·SAP Adaptive Server Enterprise (ASE) and ·SAP Replication Server Roadmaps

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·April 4, 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

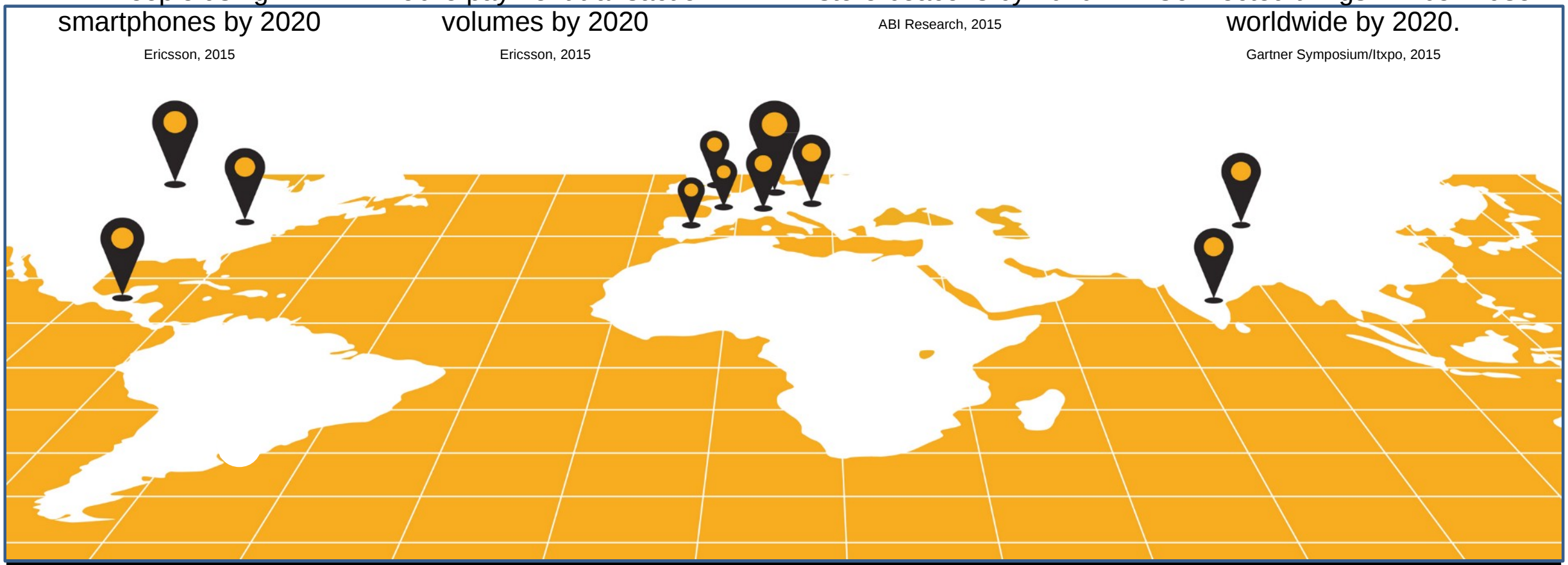
In-store beacons by 2020

ABI Research, 2015

20.8B

Connected things will be in use worldwide by 2020.

Gartner Symposium/Itxpo, 2015



The 3 OLTP Challenges

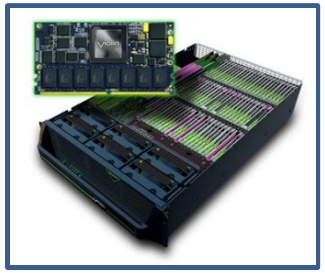
- **Concurrency is unlimited**
  - Customers are using internet/mobile apps for direct interaction
  - Transaction volumes/concurrency has lead to “flash-crashes”
    - **Many transactions are automated or very high volume**
  - Algorithmic trading, internet “bots”, micro-transactions (e.g. credit card/text to win)
  - Internet/cloud services pushing more centralized transaction processing with local/regional fulfillment (less local IT resources)
    - **Transaction latency is now in milliseconds pushing towards microseconds**

Hardware Trends to Leverage

- **Exploding cores per socket**
  - Easier to meet performance need with scale up
  - On chip memory controllers…NUMA at socket level

- **PCIe SSD's**
  - Extremely fast writes & reads
  - Great for exploiting for transient/temp data

Writes: ~10 µs
Reads: ~50-100 µs
Cost: ~$10K/TB



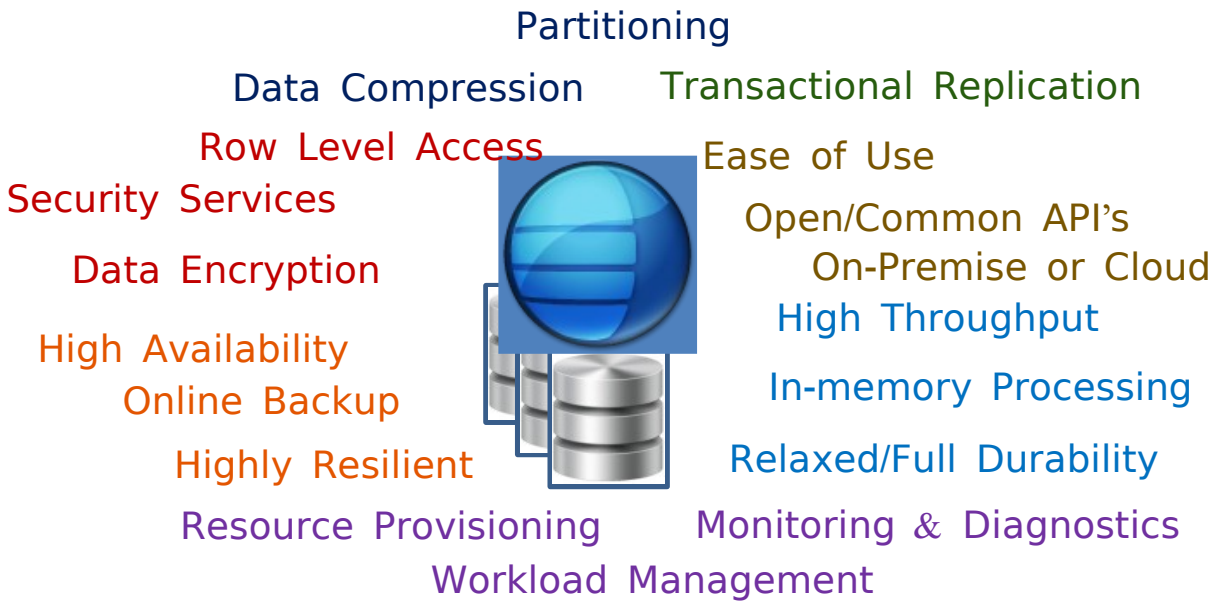
All Flash Array
Multi-hosted (HBA)
>10TB 100's of TB
<$64KUS - $200KUS

- **Memory is cheaper**
  - We are seeing more and more customers pushing for near-in-memory databases
  - Only want writes to disk after cache warms
  - Some customers are pushing in-memory OLTP due to inability of disks to keep up

SAP Adaptive Server Enterprise (ASE)

Solution for high-performance OLTP

SAP ASE is a high performance relational enterprise database management system that is designed for mission-critical transactional intensive environments. It provides the most robust, high-performance platform for running custom developed applications, and for running SAP Business Suite applications.



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

Innovation and Leadership

OLTP Performance	Linear scaling on large SMP systems Improved concurrency in systems with large user counts Enhanced query execution speed with compilation to machine code	·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
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 and On-demand encryption ·Audit repository & tracking data lineage ·Performance monitoring analytics
Virtualization and Cloud Sup	DB-as-a-Service on SAP Cloud Platform and BYOL on AWS Docker support	·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 ASE managed in HANA landscape	·Build new apps using SQLScript and IDE ·Unified admin/monitoring w/ landscape

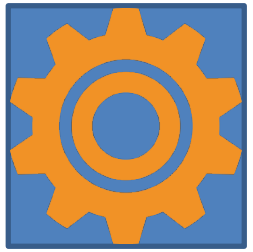
Today **Future**

ASE 16 In-Market

- Key Features
- Customer testimonial
- Benchmarks

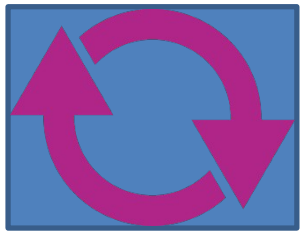
ASE 16 SP02: Key Features

OLTP Performance



Extreme Performance
(Database MemScale Option)

Data Center Operations



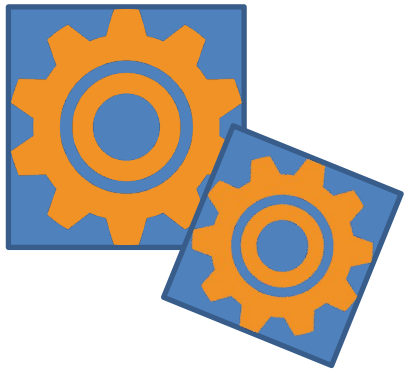
Replication Based HA
(Database Always-on Option)

Workload Analysis
(Workload Analyzer Option)

Cloud Enablement

Cloud Readiness

ASE and HANA



Report Acceleration
(SAP HANA Accelerator for ASE)

SAP ASE 16 SP02 MemScale – High Performance Features

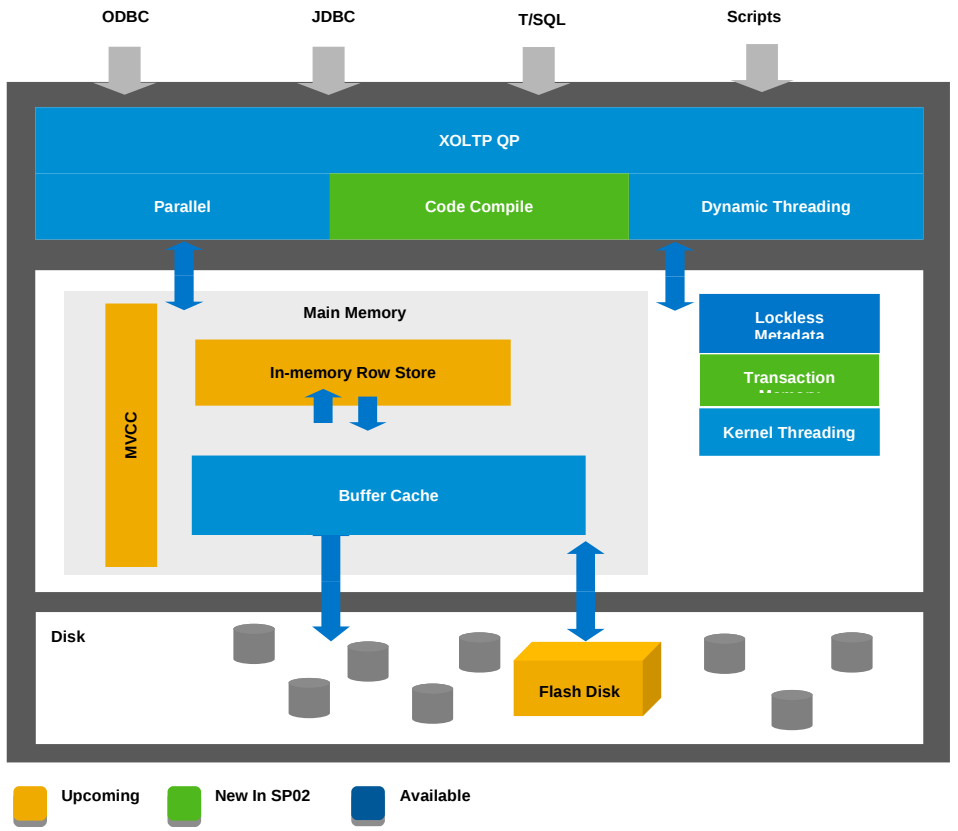
Simplified Native Access Plans (Compiled Queries)
- Compiled query plans – faster execution
- Transparent to applications and users

Latchfree B-Tree on Indexes
- Reduces contention on index pages
- Increases concurrency and performance

Lockless Buffer Manager
- Decreases cache contention on small, highly used tables
- Increases concurrency and performance

Transactional Memory
- Minimize contention leveraging hardware for identifying memory conflicts

Non Volatile Cache Management
- Leverage SSD for storing frequently accessed/updated pages



UZ Leuven: Delivering Better Care for More Patients with SAP® Adaptive Server Enterprise

Company
UZ Leuven (Universitaire Ziekenhuizen Leuven)

Headquarters
Leuven, Belgium

Industry
Healthcare

Products and Services
Patient care, medical research

Employees
9,000

Beds
2,000

Use of SAP ASE

KWS is one of the largest systems of its kind anywhere, hosting **a 12-terabyte database** handled by **64 engines**. It supports more than **25,000 named users, with 6,000 active** at any one time. It's powered by more than **21,000 stored procedures and nearly 4,500 triggers**, comprising a 1.5 million line combined code base. Each day, KWS **processes 85 million transactions, with 150,000 rows inserted, updated, or deleted every second**.

Objectives

- Continue refining a clinical workstation system to enhance patient care
- Keep up with growing numbers of patients and an ever-expanding national network of hospitals
- Prepare for the next generation of healthcare sensors and devices

Resolution

- Incorporated high-performance in-memory processing by upgrading the underlying application database to the latest version of SAP® Adaptive Server® Enterprise (SAP ASE)
- Simplified application software with the built-in optimizations of the SAP ASE database server
- Created a single source of truth, enabling consistent, shared business procedures and patient data

"Upgrading to the latest version of SAP ASE has helped us meet our commitment to provide outstanding care to our patients, while expanding our network of hospitals throughout Belgium."

Reinoud Reynders, IT Manager of Infrastructure & Operations, UZ Leuven

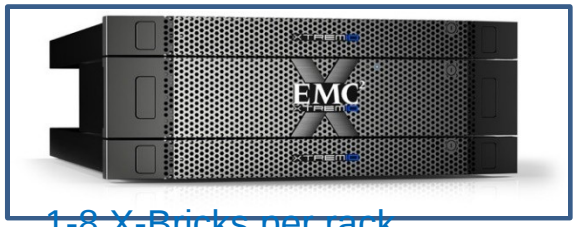
300%
Query performance improvement

Expanded
Reach and scope of clinical trials

100%
Successful certification of network hospitals

ASE with EMC XtremIO

- **XtremIO is 250% faster than HDD**
  - If database is completely in SSD using XtremIO, the performance is 2.5x faster than HDD solution
- **NV Cache using XtremIO is 175-225% faster than HDD**
  - As cache hit rates dropped, the NV Cache scaled to within 90% of the same performance as an all flash array implementation
  -



1-8 X-Bricks per rack
150K □1.2M IOPS
20-320TB capacity
~$25/GB* ~$200K/10TB*

*anecdotal pricing for single X-Brick based on internet chatter

DB Scale	XtremIO-only (tpmC)	NVC+HDD (tpmC)	HDD only (tpmC)	XtremIO vs. HDD	NVC+HDD vs XtremIO-	NVC+HDD vs HDD-only
120GB	312,378	245,895	138,071	226.24%	72.96%	178.09%
144GB	323,082	248,361	121,347	266.25%	69.91%	204.67%
168GB	316,385	272,061	134,594	235.07%	83.71%	202.13%
192GB	323,872	296,702	132,936	243.63%	90.84%	223.19%

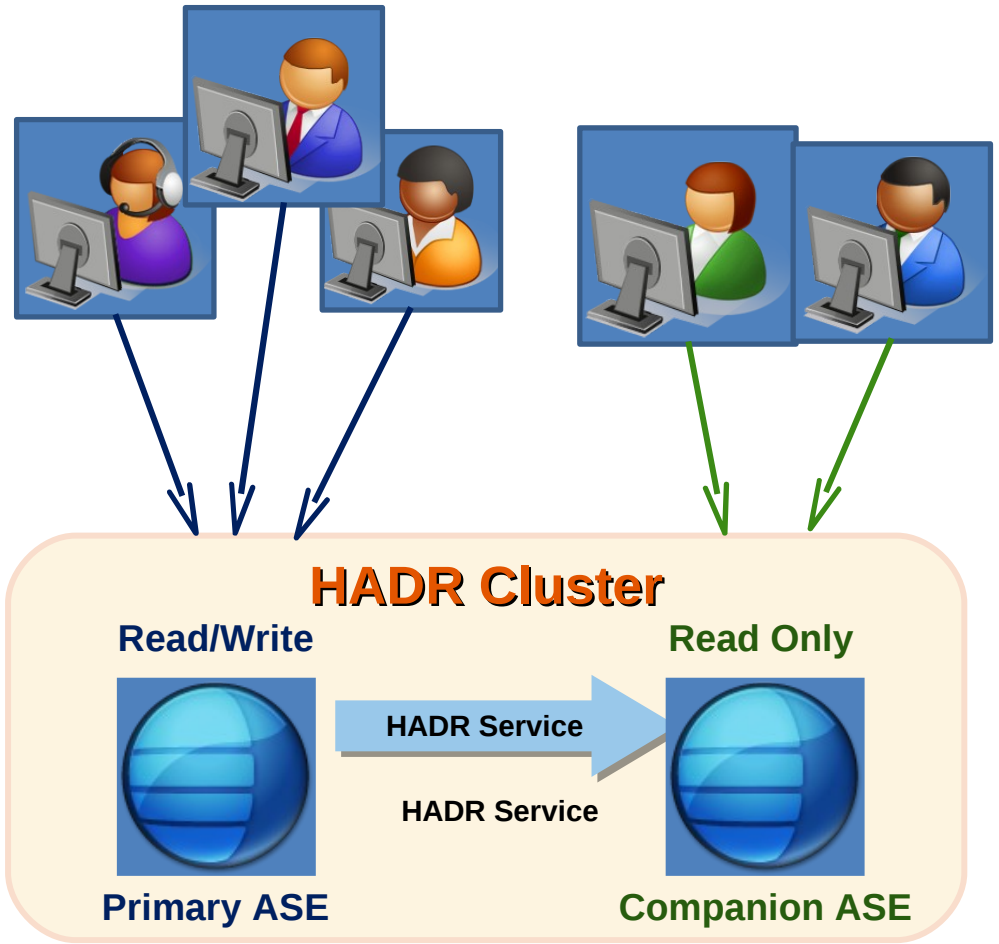
Note: Preliminary Results – Final Results and collateral to follow Q1 2016

The larger the DB size vs. the ASE memory, the more obvious the impact

New HADR Solution: Always-On

- **HADR Cluster**
  - Currently limited to 2 nodes
  - Multi-standby on the roadmap
  - Log-based Logical Replication Based
  - Synchronous, Near-Synchronous, Asynchronous
  - Zero Data Loss in Synch (RPO=0)
  - Fast failover (<2 minutes normally)
  - Planned failovers <1 minute
  - GUI (ASE Cockpit – replaces SCC)

- **Capabilities**
  - Automated fault detection
  - Automated transparent client failover
  - Planned and unplanned failover support
  - Companion can be read-only for reporting
  - Zero-down time major upgrades
  - Cloud Friendly deployment
  - No special hardware unlike SDC & OS/HA
  -



Always-On External Replication Support

- **Support added in SP02 PL05 (Dec 2016)**

- **Supports extended architectures including**
  - Long distance DR
  - Time delayed DR
  - Dual Clusters
  - Replication to reporting/analytics
  - Replication to multiple sites/locations

- **Capabilities**
  - Existing replication topologies can be retrofitted to use Always-On without disturbing existing data replication flows.
  - Data loss to external systems is minimized by replicating from the persistent queue

ASE Workload Analyzer

Capabilities

- Captures workload on production server
- Saves workload to local files
- Loads, analyzes and aggregates workload in a repository database
- Provides a GUI “dashboard” to analyze workload across multiple dimensions
- Replays captured workload
- Analyzes replay performance and compares to original

Benefits

- Reducing risk during planned upgrades or migrations
- Analyzing behavior of production applications
- Testing performance impact of changes to:
  - server version or configuration of SAP ASE
  - database and table definitions
- Generating realistic load in a test environment
- Reproducing ASE behavior for troubleshooting and diagnostics

SAP ASE in the Cloud

Vendor	Product Edition	Key Capabilities
SAP Cloud Platform (formerly Hana Cloud Platform)	Adaptive Server Platform Edition (ASP)	·Subscription pricing ·Various T-shirt sizes ·Fully managed
SAP MCD	Enterprise Edition	·Hosting services ·Subscription ·Fully managed to support SAP applications
AWS	Enterprise Edition on Linux and Windows	·BYOL (Bring Your Own License) ·Customers can run options ·Pre-built AMIs available or customer installs software
AWS	Runtime Edition (Business Suite)	·BYOL (Bring Your Own License) ·Runtime Edition itself contains options
Docker	Developer, Express and Enterprise Edition	·Certified and containerized ·Supports RHEL and AWS
Azure	Enterprise Edition on Linux and Windows	·BYOL (Bring Your Own License) ·Customers can run options ·Customer installs software and manages it

SAP Business Suite on ASE

- **~10,000+ Instances**
  - ~3000+ new ASE customers
  - Prompting a large number of SAP customers to consider standardizing on ASE for all apps
- Migrating off primarily Oracle & some MSSQL

- **Most are >>1TB**
  - Smallest are 250GB+ (Solution Manager)
  - Norm is ~3TB
  - Largest is 13TB (in a single DB!)

#1 Performance for SD Benchmark

Date	Hardware	CPU	OS	RDBMS	Users
9/15/2016	**HPE Integrity Superdome with Gen9**	**Intel Xeon E78890 v4 2.6GHz 24-core, 16**	**RHEL 7.2**	**SAP ASE 16 SP02**	**117,611**
6/6/2016	**Dell PowerEdge R930**	**Intel Xeon E7-8890 v4, 2.2 GHz, 4 Processors**	**RHEL 7.2**	**SAP ASE 16 SP02**	**41,450**
5/6/2016	**Dell PowerEdge R730**	**Intel Xeon E5-2699 v4, 2.2 Ghz, 2 Processors**	**RHEL 7.2**	**SAP ASE 16 SP02**	**21,450**

comparisons on 2, 4 processor systems on Linux only

ASE Road Map

- Today
- Planned
- Future

SAP Adaptive Server Enterprise (ASE)
Product road map overview – key themes and capabilities

Recent Innovations

·XOLTP Enhancements
- Lockless Cache
- Latch-Free B-Tree
- NVCache
- SNAP (Compiled Queries)

·Data Center Operations & Security
- Always-On
  - HADR Clusters
  - External Replication Support
- Workload Analyzer
- DSAM (storage tiering)
- ASE Cockpit

·Cloud Services
- AWS, Azure as BYOL
- Docker support
- HCP & MCD DBaaS

·HANA Integration
- A4A

·Business Suite/SAP Applications
- CDS functionality Phase 1

ASE 16 SP02 PL05 is current release

2017 - Planned Innovations

·XOLTP Enhancements
- In-Memory Row Store
- Hash based index
- MVCC
- 64K connection limit

·Data Center Operations & Security
- Always-On Enhancements
- CCL for SSL
- Idle timeout
- Granular Auditing
- On Demand Network Encryption

·Cloud Services
- Cloud services phase 1

·HANA Integration
- HANA Schema
- HANA SQL Script

·Business Suite/SAP Applications
- CDS functionality Phase 2
- Technical Monitor Cockpit
- Built-in ASE Long term performance Data Repository (BALDR)
- Read-Only Standby

2018 - Product Direction

·XOLTP Enhancements
- In-Memory Only Tables
- Temporal SQL/Time Series
- >4TB memory & >64K connections
- Proc cache enhancements
- C UDF, JSON, etc.

·Data Center Operations & Security
- 64 bit MDA + MDA repository
- Role based resource limits
- Always-On Enhancements
  - XA Support, Local Topology
  - Standby Database
- HSM, LDAP Groups
- Data Masking

·Cloud Services
- Cloud services phase 2

·HANA/IQ Integration
- Optimized, zero loss data movement to HANA & IQ
- Common Tooling (phase 1)

·Business Suite/SAP Applications
- CDS functionality Phase 3

2019 - Future Vision

·XOLTP Enhancements
- Lazy Persistence
- Non-locking R/O tables/partitions

·Data Center Operations & Security
- Workload Analyzer with MDA
- Workload network replay
- Page migration utility
- Undo/redo log utility
- User certificate authentication

·Cloud Services
- Cloud services phase 3

·HANA/IQ Integration
- Query Enhancements
- Common Tooling (phase 2)

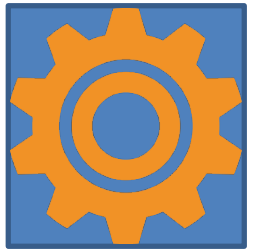
·Business Suite/SAP Applications
- CDS functionality Phase 4

·FSI Solutions
- Blockchain, Data lineage, Forensic auditing

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

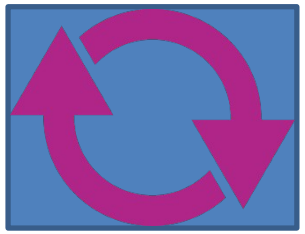
ASE 16 SP03 (June 2017): Key Features

OLTP Performance



In Memory Row Store, MVCC
(Database MemScale Option)

Data Center Operations



Always-On Enhancements
(Database Always-on Option)

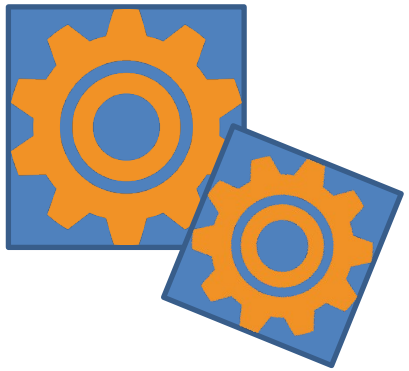
Security Enhancements

Business Suite Enhancements

Cloud Enablement

Cloud Micro-Services

ASE and HANA



HANA SQLScript Support

Planned Innovations: XOLTP

Planned Innovation	XOLTP Capability
In-Memory Row Store (IMRS)	Dynamicallytier frequently accessed rows into the Data Row Cache for faster access
Hash-based Index	Implement a hash based indexing of cached b-tree unique index keys allowing faster access methods to rows in the IMRS
MVCC	Improve performance for highly concurrent applications by eliminating conflicts between readers & writers by supporting MVCC for on-disk as
64K Connection limit	Allow up to 64K connections per ASE instance

Goal: XOLTP enable existing applications by exploiting in-memory processing features without requiring application re-write/modifications.

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

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’

Planned Innovations: Operations & Security

Planned Innovation	Operations & Security Benefits
Always-On Enhancements	SupportSQLDML 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

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

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

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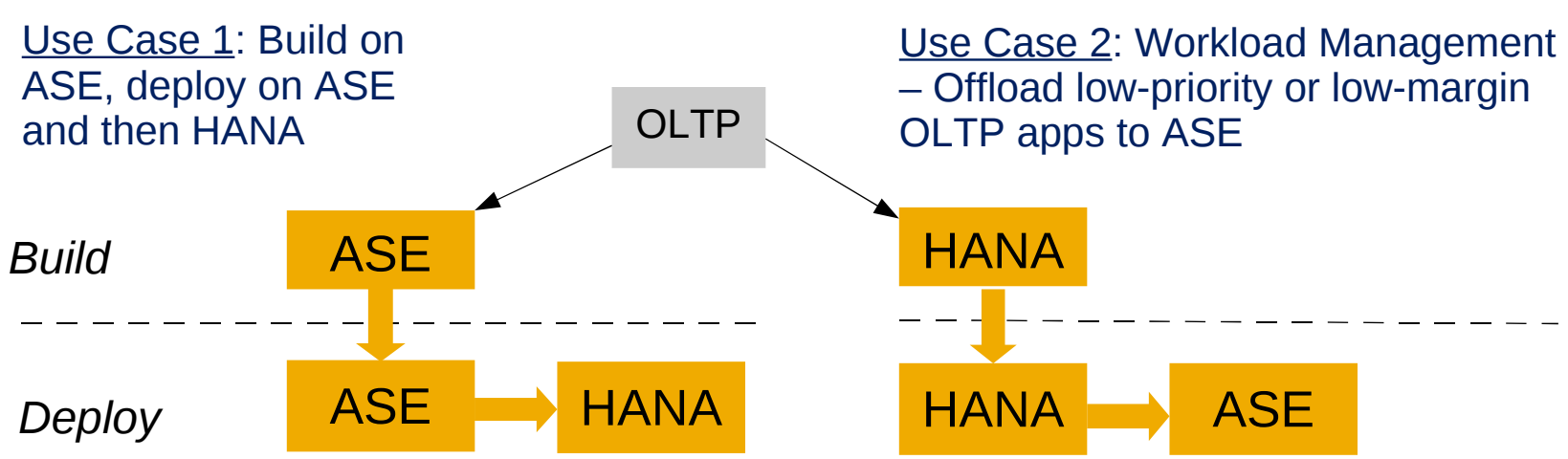
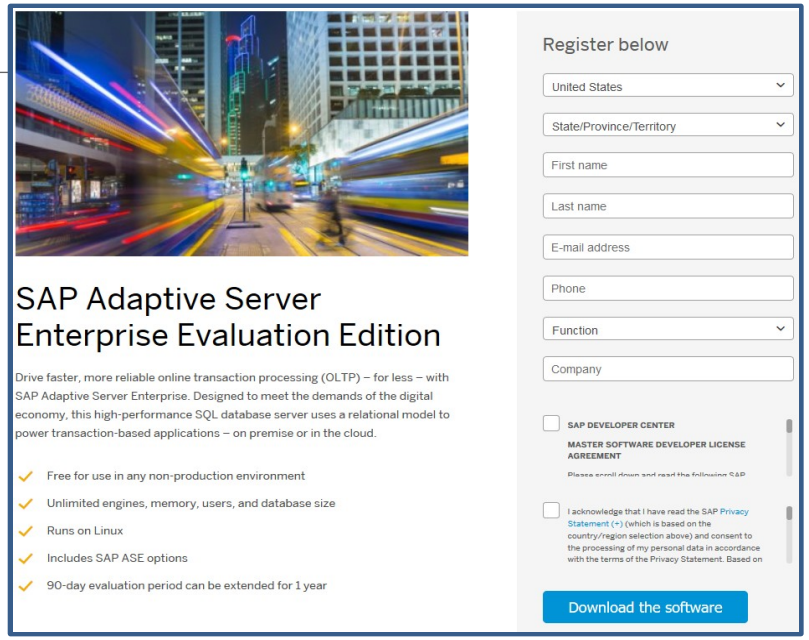
Phased implementation

- SQLScript core (ASE 16.0 SP03) is the first release followed by enhancements in future releases



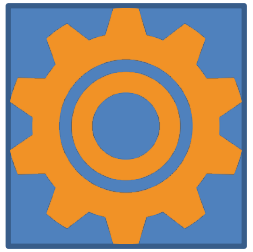
Evaluation, Packaging and Licensing Changes



- **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**
- **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
    - Warning provided to customers will remind them to be adequately licensed

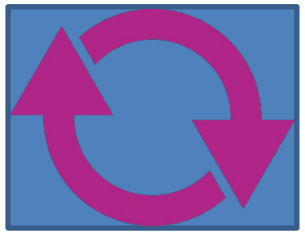
2018-2019: Focus Areas

OLTP Performance



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

Data Center Operations

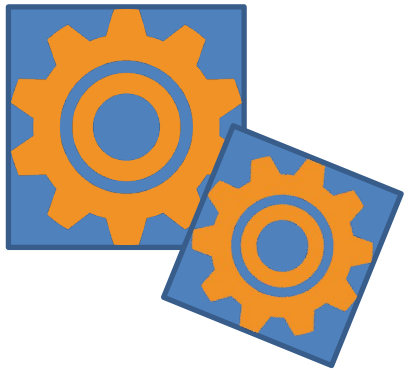


Always-On Enhancements
Data Masking
Temporal SQL
64bit MDA tables

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

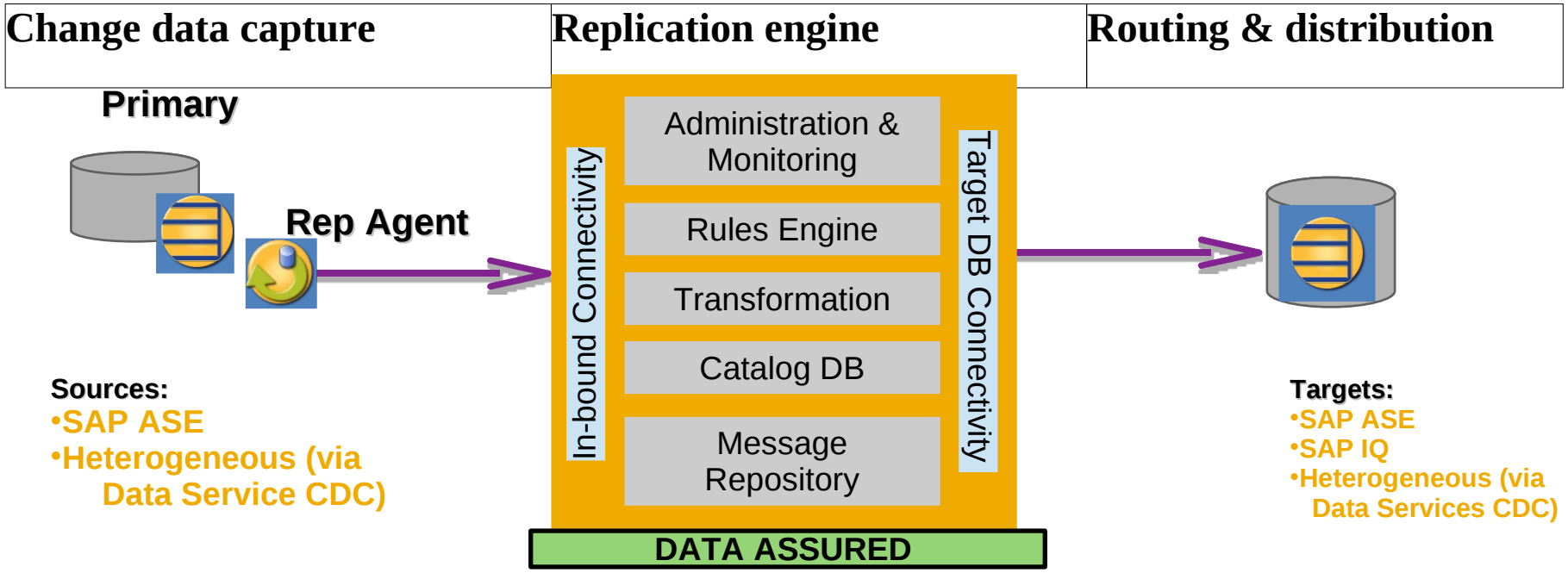
Planned Innovation	XOLTP Capability
In-Memory Only Tables	Support tables that are only in-memory (non-persisted) – similar to IMDB, but with benefits of IMRS/HCB for low latency queries
Increased server limits/capacity	Increase number of connections to support with a practical goal of 200K+ connections, 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 monitoringto 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 support forrecovery 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/Time Series data	Implement temporal SQL as well as other common time series data functionality such as window query support

SRS Road Map

SAP Replication Server – Focus on Supporting ASE



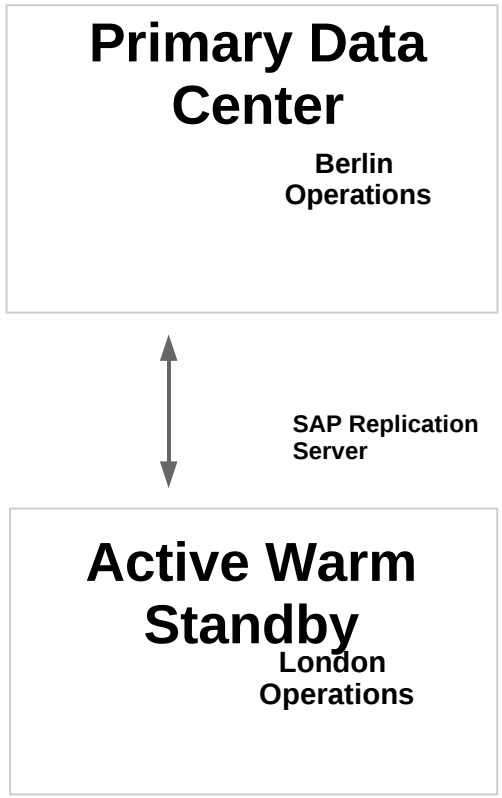
Note: Replication to SAP HANA will be supported by SAP HANA smart data integration solution.

Exceptions and limitations apply. Please check user documentation for end-to-end source and target database certification.
See appendix for expansion of acronyms

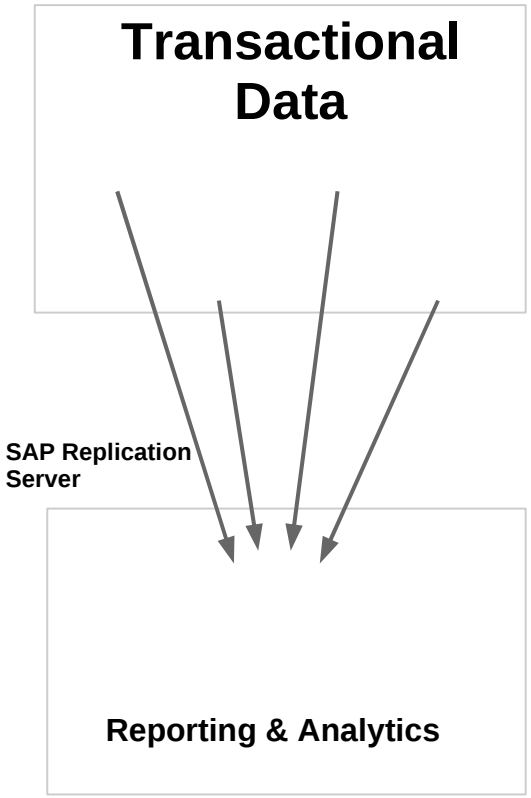
SAP Replication Server

Customer needs and the value propositions of the product

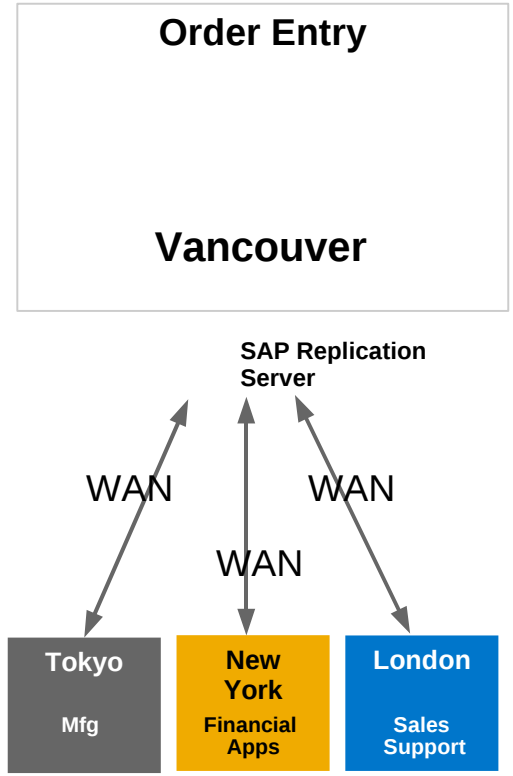
DB High Availability/ Disaster Recovery



Real-Time Reporting (data consolidation)



Data Distribution



SAP Replication Server

Product road map overview - key themes and capabilities

Recent innovations

·ASE support

- ASE 16 support (HADR and CI)
- Zero data loss (ZDL) synchronous replication with schema changes for custom apps and for Business Suite apps
- External replication into and out of HADR Cluster
- HADR materialization with subscription labels, to distinguish dump transaction and materialization marker
- DR for Business Suite on ASE
- Performance enhancements
- Virtual IP support for ASE CE

·Core enhancements

- Enhanced management and monitoring support with RMA
- AWS certification
- Data Assurance updates

·(SRS 15.7.1 SP 200 – 305)

2017 – Planned innovations

·ASE support

- ASE 16 SP03 support
  - IMRS/DRC
  - MVCC
- TCO optimizations – memory/disk
- Performance enhancements (T-shirt sizing)
- CCL support

·Core enhancements

- Certify SRS for replication within HANA Accelerator for ASE (A4A) scenario
- Certification of latest/newer versions of third party database with ASE
- Documentation for AWS
- Japanese and Chinese Localization

SRS 16 SP03

2018 – Product direction

·ASE support

- ASE 16 SP04 support

·Core enhancements

- Newer certifications of SRS for replication within A4A scenario
- User Interface improvements for Monitoring and Administration

2019 – Product vision

·ASE support

- New feature support

·Core enhancements

- Additional A4A support
- Enhance User Interface for Diagnostics and Cloud support

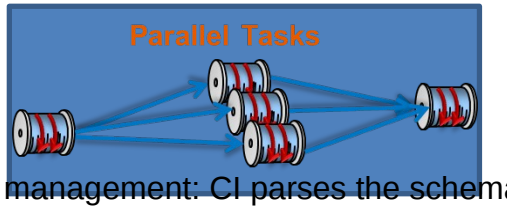
This is the current state of planning and may be changed by SAP at any time.

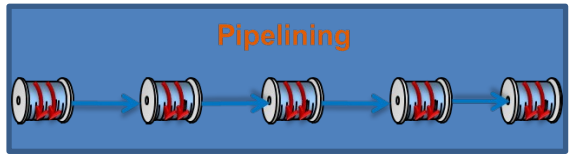
SRS Future: Canonical Interface (CI) for Replication

Canonical Interface (CI) is new method of replication by using a "Streaming" methodology. It has various advantages to RepServer's traditional Log Transfer Language (LTL) based replication.

Benefits of CI:

- **Faster processing of data packets:** In LTL, data packets are parsed and normalized before being written into inbound queue; whereas in CI, the records are immediately written to a special queue called Simple Persistent Queue (SPQ). This increases performance, but also increases buffering requirements and associated memory related operational costs.
- **Use of OS threading:** CI uses native OS threading. This makes CI threading faster than LTL's internal threading. However, since different OS implement threading slightly differently, there are small differences in how replication is processed.
- **Leverages Parallelization and Pipelining:** CI uses both parallelization and pipelining, with multiple buffers through the pipeline to reduce bottlenecks. As such, CI method is faster than LTL method of replication that mostly uses parallelization to increase performance. However, CI method also has higher memory (buffer/caching) requirements.





- Improved Schema management: CI parses the schema and stores it in RSSD the first time, compared to LTL that sends schema information in each package. As such, CI mode saves on amount of data transfer by simply sending raw log records. However, this means some functions of RepAgent processing in CI are done by SRS instead.

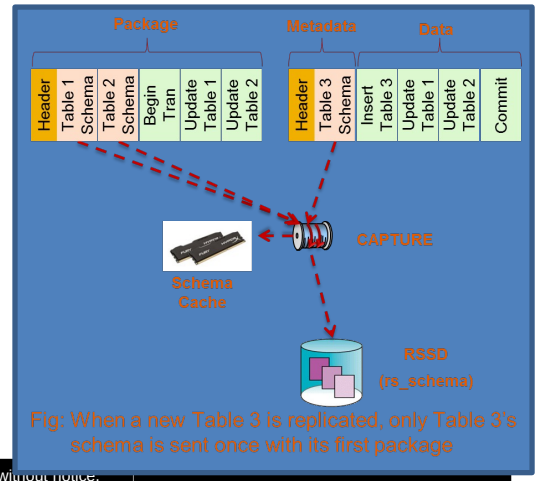
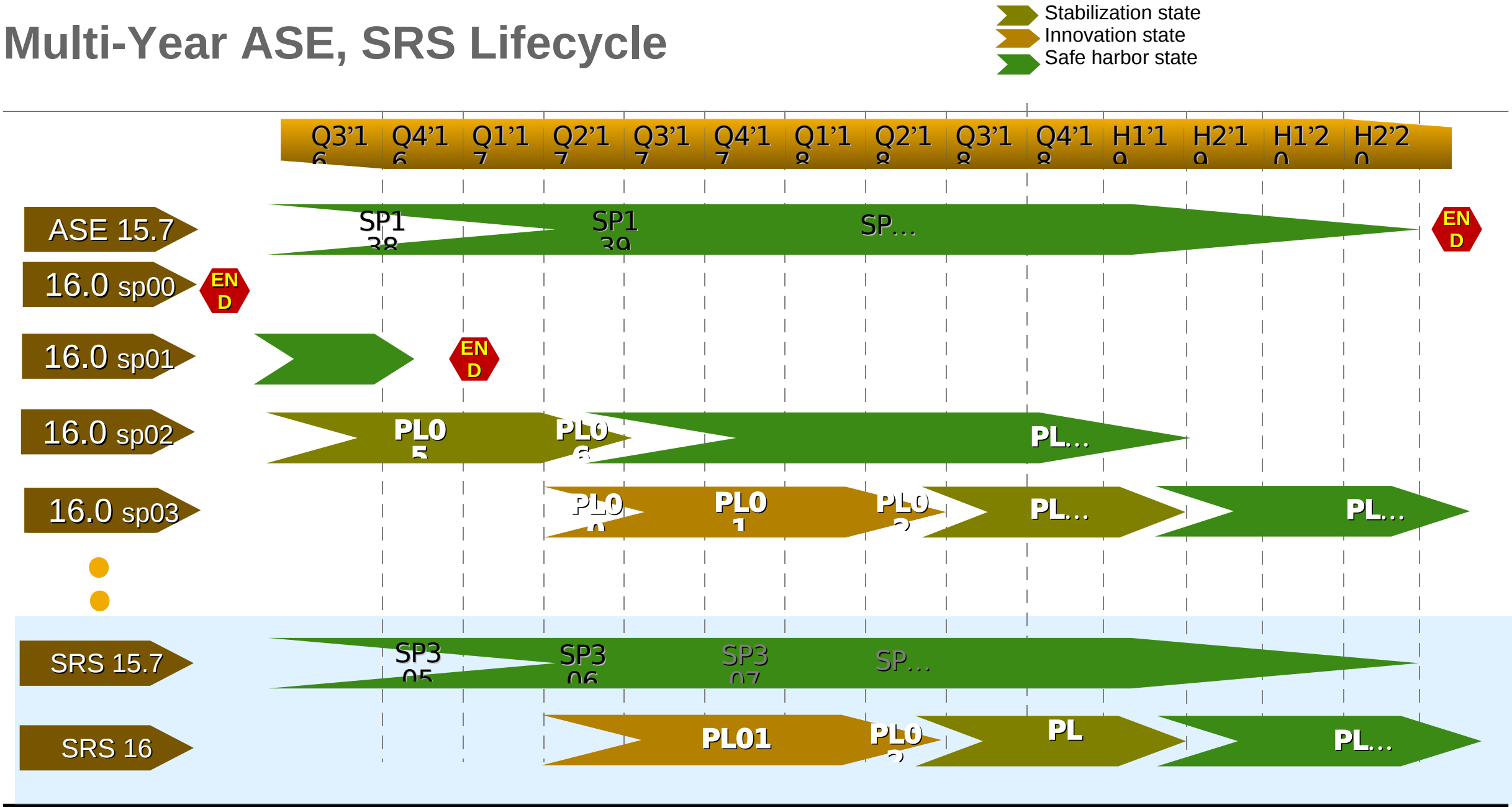


Fig: When a new Table 3 is replicated, only Table 3's schema is sent once with its first package

Multi-Year ASE, SRS Lifecycle



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

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See Appendix for abbreviations

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

Thank you

Road map contacts for customers and partners		
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· Jeff Tallman	Jeff.tallman@sap.com	ASE Product Management

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_wareho

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