IBM i in 2019: It’s Not Just AS/400

IBM’s Steve Will talks AS/400, POWER9, IBM i 7.4, cognitive systems, and everything in between.
Your Presenter and Moderator

Steve Will
*IBM i Chief Architect*
IBM

Tom Huntington
*Executive VP of Technical Solutions*
HelpSystems
Polling Question

How much experience do you have with IBM i?
IBM i in 2019 – It’s Not Just AS/400
Let’s Start with the Architecture Evolution

Steve Will – IBM i Chief Architect
IBM i Architecture

DB2 for i & Single Level Store
Automate & optimize storage management

Object Based Architecture
Enables integrity, security, virus-resistance

Integration
Integrates business components, e.g. DB2 database

Virtualized Work Management
Provides built-in application virtualization

Technology Independent Machine Interface
Ensures application compatibility across multiple technology generations

A system designed for business
1988
AS/400®

System/38 (1978)
System/36 (1983)

2000
IBM iSeries

2008
IBM for Business

Power Systems
ARCHITECTURE

- DB2 for i & Single Level Store: Automate & optimize storage management
- Object Based Architecture: Enables integrity, security, virus-resistance
- Integration: Integrates business components, e.g. DB2 database
- Virtualized Work Management: Provides built-in application virtualization
- Technology Independent Machine Interface: Ensures application compatibility across multiple technology generations
Applications are compiled to an intermediate language, not processor instructions.

The “MI” (or “TIMI”) is the defined set of these instructions.
Layered Architecture of OS/400

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The “MI” (or “TIMI”) is the defined set of these instructions.
PASE – Portable Application Solutions Environment

• By 2000, AIX and OS/400 were able to run on the same POWER processors.

• This created the possibility for executables which are MI-based and AIX-based to run on the same hardware in the same partition.

• PASE makes it possible for those binaries to run in the same process.

• PASE is a release of AIX
  – Fitted to talk to SLIC rather than directly to the AIX kernel.

• PASE gets the memory from same SLIC teraspace pools used by ILE
  – for program run stack, heap, and shared memory
  – PASE can ONLY see memory that PASE acquired through its own syscall APIs
PASE allows IBM i to host:
- Java
- SAP
- PHP
- Ruby
- And many other open source options
All storage on the system is treated as a single contiguous set of memory, so mapping storage required special methods and knowledge of storage devices.

System/38 and initial AS/400 used 48-bit addresses for what became known as “Single Level Storage.”
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System/38 and initial AS/400 used 48-bit addresses for what became known as “Single Level Storage.”
Tags

A “tag” per 32-bit word to indicate it’s part of a pointer.
The original AS/400 hardware was a 48-bit processor, which implemented a “Complex Instruction Set.”
CISC to RISC

Technology Independent Machine Interface (TIMI)

Vertical Machine Code (VMC)

Horizontal Machine Code (HMC)

48-bit CISC Processor

Technology Independent Machine Interface (TIMI)

Licensed Internal Code (LIC)
(aka SLIC)

64-bit RISC Processor
CISC-to-RISC migration: 64-bit addresses – replaced addressing scheme

- 16-byte Space Pointer
  - effective address
  - space locator
  - Header
  - first byte
  - User-Addressable Space
  - last byte
  - a space object

- 64-bit effective address
  - offset within segment
  - segment #
  - byte within segment

- 64-bit address space
  - Segment 0
  - Segment N-1
  - Segment N
  - Segment N+1
  - Segment 0xFFFF_00000000

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The Architecture – post-CISC

Technology Independent Machine Interface (TIMI)

Licensed Internal Code (LIC)
(aka SLIC)

Processor technology: 48-bit CISC to 64-bit RISC
SMP: from 0.2 core up to 192 cores; 768 threads
Memory and Disk: Increases in capacity and density
I/O adapters: SPD to PCI to PCI-X to PCIe

So, did the “Architecture” change?
Above TIMI? Not so much.
Below TIMI? You betcha!
Web Serving Drove Changes

- HTTP was gaining strength as a presentation protocol
  - With imbedded data retrieval from a web server
- V3R7 – CERN-based web server
  - Single instance only; V4R1 – Multiple servers allowed
- V4R5 – Apache-based web server

-Benefited from Multi-threading

- Drove requirements for
  - Digital Certificates
  - Server Architecture
  - Teraspace
Teraspace: Storage Revolution

• 1 Terabyte (= $2^{40}$ bytes)
  – flat (non-segmented), process-local storage
  – Temporary

• Lightweight 8-byte pointers available
  – high performance, untagged

• And definitely NOT Single-Level Store!
IBM i 6.1 Retranslation: Teraspace

- Teraspace initially implemented in software – in SLIC

- Over time, processor support was added to improve use and integrity of addressing.

- By 6.1, all supported machine types had the necessary processor support to do teraspace “right.”

- Retranslation accomplished true “hardware protection” and use of teraspace.

Parsing a teraspace address

24 bits 40 bits

91AC7E8000240008

Displacement into teraspace

Teraspace Segment ID (TSSID)
The '9' indicates a teraspace segment.
Integrated DB

Figure 1  Interface to AS/400 Data Base
Integrated DB

Figure 1  Interface to AS/400 Data Base
The Classic Query Engine - CQE

User Question in the Form of a Query → DB2 Answer
DB2 Architects Saw Opportunities

- DB2 Architects wanted a Query Engine which could
  - Take advantage of knowing it was dealing with SQL
  - Learn from the past
  - Use what it learned from queries for one application to improve queries for other applications.
The SQL Query Engine

User Question in the Form of an SQL Query

DB2 Answer
Avoiding Disruption Was Paramount
Db2 on i: Strategic Evolution of Business Data Value

- Db2 Web Query for i
- Metadata
- Show Statements
- Visual Explain
- SQL Plan Cache
- Index Advice
- Connections to Watson/IBM Cloud
- Star Schema Optimization (Look-ahead Predicate Generation)
- EVI Index Only Access
- BI/DW Tooling
- DBE Tooling
- Query Accelerators
- SQL Language
- IBM i Architecture

- Symmetric Multi-Processing
- Encoded Vector Indexing
- Adaptive Query Processing
- Maintained Temp Indexes
- Materialized Query Tables
- Aggregations in EVIs
- Result Set Caching
- SQL Aggregate Functions
- Grouping Sets, Rollup
- Single Level Store
- Large Memory Model
- SQL Stats Functions
- SQL OLAP Extensions
- Rank, Dense Rank

Delivered at various points over time
File Systems

- System/38 had one file system – QSYS.LIB – which was (is) “flat”
  - By the late ’70s, hierarchical file systems were proving their value

- System/36 implemented QDLS and AS/400 included it as a system-wide architecture
  - So, again, the AS/400 architecture was more than just the S/38

- The industry defined a standard hierarchical file system, as part of the POSIX standards

POSIX
Today's modern applications assume a standard, hierarchical file system.
IBM i Milestones

1988

AS/400®

2000

2008

2018

thirty
years
IBM i Thought Leadership at HelpSystems

- Annual IBM i Marketplace Survey
  - 2019 marks our five-year anniversary!

- Annual State of IBM i Security Study
  - Free Security Scans

- Free Tech Updates
  - Sharing IT roadmaps with IBM i experts
HelpSystems Professional Services

- **Business Continuity Services**
  - Backup/recovery assessments
  - Business continuity architecture
  - Role swap testing

- **Security Services**
  - Risk assessments
  - Penetration testing
  - Security architecture
  - Remediation

- **Capacity Planning Services**

- **Document Management Services**
  - Business process assessments

- **Managed Services**
  - Managed security services
  - Managed single sign-on services

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Carol Woodbury

Pat Botz
Cybersecurity
Powertech Solutions for IBM i

- Compliance Reporting: Compliance Monitor for IBM i
- Privileged Access Management: Authority Broker for IBM i
- Self-Service Password Reset: Password Self Help for IBM i
- Database Monitoring: Database Monitor for IBM i
- User Provisioning: Identity Manager for IBM i
- Multi-Factor Authentication: Multi-Factor Authentication, SecurID Agent for IBM i
- Native Encryption: Encryption for IBM i
- Security Scan: Free IBM i security snapshot

- Perimeter Access Control: Exit Point Manager for IBM i
- Command Monitoring: Command Security for IBM i
- Automated Risk Audit: Risk Assessor for IBM i
- Security Information and Event Management: SIEM Agent for IBM i, Event Manager
- Native Virus Protection: AntiVirus for IBM i
- InfoSec Policy Control: Policy Minder for IBM i
- Secure Managed File Transfer: GoAnywhere
IT Operations Management

Robot Solutions

Automated Job Scheduling
- Robot Schedule
- Robot Schedule Enterprise
- Robot Replay
- Robot Alert

Performance Monitoring
- Robot Monitor
- Robot Space
- Robot Autotune
- Robot Alert

Message Management
- Robot Console
- Robot Network
- Robot Alert

Capacity Planning and Analysis
- Performance Navigator for IBM i
- Performance Navigator
  - AIX, Linux, Solaris, and HP-UX

High Availability and Backup
- Robot HA
- Robot Save
- Robot Alert

Report Management
- Robot Reports
- Robot Alert
Polling Question

How can HelpSystems help you?
IBM i Milestones

1988

AS/400®

2000

Power Systems

2008

for Business

2018

thirty years
More architectural advances not covered above

- Threads
- Development Tools
- ILE
- Display & Print
- Management via Services
- Object Signing
- Enterprise Identity Mapping
- Scaling
- Nodal Affinity
- Independent ASPs
- Logical Partitioning
- N-2 Support
- Technology Refreshes
- Evolution to Waiting Servers
- Integration of Open Source
Though IBM i rarely removes things …

- Storage Technology
  - From 520-byte proprietary, to 512-byte commodity, to SAN

- I/O
  - During the CISC-to-RISC transition, the move from IOP-based I/O to IOA-based I/O was happening

- Networking
  - Does anyone remember SNA? The networking architecture of AS/400 was based on it.

Major pieces of the architecture of S/38 & AS/400: Gone or transformed to be nearly unrecognizable.
New Development Paradigms

- Graphical User Experiences
  - Grown from GUIs to Experiences

- Agile Development
  - Work in highly collaborative groups
  - Time line is strict
  - Small adaptive modules

- Framework Development
  - Consistency in code creation
  - Component based
  - Model – View – Controller
  - Agile
  - Services Orientation

- Modern development tools
  - Eclipse based rich editor
Modern Application Environment

Java
PHP
GCC
Ruby
Node.js
Python

RPG
COBOL
CL
etc

User defined Types
Stored Procedure
Trigger
Aggregate Functions
User defined Functions

Database

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Continuous Availability

What is the API economy?

The API economy is your opportunity to disrupt business as usual—the chance to rethink business models and reach new audiences. It’s the new way to deliver digital services to employees, partners and consumers, so you can:

Unlock efficiencies.

1.6M applications are now in the Google Play Store.*

Rise above the crowd. Create smart applications that connect with back-end data for new value.

Drive innovation.

70% of US organizations are actively consuming APIs, according to IDC.†

Make an impression. Build stronger customer relationships based on rich user experiences.

Reveal new market opportunities.

1.8x is how much more likely Generation D (data rich, analytics driven) enterprises are to use API-based services.‡

Satisfy real needs. Innovate at the speed of thought, connecting with partners around the world.

Let’s start disrupting together.

Find out how you can get started in the API economy by visiting ibm.com/api-economy

* Based on data from Google Play, as of 2018.† Based on the results of the 2016 Study of API Adoption Among Global Enterprises by International Data Corporation (IDC).‡ Based on the results of the 2016 Study of API Adoption Among Global Enterprises by International Data Corporation (IDC).
IBM i for Innovation – Solutions Using New Workloads
Internet of Things – Sensors and More
Norwegian Air Ambulance - Norway

27 C

Mostly Cloudy

Wind: W at 6 mph

Humidity: 79%
Robotics
Brødrene A&O Johansen A/S - Denmark
Highly Sensitive Robotics
Cras Woodshops – Belgium – Future Robotics TODAY!
Robertet - France
The emerging realm of AI and Machine Learning can bring seemingly-limitless opportunity for your enterprise (and perhaps even mankind). How can you leverage these new technologies from IBM i? This session will provide an overview of what technologies you can be using from your IBM i today. We will cover various AI/ML packages available to run on the system, as well as the cloud-based capability of IBM Watson. After all, IBM i has always been a data-centric platform. Surely, Db2 for i houses mission-critical and intensely valuable data. Coupling AI and ML with this data can bring an unprecedented amount of innovation.
IBM i & Watson

IBM Cloud

IBM Watson
Services and APIs

for Business

IBM Watson Analytics
The Cloud
Steffimmo - Belgium
Modernization and Cloud Journey for POWER Customers

- Manage Hardware and Ops
  - HMC
- Manage Cloud Infrastructure
  - PowerVC Cloud
- Create and Manage Cloud Native Apps
  - IBM Cloud Private
  - + Cloud Automation Mgr.
db2-for-ibmi

service

Deploy an IBMi DB2 instance.

i-nodejs-setup

service
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<th>IBM Cloud for Skytap Solutions (ICSS)</th>
<th>PowerVM on IBM Cloud</th>
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<td>A purpose-built, public cloud designed for traditional legacy applications that are stuck in the datacenter. We migrate and then accelerate modernization to unlock innovation.</td>
<td>Self-service Power Virtual Servers in the IBM Cloud for mission critical workloads where full architectural equivalency with on-prem Power infrastructure is desired</td>
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Self-Service on demand cloud for running dynamic & always-on workloads for Power - AIX, Linux, IBM i®, x86 – Windows & Linux based applications together

Consistent architecture with certified mission-critical enterprise Independent Software Vendors

Announced June 17 2019

* IBM i support Target June 2019
What Will the Future Bring?
IBM i Release Roadmap

** All statements regarding IBM's future direction and intent are subject to change or withdrawal without notice, and represent goals and objectives only.

** Arrows indicate "ongoing status and do not imply any specific dates."

IBM i: A platform for innovators, by innovators

IBM i never stops innovating with new features so that you never have to stop innovating your organization.
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Ensures application compatibility across multiple technology generations
IBM i - "Technology will change and IBM i is built to change with it"
ithankyou
Any questions?
Flexible IT Software Solutions
Our solutions help customers save time, money, and eliminate errors.

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Thank you for joining us!

www.helpsystems.com

tom.huntington@helpsystems.com