SAP Adaptive Server Enterprise (ASE)

What is New with ASE 16 in 2017 and Beyond

August 22, 2017

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The Digital Economy: Going to Extremes

Transaction-intensive, with more data, more users, more devices, more locations

6.1B
People using smartphones by 2020
Ericsson, 2015

$106B
Mobile payment transaction volumes by 2020
Ericsson, 2015

400M
In-store beacons by 2020
ABI Research, 2015

20.8B
Connected things will be in use worldwide by 2020.
Gartner Symposium/Itxpo, 2015

Extreme OLTP Challenges

Transaction Velocity

- Automated Processing
- Streaming Data

Need for greater throughput in highly concurrent environments

- Algorithmic trading, internet “bots”, micro-transactions (e.g. credit card/text to win) result in greater user concurrency and transaction volumes
- Internet/cloud services pushing more centralized transaction processing with local/regional fulfillment

Transaction Latency

- Internet of Things/Sensor Data
- Mobile apps

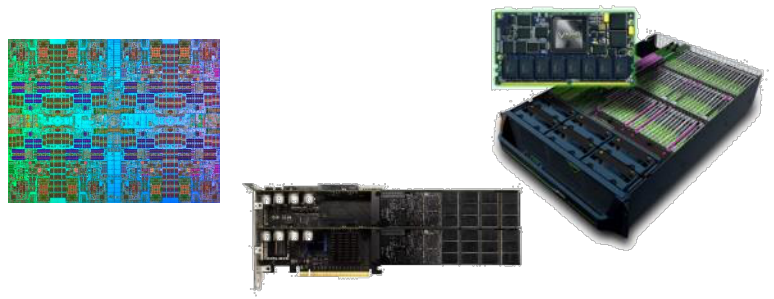
Transaction latency is now in milliseconds pushing towards microseconds

- Customers are using internet/mobile apps for direct interaction

SAP Adaptive Server Enterprise (ASE)

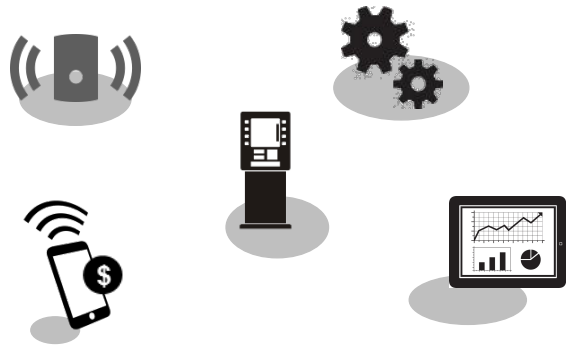
Key trends and impacts in business and technology

Hardware is rapidly evolving
- Very high core counts per socket (24+) & chip level API's (TSX, SIMD, etc.)
- Larger memory (>4TB) → in-memory processing
- Movement away from HDD to SSD (PCIe & AFA….NVMe/UltraDIMM next)



Cost, TCO & ROI are key factors
- Commodity hardware
- OpenSource → reduce acquisition costs for simpler/smaller systems
- Cloud → reduce data center & infrastructure costs for surge applications
- Limitations in data center power & cooling → denser platforms & virtualization

Architectures & Application development shifting
- JSON not only used for data interchange, but also schema simplification
- Shared nothing clusters for scalability
- Streaming replication for High Availability/Disaster Recovery
- Cloud for dev/test & common micro-services
  - Cloud backups, cloud DR, data tiering to cloud, etc.



Security is crucial
- Data and network protection from hackers
- Regulatory compliance for auditing/access controls
- Data encryption & masking for cloud

Powering Next-Gen Applications for Digital Enterprises

SAP ASE is a Transactional RDBMS designed for speed, efficiency, and reliability

Scalability & Performance

Workload Optimization

Security

Real-time Data Distribution

High Availability/
Disaster Recovery

Cloud-Ready &
Flexible Deployment

- Achieve fast performance for transaction-intensive applications on common, open platforms
- Scale transactions, data, and users in the cloud and on premise
- Simplify operations and reduce costs with workload analyzer, built-in high availability and disaster recovery and resource optimizations

ASE Roadmap – Strategic Thrusts for the Digital Enterprise

Innovation and Leadership

	Today (ASE16 SP03)	Future
OLTP Performance	• In-memory processing with ACID property • Concurrency enhancements with Multi-version concurrency control support – in memory and on disk • Extreme performance with order of magnitude throughput increase on large core count machines	• Support in-memory tables that are not persisted – similar to IMDB, but reduced latency from use of IMRS/HCB • Support >200K conn and >4TB memory • Additional enhancements to reduce contention and increase concurrency
Datacenter Operations (Availability, Security, cost reduction)	• Built-in, unified solution for HA and DR using synchronous replication • Ease of tuning and upgrade with Workload Analyzer in ASE Cockpit • Full-text auditing of DDL commands	• Replication and XA support with HADR • 100% online utilities for max uptime • Data Masking • Audit repository & tracking data lineage • Performance monitoring analytics
Virtualization and Cloud Support	• DBaaS on SAP Cloud Platform and BYOL on AWS, Azure for custom & Business Suite	• Subscription model on Amazon • Cloud services on AWS and other cloud providers for hybrid deployments • Cloud Foundry, SCP support for app dev
ASE and HANA	• Run reporting applications on HANA without any code changes • Build new apps on ASE using SQLScript	• Support for IBM/Linux platform for accelerating reporting apps • SQL Script phase 2 support

ASE 16 SP03

Extreme Transaction Processing for the Digital Enterprise

ASE 16 SP03 (June 2017): Key Features

OLTP Performance

In Memory Row Store, MVCC
(Database MemScale Option)

Data Center Operations

Always-On Enhancements
(Database Always-on Option)

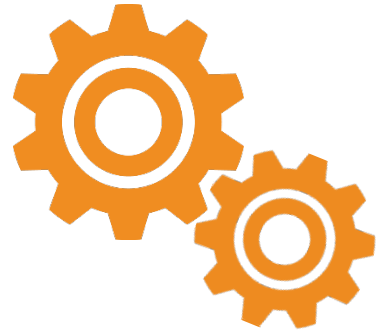
Security Enhancements

Business Suite Enhancements

Cloud Enablement

ASE Cloud Backup
SAP and 3rd party cloud platform support

ASE and HANA



HANA SQLScript Support

OLTP Performance: Overcoming Cache Contention

Cache Management is source of problem

When the database size exceeds memory capacity, some form of cache management is required to optimize cache hits

Typically, this uses algorithms similar to MRU-LRU

ASE 16 SP02 MemScale was a partial solution

Lockless data cache (LLDC) worked well on relaxed caches, but not the more typical strict MRU/LRU such as default data cache

Transactional Memory helped reduce the contention by using hardware atomic instructions instead of mutexes for swapping cache pointers in MRU/LRU

Core ASE Features

Cache partitions

Named caches

Relaxed cache replacement strategy

ASE 16 SP02 MemScale Features

Lockless Data Cache (LLDC)

Transactional Memory (TSX)

Supporting XOLTP - In-Memory Row Stores

ASE 16 In-Memory Row Store (aka Data Row Cache)

Focus is on

- Frequently read data rows
- Frequently updated data rows (including initial insert + subsequent updates)
- May not be any benefit to streaming/bulk inserts in which data is rarely read immediately after inserted

ASE 16 SP03 MemScale Features

In-Memory Row Store

Hash Cache B-Tree

Data Row Caching via the In-Memory Row Store

Key Facts

Some of the most active tables are also the largest
- For example, transaction tables, etc.

It all won't fit in memory

Today's data hotter than yesterdays, ….

Data Row Caching

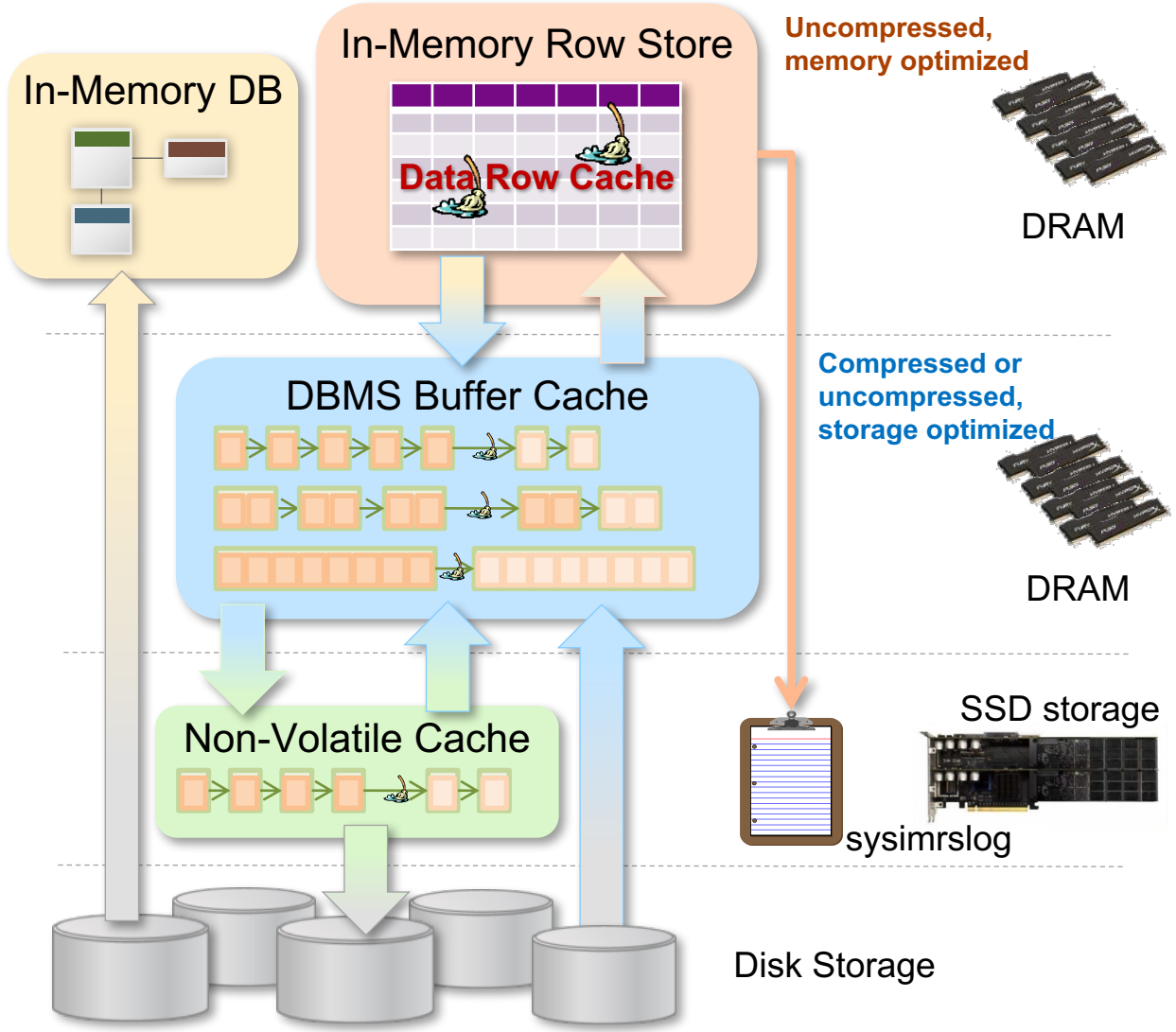
Frequently accessed data is promoted to DRC
- Newly inserted rows
- Frequently selected or frequently updated

Uses memory optimized cache techniques
- Row versioning for updates
- Data is uncompressed for frequent reads/updates

Optimized IMRS log for ACID durability/recovery

As it "cools", it is packed back to normal DBMS buffer cache

Works in conjunction with MVCC and HCB



In-Memory Row Store & Data Row Cache

Key point to remember

All data eventually is on page-based disk

In-Memory Row Store (IMRS)

A special type of named cache that is used as a row store buffer

1:1 correspondence with a database

Data Row Cache (DRC)

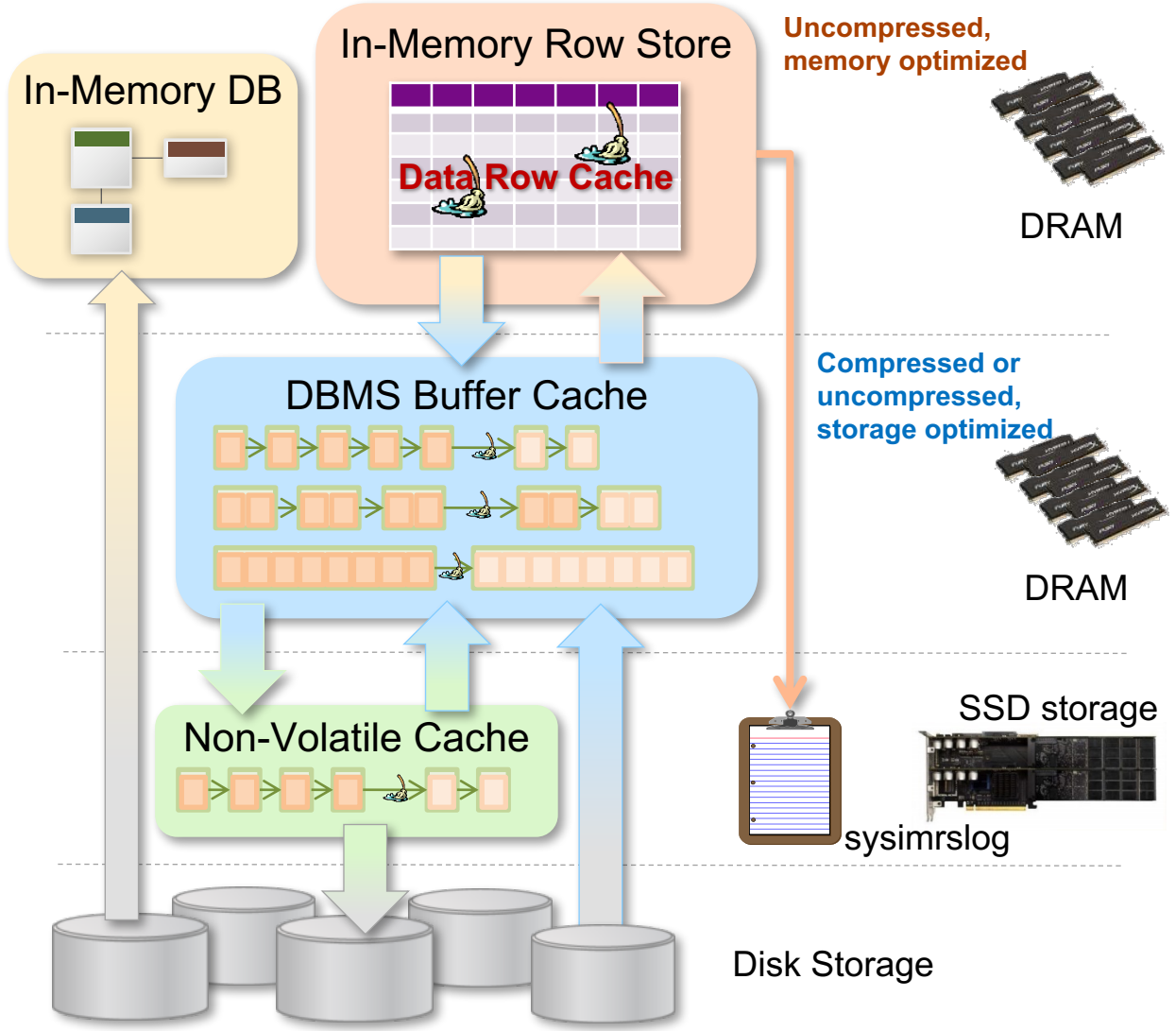
The cached rows from imrs-enabled tables

Database imrslog

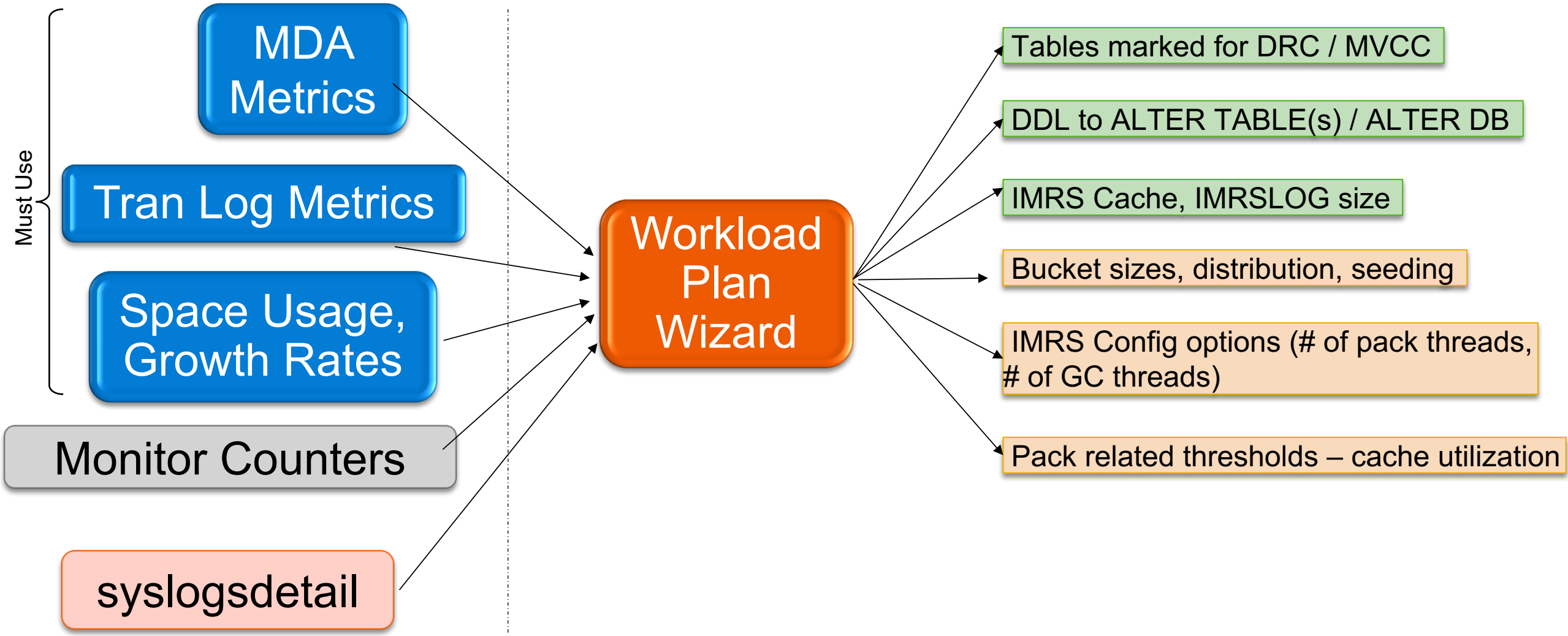
A database device/segment that contains both the imrs cached rows as well as the committed txn journal

- Sysimrslogs (similar to syslogs) plus data

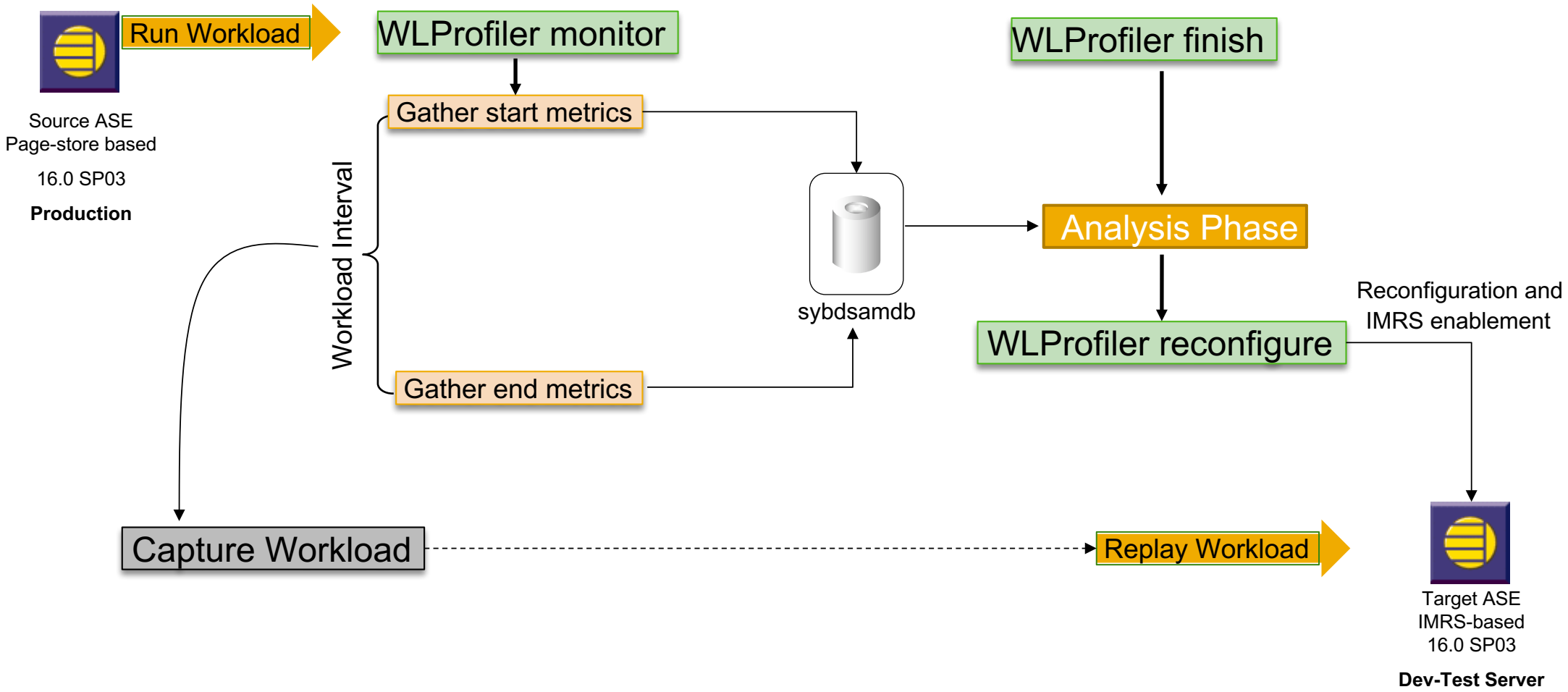
It is created on a standard ASE virtual device



Avoiding the Guessing….. Workload Profiler

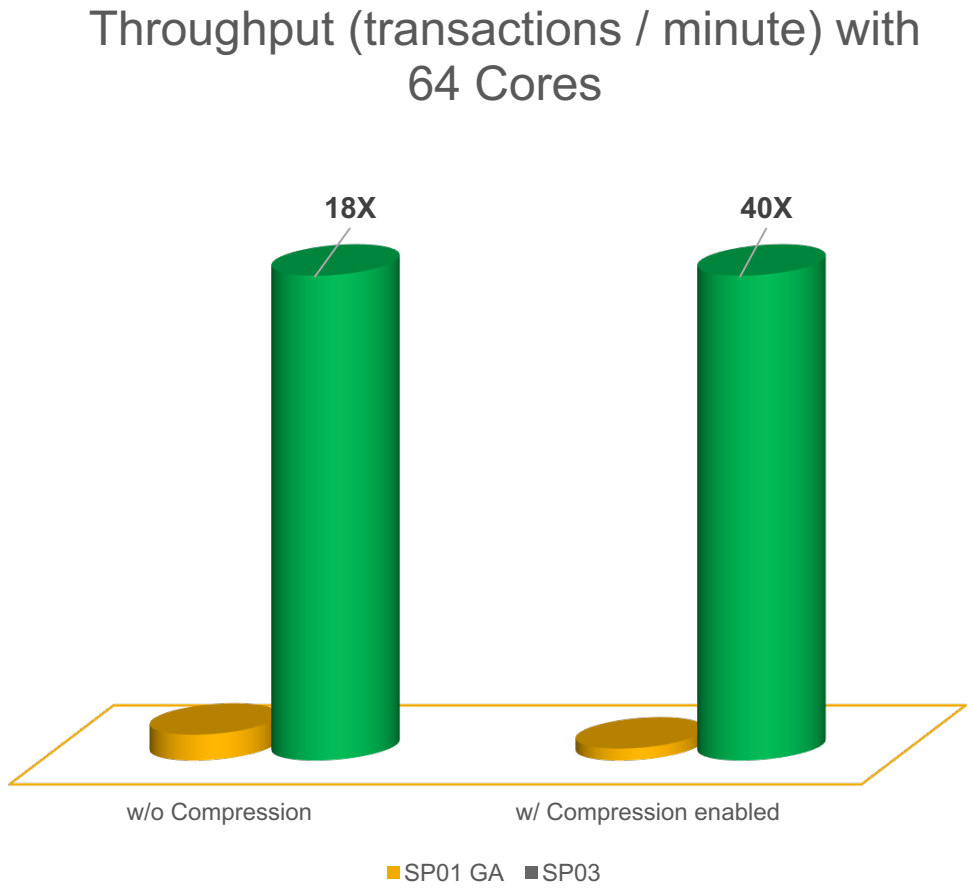


WLProfiler & WL-Analyzer: Co-deployment Workflow



Note: Capture & Replay of Workload is done using Workload Analyzer (ASE 16.0 SP02)

E-2-E Throughput Gains



Scaling Improvements with minimal tuning

- Mostly only configuration changes; e.g. lock hash table size, named cache for syslogs, procedure / statement cache sizing, …
  - No table- / object-level tuning included (e.g. partitioned tables, named caches for tables & indexes … not done)
- **SP02 scaling improvements:**
  - Latch Free Btree (LFB)
  - Lockless Data Cache (LLDC)
- **Further scaling improvements SP03:**
  - In-Memory Row Cache
  - Hash Indexing
  - Compression code-path improvements
- More than 2.5X performance gains with SP03 features compared with results with ASE 16 SP02

Best of Both Worlds: Hash Cache B-Tree

Hash Cache B-Tree

Only on unique indexes for IMRS enabled tables

Rows promoted to IMRS will have unique index keys hashed and added to HCB

- Hash chain node points to IMRS row

If row is demoted from IMRS, unique index keys stay hashed in HCB

- Hash chain node points to row in row offset table same as b-tree index page+RID

Advantages of HCB

Reduces Read/Write conflicts

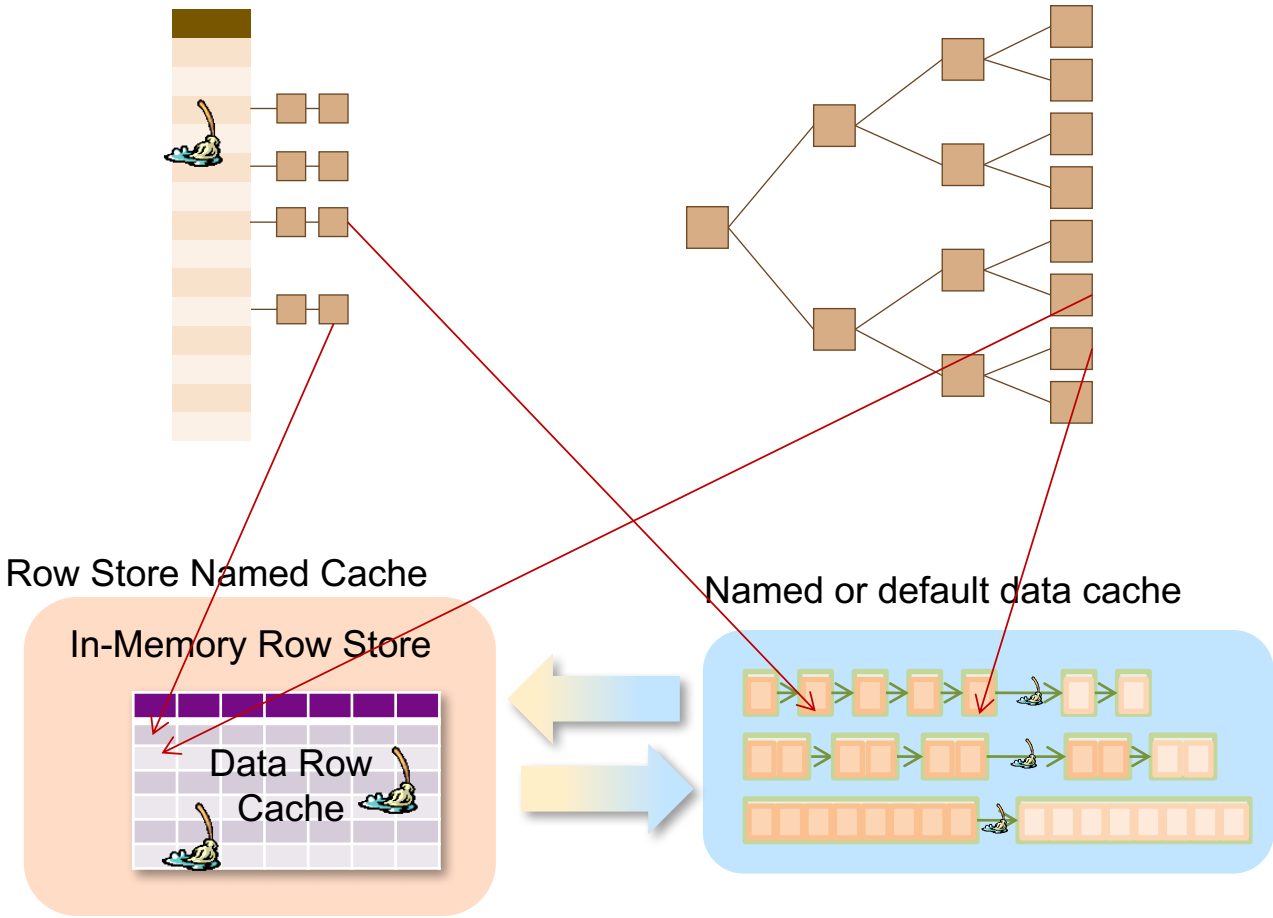
As there is no concept of a page, it avoids the latch contention between reads & writes

Faster query execution

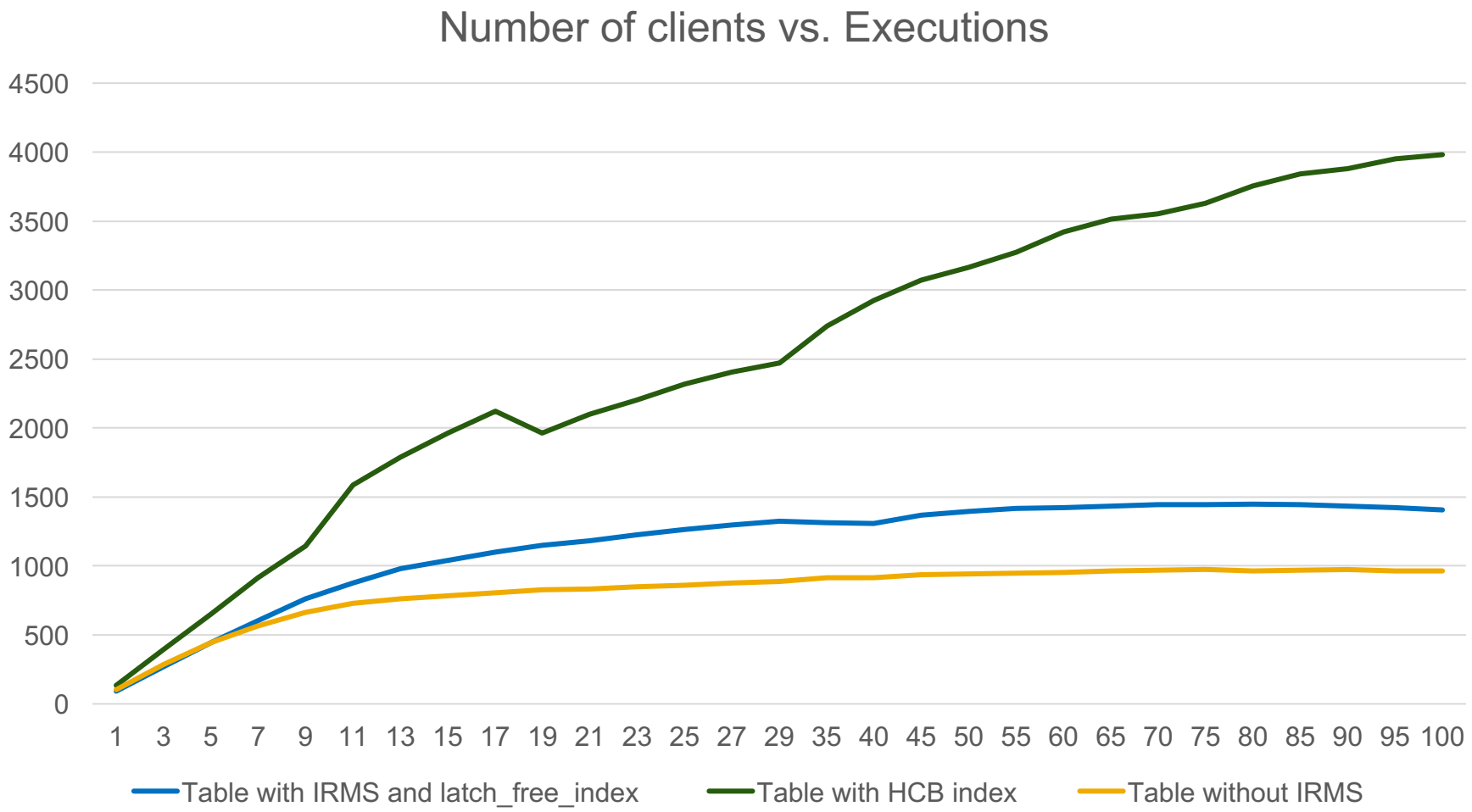
Typically, a primary key lookup must traverse the full B-Tree

With HCB

- Hash operation on keys (no LIO)
- Hash chain scan
  - Sized correctly, this would be 1-2 at the most



Beta Customer – 100 engine scaling test with HCB



Primary key selects in a loop on a table

…all graphs are 100% CPU busy

Performance Gains in Other Common Scenarios

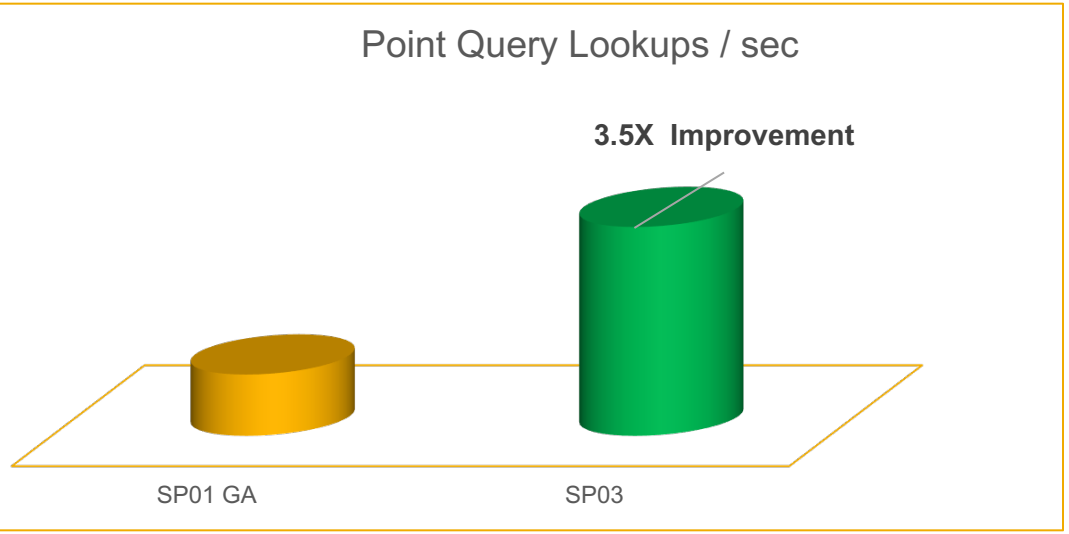
Point Query Lookups

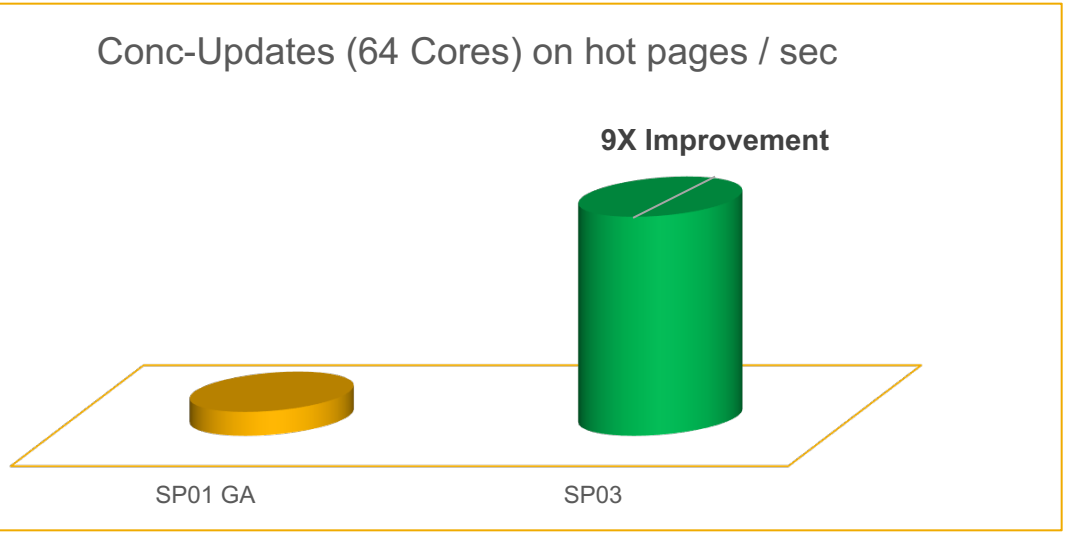
Improvements coming from codepath reduction:

- ‘Compiled Queries’ (SP02)
- ‘In-Memory Row Cache + Hash Indexing’ (SP03)

Highly Concurrent Hot Data Access

- Scaling improvement by avoiding page level latch conflicts using ‘In-Memory Row Cache’





MVCC Details

Support is limited to….

Datarows locked tables only

Datarows locked tables in user databases

- Not system tables and not tempdb tables

Will support both IMRS and traditional disk/page-based tables

IMRS → row versions are stored in database linked row store

Traditional disk/page-based → row versions are stored in linked tempdb

Typical ANSI Isolation Levels (part of SQL standard):

“READ UNCOMMITTED” (Level 0)

“READ COMMITTED” (Level 1)

“REPEATABLE READS” (Level 2)

“READ SERIALIZABLE” (Level 3)

Typical MVCC Isolation Levels (not part of SQL Standard)

“STATEMENT SNAPSHOT” → ISO level 1

“TRANSACTION SNAPSHOT” → ISO level 2

“READONLY STATEMENT SNAPSHOT” → ISO level 1

MemScale Feature Summary

MemScale Feature	Problems Resolved	Comments
Lockless Data Cache (LLDC)	Cache contention	Relaxed caches only
Simplified Native Access Plans (SNAP)	QP Plan Overhead	Linux only
Transactional Memory (TSX)	Reduce mutexes for MRU/LRU & lock hashtables	Linux only
Latch-Free B-Tree (LFB)	Index Latch R/W Conflict	Use with HCB in sp03
In-memory Database (IMDB) & RDDB	Avoid Physical IO	Good for tempdb or common scratch DB using a template (vs. pre-creating temp tables)
Non-Volatile Cache (NVCache)	Reduce PIO cost	Currently incompatible with IMRS
In-Memory Row Store (IMRS)	Cache contention Compression overhead Log concurrency	Enable for hot tables – whether in LLDC or not Consider reducing data cache size and shifting memory to IMRS cache
Hash Cached B-Tree (HCB)	Cache contention Index traversal speed Compression overhead R/W conflict	Must be used with IMRS, indexes also should have LFB set for non-cached index rows
Multi-Version Concurrency Control (MVCC)	Read/Write conflict	Needs IMRS but supports on-disk

ASE 16 SP03: Operations & Security

Innovation	Operations & Security Benefits
Always-On Enhancements	Support SQLDML to reduce latency and applied function (procedure) replication for external replication.
CCL	Transition from OpenSSL ASE implementation to SAP Common Cryptographic Library.
Idle timeout	Disconnect idle users after a defined period of inactivity
Granular Auditing	Allow auditing at role level
On Demand (Network) Encryption	Allow application developers as well as packaged utilities to dynamically encrypt SQL commands using AES-256 to prevent sniffing of passwords in commands without requiring SSL

Goal: Continue to improve ASE security while adopting common security infrastructure to ease application development across SAP products.

ASE 16 SP03: Business Suite on ASE

Innovation	Business Suite on ASE Benefits
CDS Support	Provide support for the next phase of Common Data Services (CDS) SQL functionality used by SAP applications
Technical Monitor Cockpit	Implement a replacement for DBA Cockpit for ease of administering ASE for SAP applications
Built-in ASE Long term performance Data Repository (BALDR)	Provide support for long term performance data collection and analysis to support EOM/EOQ/EOY comparisons.
Read-Only Standby	Transparently provide ability to offload reports and other read-only transactions to the standby environment in Always-On HADR implementations

Goal: Ensure that ASE is the DBMS of choice for non-HANA SAP R3 application enhancements/releases.

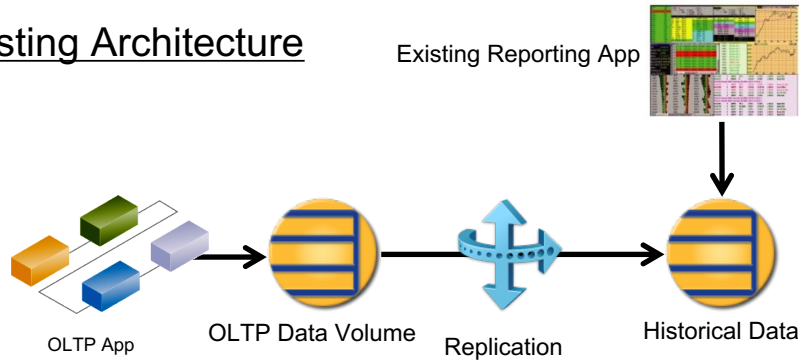
ASE and HANA – Accelerator for ASE (A4A)

Use cases where A4A is applicable?

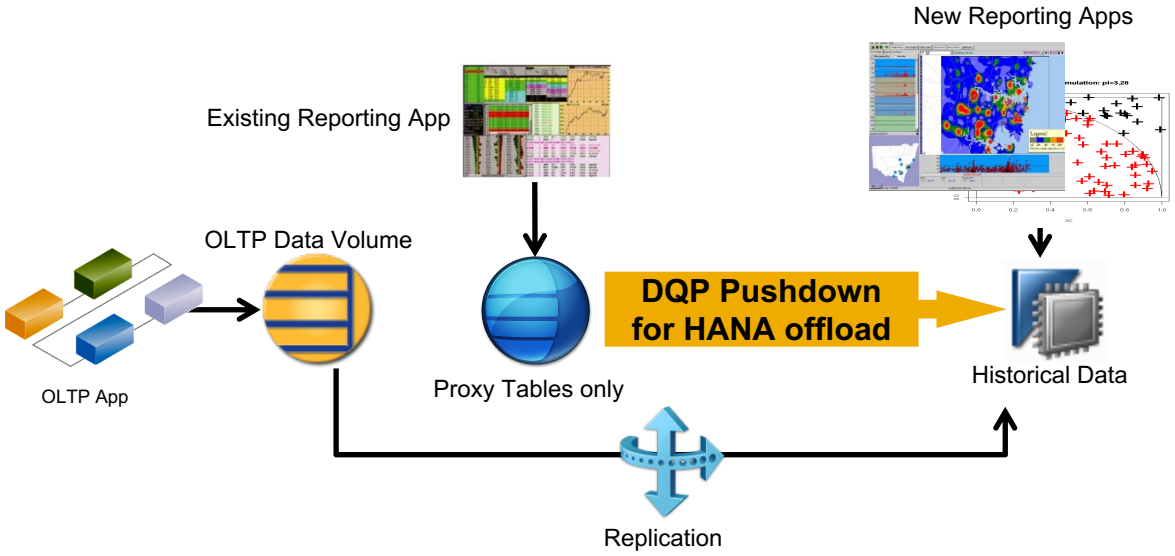
- **Large Financial Services Customer** that provides a complete suite of fund accounting, fund administration and risk services to hedge funds and private equity funds.
- Transactional (fund accounting) systems runs on ASE. **Reporting systems running ASE and IQ.** Data replicated from the transactional systems to reporting systems. (typical for Sybase ASE OLTP customers)
- The customer reporting uses **complex nested stored procedures that run on ASE and/or IQ.** Reports are scheduled and run on an ad hoc basis. IQ requires a separate different transact-sql code line.
- Customer reporting SLA's are not being met
- Daily and year to date reporting for customers starts to exceed SLA's after first few months of the year
- Causes continued escalations

A4A – Architecture

Existing Architecture



Existing App with HANA Accelerator For ASE



Benefits

- **HANA runs new OLAP apps**
- **Existing ASE reporting apps run faster in HANA, with no code changes**
- **Leverages Component Integration Services (CIS) functionality**

Steps

1. **Install HANA, with tables same as ASE reporting server**
2. **Replicate data to the SAP HANA server**
3. **Upgrade to new instance of ASE server – SAP HANA Accelerator for ASE. Existing reporting apps will run against this server**
4. **Create virtual tables on the SAP ASE server – map to replicated tables in HANA**
5. **Enable Push Down**
   - **Automatic creation of remote temporary tables in SAP HANA.**
   - **HANA pushdown optimization; mapping SAP ASE functions, expressions, and operators to their SAP HANA equivalents.**
6. **Run existing SAP ASE reporting applications on the SAP ASE reporting server**

Accelerator For SAP ASE – Sample Results

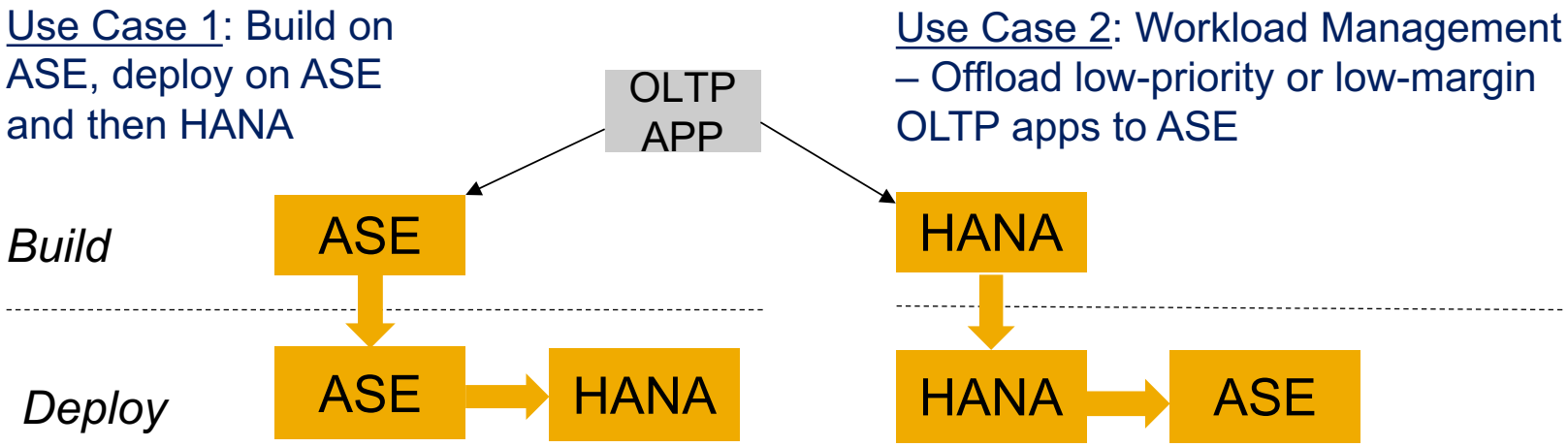
Test Query	Execution time in ASE	Execution time in HANA (via ASE)	Performance Improvement
Q02	13.90224886	0.381311893	36x
Q03	10.13654184	1.500849009	7x
Q07	6.785197973	0.629307032	11x
Q08	13.69952703	0.473933935	29x
Q09	22.83579993	10.71426106	2x
Q11	69.39425993	0.738453865	94x
Q16	1.92553997	0.644078016	3x
Q17	17.37528706	0.179432154	97x
Q19	4.770226955	0.132165909	36x
Q22	2.327113152	0.513650179	5x

3x – 90X

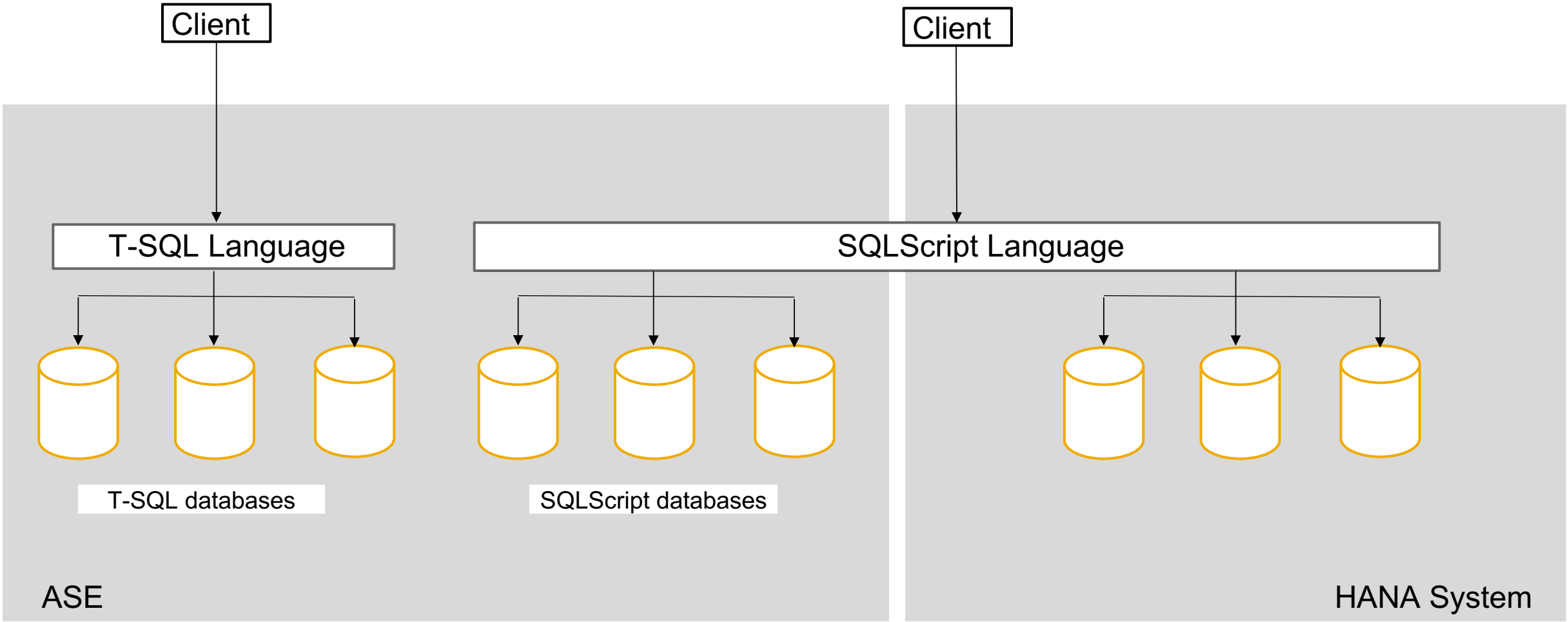
- Test results based on internal sample queries
- Query Execution Time = Time to ship query to HANA + **Execution time in HANA** + Time to return results to ASE
- Several show significant enhancement
- Key is to avoid bringing data back to ASE for execution, or executing logic in ASE

ASE and HANA: HANA SQLScript Support

- **Overview**
  - Support HANA SQLScript procedure
  - Support HANA SQL in ODBC, JDBC applications
  - SQLScript and TSQL parser co-exist but mutually exclusive
  - Database level separation
- **Phased implementation**
  - SQLScript core (ASE 16.0 SP03) is the first release followed by enhancements in future releases



SQLScript Overview - Common language interface



HANA SQL/SQLScript Features – plan

SQLScript Core (ASE 16.0 SP03)

- Procedure support
- Imperative logic
- Scalar data types
- Expressions
- Scalar functions
- DDL
- DML (non column-store related)
- Trigger
- Cursor
- Scalar and table UDF
- Dynamic SQL
- Core language features
  - Table type
  - SEQUENCE
  - Schema
  - Exception handling
  - Session variable
  - Limit/offset
  - Intersect/minus operator
  - Global/local temp table
  - Table type and table variable

SQLScript Extended (SP03+)

- Visualize plan
- Explain plan
- Synonyms
- Semantic gaps
  - Null handling
  - Trailing blanks
  - Error code
- Advanced data types
  - Array
  - Text
  - Series data
  - Spatial
- Full DDL support
- Access control statements
- Grouping Sets
- Windowing functions

SQLScript Future

- Temp table handling
- Transaction management
- Parallel execution of SQLScript statements
- Import and export statements
- Session management
- System management statements
- Workload management statements

Summary of ASE Support on Cloud Today

Vendor	Product Edition	Key Capabilities	Status
Amazon	Enterprise Edition on Linux and Windows	• BYOL (Bring Your Own License) • Customers can run options	Available Now
Amazon	Runtime Edition (Business Suite) on all platforms	• BYOL (Bring Your Own License) • Runtime Edition itself contains options	Available Now
Amazon	Enterprise Edition on Linux and Windows	• Subscription pricing and licensing • Multiple AMIs with different sizes	H2 2017
Docker	Developer, Express and Enterprise Edition	• Certification	Available Now
SAP HEC	Enterprise Edition	• Hosting services • Fully managed	Available Now
SAP Cloud Platform	Adaptive Server Platform Edition (ASP)	• Subscription pricing and licensing • Managed service	Available Now

SAP ASE Cloud Backup through AWS Storage Gateway to S3

Advantages

- Gives elastic and geographically remote storage
- Removes storage purchase and management
- Only pay for what you use
- Data is secure and encrypted at rest and in transit
- Meets compliance retention requirements
- No changes required to existing backup scripts or schedules except for backup location

How it works

- AWS Storage Gateway is installed on premise
- AWS S3 storage is mounted on premise as an NFS file system directory managed by Gateway
- SAP ASE saves backup files to NFS file system directory
- AWS Storage Gateway manages data transfers and retrievals between on premise and AWS S3

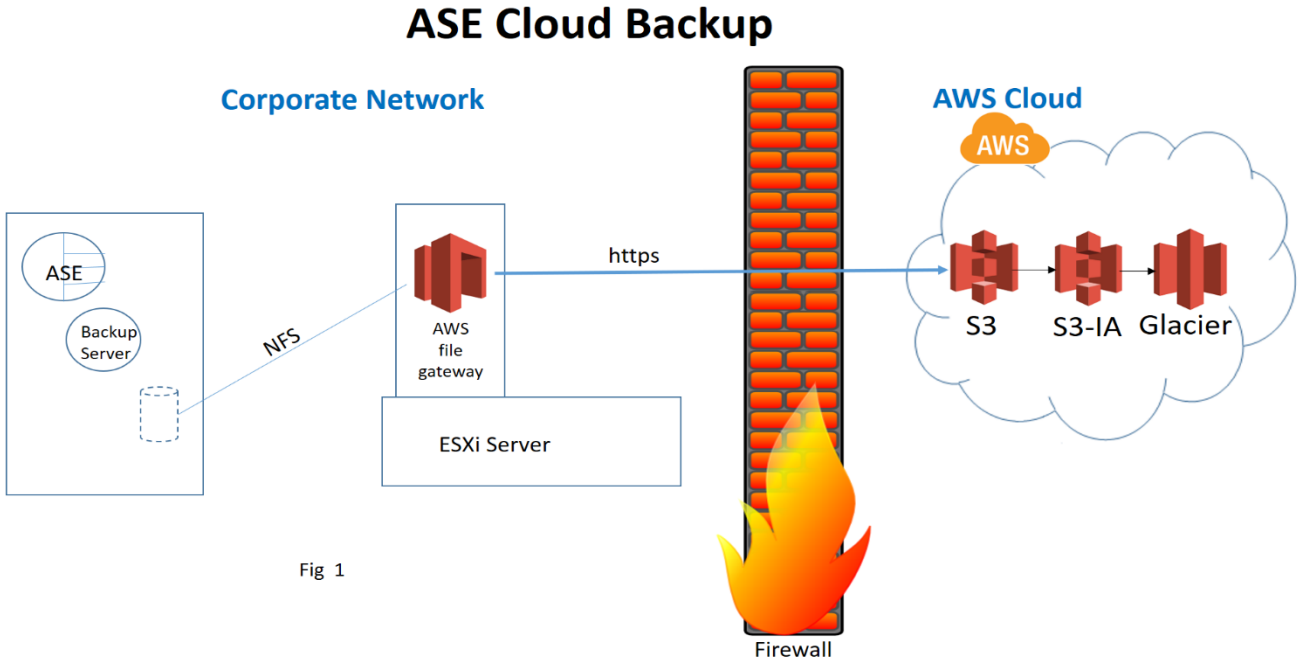
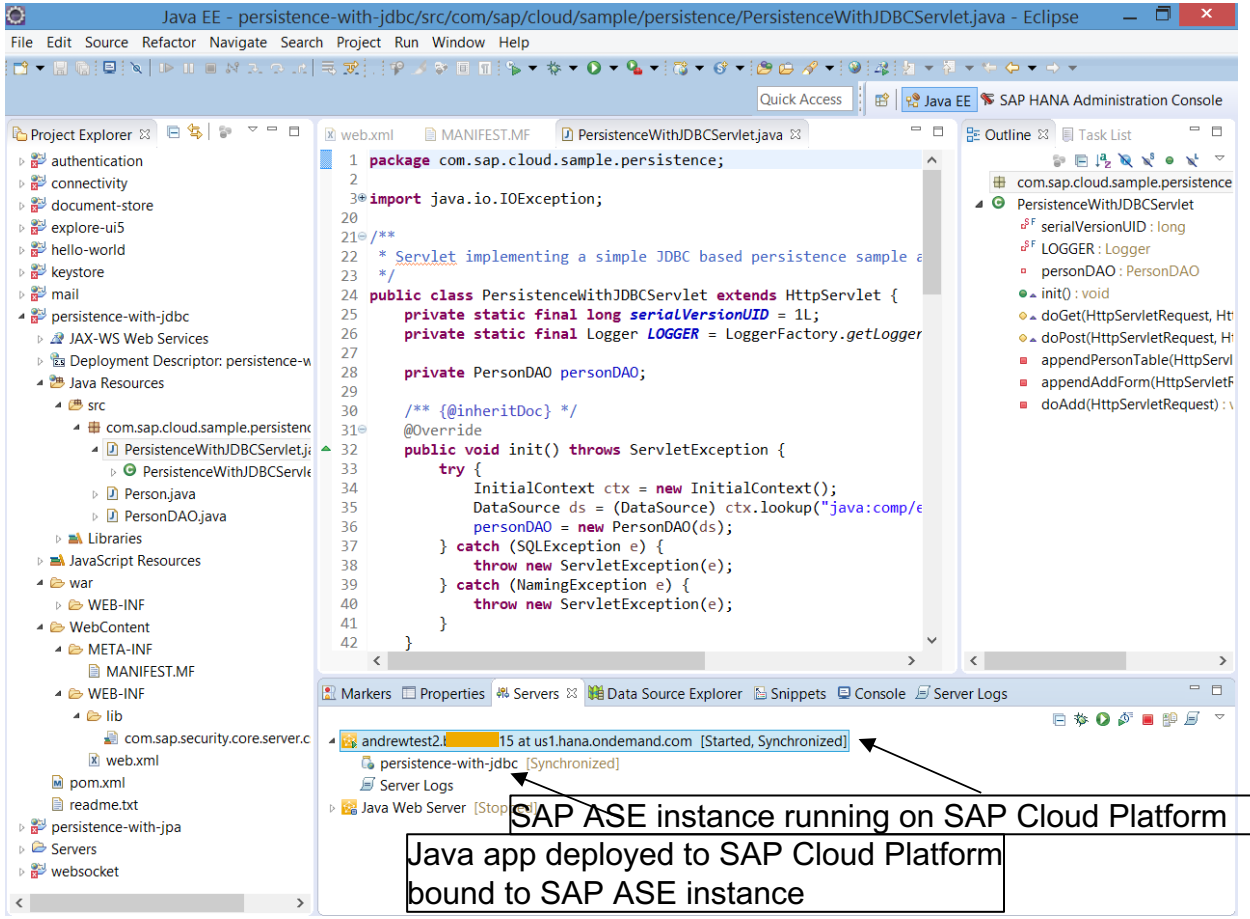


Fig 1

SAP ASE on SAP Cloud Platform - Persistence as a Service

Quick Deployment

- Quick set up and no maintenance worries with full cloud management
- SAP Cloud Platform manages data replication, backup and recovery, monitoring and alerting, balancing and scaling, configuration
- Provides high availability and disaster recovery for continuous operations
- Supported sizes (HDD): 32 GB, 80 GB,160 GB, 320 GB, 640 GB



Eclipse IDE with SAP Cloud Platform plug-ins and SDKs

2018-2019: Focus Areas

OLTP Performance

>4TB and >64K connections
In-memory only tables
Non-locking RO tables/partitions

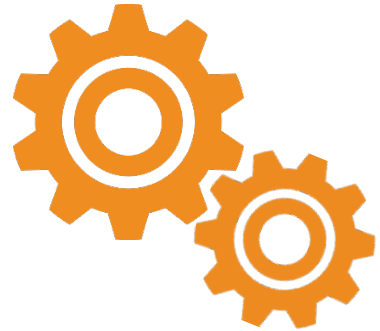
Data Center Operations

Always-On Enhancements
Data Masking
Temporal SQL
64bit MDA tables

Cloud Enablement

Additional Cloud Services -
Workload Analyzer
Dev/test

ASE and HANA



Common tooling
HANA SQL Script enhancements
Optimized data movement

Planned Innovations: Extreme Performance

Planned Innovation	XOLTP Capability
In-Memory Only Tables	Support tables that are only in-memory (non-persisted) – similar to IMDB, but with benefits of IMRS/HCB for low latency queries
Increased server limits/capacity	Increase number of connections to support with a practical goal of 200K+ connections, as well as increase memory supported to >4TB with 8TB+ a goal
Proc cache enhancements	Segment proc cache to minimize spinlock contention and provide faster query optimization times (e.g. sharable index statistics)

Planned Innovations: Data Center Operations & Security

Planned Innovation	Operations & Security Capability
MDA Enhancements	Increase datatypes used for MDA monitoring to 64 bits to reduce the frequency of counter rollover on high volume systems. In addition, implement a built-in MDA collection and repository for providing common performance analysis capabilities
Always-On Enhancements	Provide local topology support as well as support for recovery of XA transactions during a failover. In addition, provide 'standby database' that is R/W by DBA's & Always-On, but enforced read-only for other users until active as primary.
Hardware Security Modules	Invoke chip level API's for data encryption as well as network encryption to improve performance when working with encrypted data.
Temporal SQL	Implement temporal SQL as well as other common time series data functionality such as window query support

Planned Innovations: SAP ASE Cloud Services

SAP ASE Cloud Backup Service

- Allows database to push and retrieve backup files from the cloud
- Gives elastic and geographically remote storage
- Removes storage purchase and management
- Only pay for what you use
- Data is secure and encrypted at rest and in transit
- Meets compliance retention requirements

SAP ASE Cloud Disaster Recovery Service

- Create duplicate instances from an on-premise database to a remote disaster recovery site
- Provides a geographically separate instance for safety and compliance reasons
- Gives elastic compute power and storage
- Only pay for what you use
- Data is secure and encrypted at rest and in transit

SAP ASE Cloud Development and Test Service

- Creates and instantiates an instance in the cloud
- On-premise tool to choose databases and tables to securely move to cloud instance (materialization)
- Provides a mechanism to refresh/sync data on demand
- Ensures security and encryption of data at rest and in transit

SAP ASE Cloud Workload Analyzer Service

- Replays on-premise workloads in new server versions or configurations in the cloud
- Provides comparative analysis and recommendations
- Avoids having to build or maintain a second on-premise system

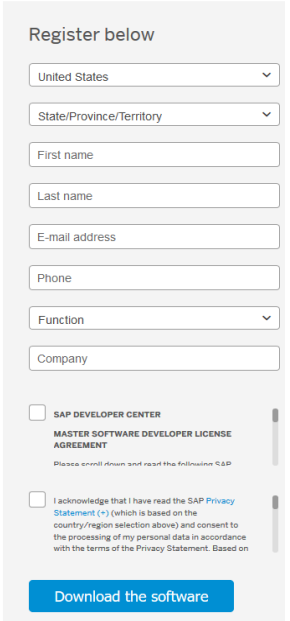
Evaluation, Packaging and Licensing Changes

- **New evaluation license to evaluate ASE EE**
  - For non-production environments only
  - No limits on engines, connections, memory and storage space
  - Valid for 90 days. Can be extended for an additional year.
  - **http://www.sap.com/product/data-mgmt/sybase-ase.html**

SAP Adaptive Server Enterprise Evaluation Edition

Drive faster, more reliable online transaction processing (OLTP) – for less – with SAP Adaptive Server Enterprise. Designed to meet the demands of the digital economy, this high-performance SQL database server uses a relational model to power transaction-based applications – on premise or in the cloud.

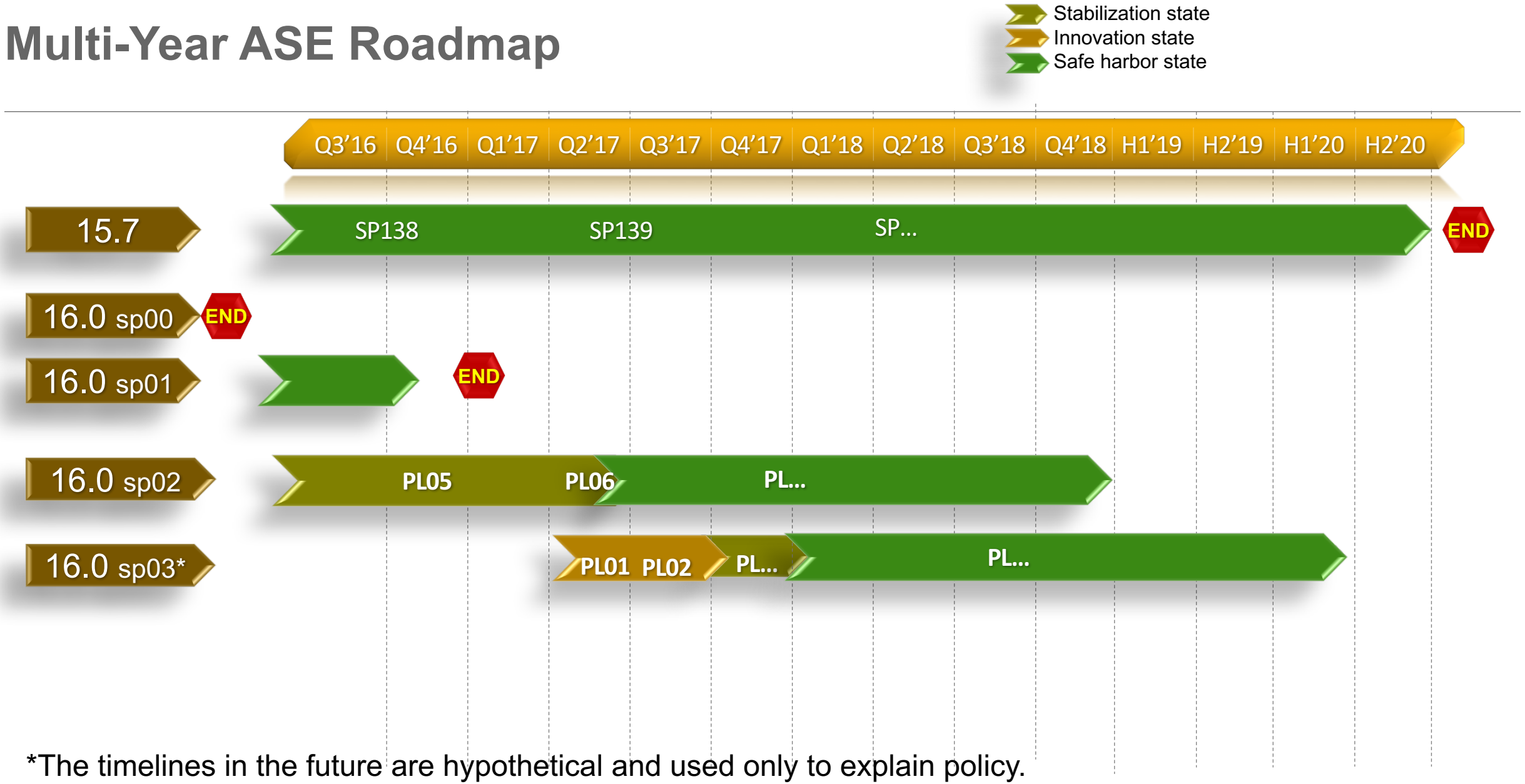
- Free for use in any non-production environment
- Unlimited engines, memory, users, and database size
- Runs on Linux
- Includes SAP ASE options
- 90-day evaluation period can be extended for 1 year



- **Enhanced Xpress Edition – free for production**
  - Added capacity to lower costs for small businesses - 4 cores and 50 GB limit only

- **User Friendly Licensing to Avoid Business Disruption**
  - Customers can install upgrades/patches even if their support contracts have expired
    - Warning notice to customers allows them to renew support and update their licenses
  - Customers that need to run on larger machines than what they are licensed will be allowed to do so

Multi-Year ASE Roadmap



*The timelines in the future are hypothetical and used only to explain policy.

Summary

SAP ASE brings more than 25 years of industry-proven reliability and scalability to the SAP landscape. SAP customers can now have a fully integrated, SAP-supplied technology stack providing best optimization, best TCO and best support

Capable of powering the most demanding mission-critical systems, from Wall Street to Main Street and everywhere in between

SAP ASE and SAP Replication Server will enable SAP customers to cut operational costs for SAP applications, while providing new, innovative capabilities for SAP applications such as report offloading and tightly integrated high availability and disaster recovery

Lowest TCO

- Optimized for storage efficiency
- Superior operational scalability with reduced DBA resources
- High performance and reliability on industry-standard hardware
- Unmatched resource efficiency

See Appendix for abbreviations

This is the current state of planning and may be changed by SAP at any time.

Upcoming ASE Webcasts and Events

Register here: https://event.on24.com/wcc/r/1480117/EC65E8FCB99D96463A86466A9157D459/150696

- **September 5, 2017: MemScale Part 1: Technical Overview of xOLTP Features in ASE 160 SP03**
- **September 12, 2017: MemScale Part 2: Multi-Version Concurrency Control, Migration Considerations**
- **October 3, 2017: SAP ASE 16 Cloud Strategy and Offerings Available Today**

Upcoming in-person SAP ASE events:

- **SAP TowerTalk Frankfurt, October 10**
  - Register here: http://events.sap.com/de/sap-tower-talk/de/home
- **TechSelect New York, October 12**
  - Register here: http://my.isug.com/p/cm/ld/fid=1200
- **TechSelect London, October 17**
  - Register here: http://www.uksug.com/events/techselect-london-2017-sap-ase-sp03-launch-party

Thank you

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Key links for more information

For customers and partners

Key links

- SAP Road Maps http://sap.com/roadmaps
- SAP Community Network http://www.sap.com/community
- IT Planning Resources https://service.sap.com/~sapidb/011000358700001160122012E
- SAP ASE http://www.sap.com/ase

Where to go to provide product feedback and ideas

- SAP Idea Place https://ideas.sap.com
- Influence programs http://service.sap.com/influence
- SAP User Groups http://www.sapusergroups.com/

Key links for more information

For SAP internal

Key links

- SAP Road Maps http://sap.com/roadmaps
- Road maps page on Corporate Portal https://portal.wdf.sap.corp/go/roadmaps
- Database Solutions Management https://community.wdf.sap.corp/sbs/community/dbms
- D&T – DB and DW https://community.wdf.sap.corp/sbs/community/dt/data_warehousing

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