitive era is here in large part because it makes practical business sense. It's no surprise then that demand for cognitive computing technologies is skyrocketing.

For the past three years, IBM has been introducing IBM i clients to the world of cognitive computing. This has been a journey alongside clients and partners who have the desire to look at new ways of gaining competitive advantage and providing benefit to their customers.

IBM i client Caixa Geral de Depósitos France recently extended its banking application to include the ability to retrieve information from available social data, thus improving the odds of making good decisions about granting financial loans.[5]

Other companies have been using the value of AI for purposes like help desk operations, thus precluding

the requirement to have a 24-hour manned help desk. Instead, IBM Watson® answers queries and services end client needs.

Today, clients are beginning to look at other opportunities to realize additional value from their applications by utilizing non-traditional technologies such as visual recognition or text-to-voice translation. These are available from the IBM cloud or from on premise solutions such as an AC922 Power Systems server running IBM Watson Machine Learning Accelerator. Some machine learning libraries can also be run directly on IBM i, allowing clients the flexibility to create machine learning applications inside IBM i as well as outside. Technologies such as these can do tasks as basic as improving a user's experience or as complex as fraud detection. Many companies today are recognizing the business benefit inherent when integrating machine learning, deep learning and/or AI with their business application.

As the age of cognitive moves toward the world of AI and the convergence of graphics-based processing and compute-based processing, IBM i will evolve, providing the interfaces or code required to support our clients as they choose to make use of these emerging technologies.

Application modernization

While some IBM i clients run industry specific applications from ISVs, many clients develop and maintain their own applications. Many more clients customize ISV applications to suit their environment. The Norwegian Air Ambulance Foundation, for example, uses IBM i and Db2 as the system and database for their HemsWX weather camera system, which collects and distributes weather data all over Norway and Denmark to optimize rescue operations.[6]

IBM i offers a broad choice of development languages including the more traditional RPG, COBOL, C, C++ and Java languages. However, in the last six years, at the request of users, IBM has provided a wide variety of open source languages, tools and environments on IBM i.

In most shops and for most applications a blended approach to language use seems most common. Typically, RPG and COBOL are used for transaction processing or business logic, whereas open source languages are used for interfacing with users, AI and IoT devices.

The traditional languages of RPG and COBOL have undergone major changes in the last 10 years. IBM began shipping an open access component to RPG IV, enabling developers to call directly from RPG to other languages and interfaces. This was driven by the requirement to support multiple user interfaces, including mobile devices. Most recently, RPG Free form was announced a few years ago, and since that time has seen dramatic uptake by the community of RPG developers. This version of the language appeals to young developers as it resembles the format of many other "modern" languages with which they are familiar.

The COBOL language has been used on IBM i for more than 30 years. IBM continually reviews and updates the language, providing additional capabilities requested by clients. The recently announced IBM i 7.4 includes some of these additional features and functions.

IBM provides state-of-the-art development tools and enterprise modernization capabilities for IBM i. Based on the Eclipse standard, Rational® Developer for i (RDi) maximizes developer productivity. Industry experts in RDi cite 25-50 percent productivity improvement by just moving to the Integrated Development Environment on the desktop. IBM Team Concert and IBM Urban Code Deploy are the tools from IBM that assist in deployment and tracking of code across applications and systems.

Application development tools for IBM i are available from industry expert vendors. Many of them support traditional and open source development and bring additional unique capabilities to assist clients in creating applications that meet today's business requirements. IBM has included two of these vendor modernization tools in our channel: 1) ARCAD Converter for changing traditional RPG code into free-form RPG; and 2) ARCAD Observer for assisting in understanding and modularizing older styles of application code.

For clients extending their application portfolio to include Java or the web, IBM i is tightly integrated with the IBM WebSphere® portfolio of products. Formerly known as IBM WebSphere Application Server, the newest modern version, called the Liberty Profile, ships as part

of IBM i, allowing easy installation, configuration and management of web application serving. Additionally, the Integrated Application Server, imbedded in IBM i, provides an easy-to-use high performance environment for clients who require support for less complicated web applications.

Open source

More than 10 years ago, IBM brought the first open source language, PHP, to IBM i. Since then, the implementation of open source on IBM i has grown dramatically.

Today, Zend Server from Perforce is shipped with IBM i, providing the PHP runtime and a toolkit, giving easy access to IBM i applications and data. The most current release of Zend Server supports PHP applications split between server components and code running on mobile devices. Customers such as Swift Transportation use PHP extensively in their application portfolio to provide graphical interfaces for their users. RPC Superfos, for example, has converted much of their RPG environment to Free Form RPG for backend core operations and new open source languages (such as Python and Node.js) for frontend user interface modernization.[7]

Since the announcement of IBM i 7.2 in 2014, IBM has worked diligently to provide more open source languages, tools and environments inside IBM i. Today, the number of packages exceeds 250. These are delivered in the form of RPMs, a manner traditional to various Linux distributions, including Red Hat. This new mechanism allows IBM to deliver new versions of the many open source offerings quickly, without waiting for traditional code delivery through versions, releases or even TR announcements.

Open source is often called the language of cognitive and the language of IoT. Many devices that fall under the IoT have interfaces written in open source. Many cognitive services—IBM Watson and others—are most easily accessed using open source technology. There are examples of clients using these technologies to talk to robots in a warehouse or to sensors on a manufacturing floor.

Open source languages are the most widely taught development languages in the world. As these young developers join IBM i shops, it is critical that the development environment evolves as well, providing the most modern and up-to-date environments possible.

Mobile computing and mobile access

Providing access from mobile devices has become a key consideration for delivering applications. Mobile users demand mobile websites and mobile applications that enable them to securely transact business with a wide variety of enterprises.

IBM i has numerous enabling technologies to assist companies as they embrace mobile computing. Building on top of IBM i integrated security and the ability to easily lock down critical business data, there are many ISV tools that allow clients to expand the application user interfaces to mobile phones and tablets. Kawasaki Heavy Industries Motorcycle and Engine Company, for example, developed a new eKanban mobile solution that allows their assembly inventory specialists to scan in or enter deliveries of parts at their assembly line and to monitor the balance of parts at the line and on the floor.[8]

Extending the breadth of reach of the tools made available by IBM, many experienced vendors provide tools and services to assist companies that are building mobile interfaces to their business applications. Many of them provide code generation capability targeting multiple mobile platforms. Others provide guidance and templates, letting developers tailor these to suit company requirements.

Server virtualization and cloud technologies

IBM i has a heritage of virtualization technology going back to the announcement of AS/400 in 1988. The operating system design featured subsystems that enabled multiple applications to run separately in a single system image.

In 1999, IBM also introduced the first PowerVM® logical partitioning technology, enabling separate virtual machines to run on the same Power Systems server. PowerVM, which ships on all IBM i Power Systems servers, provides scalable and secure server virtualization for AIX, IBM i and Linux environments. PowerVM features micro-partitioning with up to 20 partitions per

core, Live Partition Mobility between servers, dynamic or automatic movement of processor and memory resources, and a wide range of I/O virtualization capabilities. PowerVM and IBM i subsystem virtualization are used extensively by IBM i clients and are a key driver of lower operations costs.

Today's world is becoming increasingly about cloud. For IBM i, this is nothing new. Many ISVs have offered "cloud" options for their clients for years, long before the industry even called it a cloud. These SaaS models remain a growing investment area for both end clients and ISVs.

IBM i clients are increasingly taking advantage of the rise of IaaS and PaaS models for cloud. These models allow clients to move their infrastructure out of their enterprise and into a data center owned and operated by a third party provider. Clients anticipate that this will relieve the requirement for them to manage the complexities of the data center themselves, and may free up resources for other tasks.

IBM recently announced the availability of IBM i and AIX in the IBM Cloud. This will allow clients to move their workloads to an off-premise data center, run by IBM. Other service providers in the marketplace offer similar services to the IBM Cloud. Most of these can be found by contacting local IBM representatives or IBM Business Partners®.

Deploying an effective cloud computing environment, organizations may reduce IT costs, improve service delivery and enable business innovation. By migrating to a cloud-based version of IBM i on an IBM Power System S924, for example, family-owned wine merchant Wijnen Van Maele has been able to reach more B2C customers, innovate blockchain solutions, and avoid capital costs.[9]

Resiliency and high availability

There are three approaches to providing high availability/disaster recovery solutions for IBM i—continuous availability, logical replication and hardware clustering. As with HA/DR technologies, all three solutions replicate data from a production system to another system and enable switching (also known as a role swap) between the two systems in the event of an outage on the production system. However, the way in which each approach is implemented is quite different.

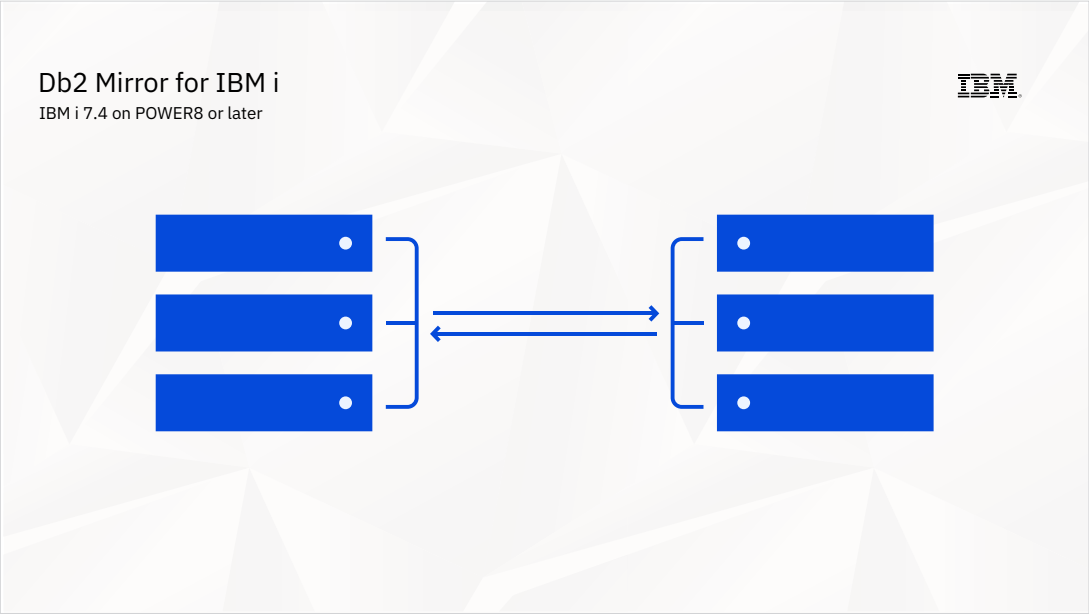


Figure 4 — Db2 Mirror for IBM i

IBM i 7.4's new LPP—IBM Db2 Mirror for i—is designed to address environments requiring continuous application availability: a recovery time objective (RTO) of zero and a recovery point objective (RPO) of zero. The foundational technology is based on integrated IBM i operating system function that enables two copies of the IBM i integrated Db2 database to synchronously replicate inserts, updates and deletes across two

systems in a tightly coupled active-active configuration at the database level. At the application level, applications can be deployed in an active-active configuration or in an active-passive configuration, and both options will enable a near-zero RTO.

IBM PowerHA provides a disk clustering solution for IBM i. PowerHA is an easy-to-manage clustering solution that makes it simple to switch between systems, is easy to maintain and is supported directly by IBM. As more IBM i clients transition to SANs, PowerHA also offers the advantage of a resiliency solution that is tightly integrated with both the IBM i operating system and IBM System Storage® servers and software.

Logical replication solutions are available from ISVs that base their software on the remote journaling capability of the IBM i operating system.

With these disk clustering and logical replication options, IBM i clients have a broad range of choices for their high availability and disaster recovery needs.

Systems management

Systems management is a broad term used when referring to the ability to configure hardware and software, allocate resources, distribute workload, monitor performance, maintain security and access to the system, plan capacity, and execute other tasks that pertain to efficient resource allocation.

IBM Access Client Solutions for i is the strategic product used by system administrators for management of IBM i. As the name infers, it is used by end clients to access system resources. Additionally, the suite of database tools and interfaces allow a database engineer to do the kind of database configuration and monitoring required to ensure that the needs of the business are met. Access Client Solutions for i is updated on a regular cadence based on input from the IBM i community.

The IBM Navigator for i tool offers an easy-to-use, web-based management solution with graphs and visualizations to help a system manager review and gain deeper understanding of the performance characteristics of their IBM i implementation. For those enterprises with multiple IBM i systems, the IBM Administration Runtime Expert product helps to compare environments between systems, including such things as job execution parameters, job description information or PTF levels. Systems administrators can use this information to assist with debugging of incorrect execution or to manage the distribution and installation of fix levels from location to location.

There is also a wide range of additional integrated service management tools available from IBM Software.

IBM Power Systems servers

IBM Power Systems servers are powerful, flexible servers built to deliver value for diverse workloads and mission-critical applications for IBM i environments as well as for AIX and Linux. These servers feature the latest POWER9 processor technology. With an integrated set of resources that are always available and comprehensive data management capabilities, POWER9 servers can align technology with business demands, uncover new value in data, and drive innovation, all while securely and efficiently delivering business services to help reduce costs.

POWER processor technology is the foundation of the Power Systems server design, optimized for both traditional transaction processing like financial and ERP applications as well as compute and data-intensive workloads like web, analytics, mobile and AI application workloads. This is the same IBM POWER9 processor that drives the world's fastest supercomputers, Summit and Sierra. To achieve maximum performance, POWER9 processor-based systems are designed with dynamic performance and virtualization optimization technologies that enable the system to tune automatically to a variety of workloads. The current POWER9 processor-based systems support three different operating systems—AIX, IBM i and Linux.

IBM Power Systems have security built in at all layers in the stack—processor, systems, firmware, OS and hypervisor. With accelerated encryption built into the chip, data is protected in motion and at rest.

IBM Power Systems servers are optimized for the rigorous demands of enterprise computing, but IBM understands that applications and business processes have differing demands and that one size doesn't fit all. To ensure that infrastructure technology aligns to business rather than the other way around, IBM offers a full range of Power Systems servers, each of which

delivers leadership capabilities for security, performance and scalability in its class.

IBM has the right servers to support business strategies of all types with the flexibility to make a multi-cloud strategy a reality, featuring less downtime, lower licensing fees and easier management than x86 servers.

System Storage

IBM i clients have a variety of storage requirements based on capacity, performance and cost. These requirements can be met with internal and external storage options.

Historically, most IBM i clients deployed integrated, or internal, storage that was managed and optimized directly by the operating system. The use of high-speed RAID adapters ensured that internal storage provided optimal performance, especially for high volume transaction processing applications. Internal storage continues to be one of the lowest latency and among the most highly optimized storage options for IBM i.

SSD drives with their ultra-fast IO performance have enabled many IBM i users to significantly reduce the runtimes of their daily, weekly and monthly batch jobs. IBM i maintains its leadership position in the intelligent management of data on SSDs, placing the most frequently accessed data onto the SSDs and managing a hierarchy of storage options.

Over time, however, more IBM i clients have adopted external storage that is managed both by the operating system and an external storage server. External storage has brought features and functions to the IBM i platform that are not available with internal storage. For example, the use of Copy Services on external storage has introduced new ways to do backups that significantly reduce the downtime window. PowerHA has integrated operating system function and external storage to provide robust HA/DR solutions. PowerVM utilizes the flexibility of configurations to provide capabilities like Live Partition Mobility. PowerVC exploits external storage to be able to provision IBM i LPARs in minutes.

IBM i supports many IBM storage servers including the IBM DS8000 family, IBM Spectrum® Virtualize based systems, and Flash Systems. This range of attachment options spans from highly performance optimized to highly virtualized, allowing for a right fit in external storage.

IBM constantly updates storage hardware and software to support the wide variety of available storage options, providing flexibility to meet client requirements.

IBM i community resources

As stated previously, IBM i has a large community of passionate and active user groups around the world. There is a wide range of resources available to the IBM i community, listed in the following sections.

IBM resources

- The developerWorks IBM i Zone is aimed at technical professionals and contains a wide variety of easily accessible technical articles, tutorials, new release and IBM i TR information.
- The You and i blog by Steve Will, the Chief Architect of IBM i, discusses trends and strategies for the IBM i platform.
- The Open Your i open source blog by Jesse Gorzinski outlines many of the new open source environments being added by IBM and the community.
- Tips found in the Db2 for i blog by Mike Cain, Team Leader Db2 for i Center of Excellence, can assist database administrators and database programmers in learning new features and functions but also learning new ways to do old things.
- IBM Db2 Web Query for i by Doug Mack, Senior Consultant Db2 Web Query, outlines new features and best practices for using Db2 Web Query for analytics and how to access APIs with Watson.

– The IBM Champions program recognizes thought leaders from the business and technical community of IBM clients and Business Partners. These respected IBM i subject matter experts comment on a wide range of topics, and can be accessed at the Power Champions website.
– IBM Technical Conferences feature Power Systems and IBM i topics for IT professionals.

IBM i community resources

– The i Can blog written by Dawn May shares hidden gems and best practices advice for IBM i technical professionals.
– For RPG developers, IBM Champions Jon Paris and Susan Gantner's iDevelop blog is an outstanding resource.
– Using his electronic publication, iTalk with Tuohy, IBM Champion Paul Tuohy publishes interviews with leading industry experts from all parts of the IBM i community.
– IBM Bi-Weekly is a podcast focused on the technical aspects of the IBM i operating system and the community revolving around it. The podcast has both an audio and video format. Co-hosts Liam Allan and Josh Hall, along with occasional guests, explore IBM i hot topics.
– COMMON North America provides a number of publications and educational offerings for all skill levels, from basic to advanced. In addition, they run one large annual conference in the spring and a smaller focused event in the fall each year.

Website

– **IBM i Home Page**
www.ibm.com/systems/i
– **IBM Systems Magazine IBM i Edition**
www.ibmsystemsmag.com/ibmi/
– **Support Life Cycle**
www-01.ibm.com/software/support/ibmi/lifecycle/

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Endnotes

1 Case Study: JORI
2 Case Study: Caixa Geral de Depositos France
3 Case Study: Carhartt
4 "2019 IBM i Marketplace Survey Results." Tom Huntington, helpsystems 2019.
5 Case Study: Caixa Geral de Depositos, France
6 Case Study: Norwegian Air Ambulance Foundation
7 Case Study: RPC Superfos
8 Case Study: Kawasaki
9 Case Study: Wijnen Van Maele

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