AdNovum the i-engineers

Health Engine: Image-Enabled Patient Health Records with Oracle Multimedia DICOM

Oracle Open World 2009, San Francisco

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October 13, 2009

Agenda

- Motivation
- Company Presentation
- The Health Engine
- Use of Oracle Multimedia DICOM
- DICOM Performance Measurements
- Outlook
- Conclusions
- Q & A

Motivation

Efficiently manage all patient health records of a large hospital or hospital network including all type of medical images (X-Ray, MRI, CT, etc.) in one place – the *Health Engine*.

Company Presentation

the i-engineers	AdNovum
▪ Development and integration of the i-engine system core of the Health Engine	▪ Swiss-Quality High-End Security & Software Engineering
▪ Since 2002	▪ Since 1988
▪ 25 employees	▪ 190 employees
▪ Aarau (Switzerland)	▪ Zurich (HQ, Switzerland), Bern (Switzerland), Budapest (Hungary)
▪ Customers: Health, Government	▪ Customers: Financial, Government, E-Health
▪ Oracle Partner	▪ Oracle Partner and Member of Oracle Partner Advisory Board

☑ The two companies maintain a successful partnership.

☑ AdNovum offers integration of i-engine solutions into existing IT environments.

The Health Engine

- Universal archive and content management system
- (Virtual) patient dossier containing patient health records
  - medical, administrative, legal and care documents
- Medical record management workflow
- Meet regulatory requirements
  - Full traceability
  - Strict Access Management
- Information life cycle support
  - Audit-proof archive on leading archives (EMC, IBM, HP, Sun)
- Fully integrated into key hospital applications
  - Does not replace other systems

The Health Engine – Swiss Medical Suite

- Integration of hospitals, doctors, pharmaceutical companies
- Secure communication and data exchange of medical, administrative and financial information
- Installed base (Switzerland)
  - 180 hospitals / 6'200 doctors / 70 pharmaceutical companies
  - 50% / 50% / 80% of Swiss market

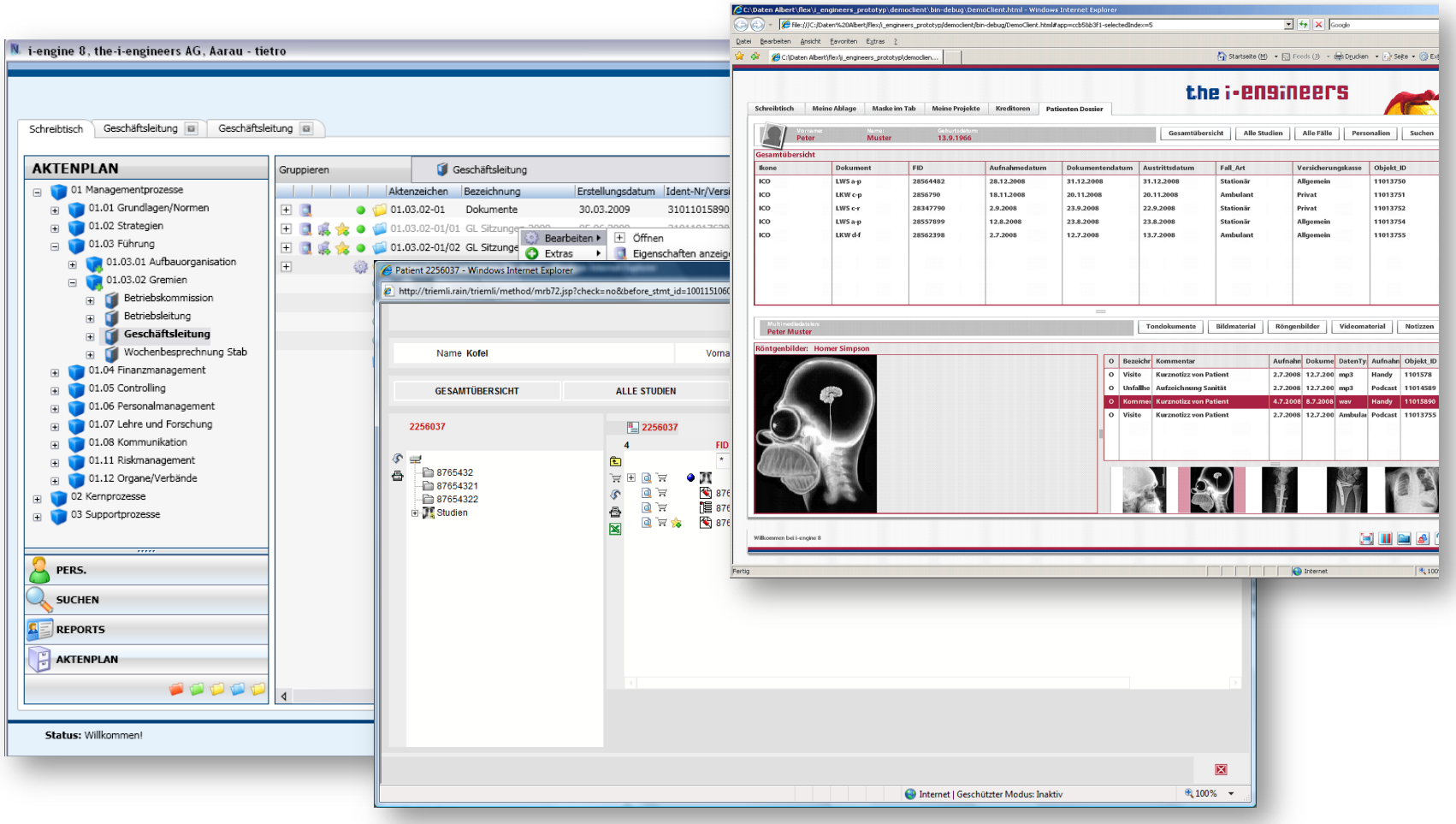
The Health Engine – Software Infrastructure

Based on **Oracle 11g** technology

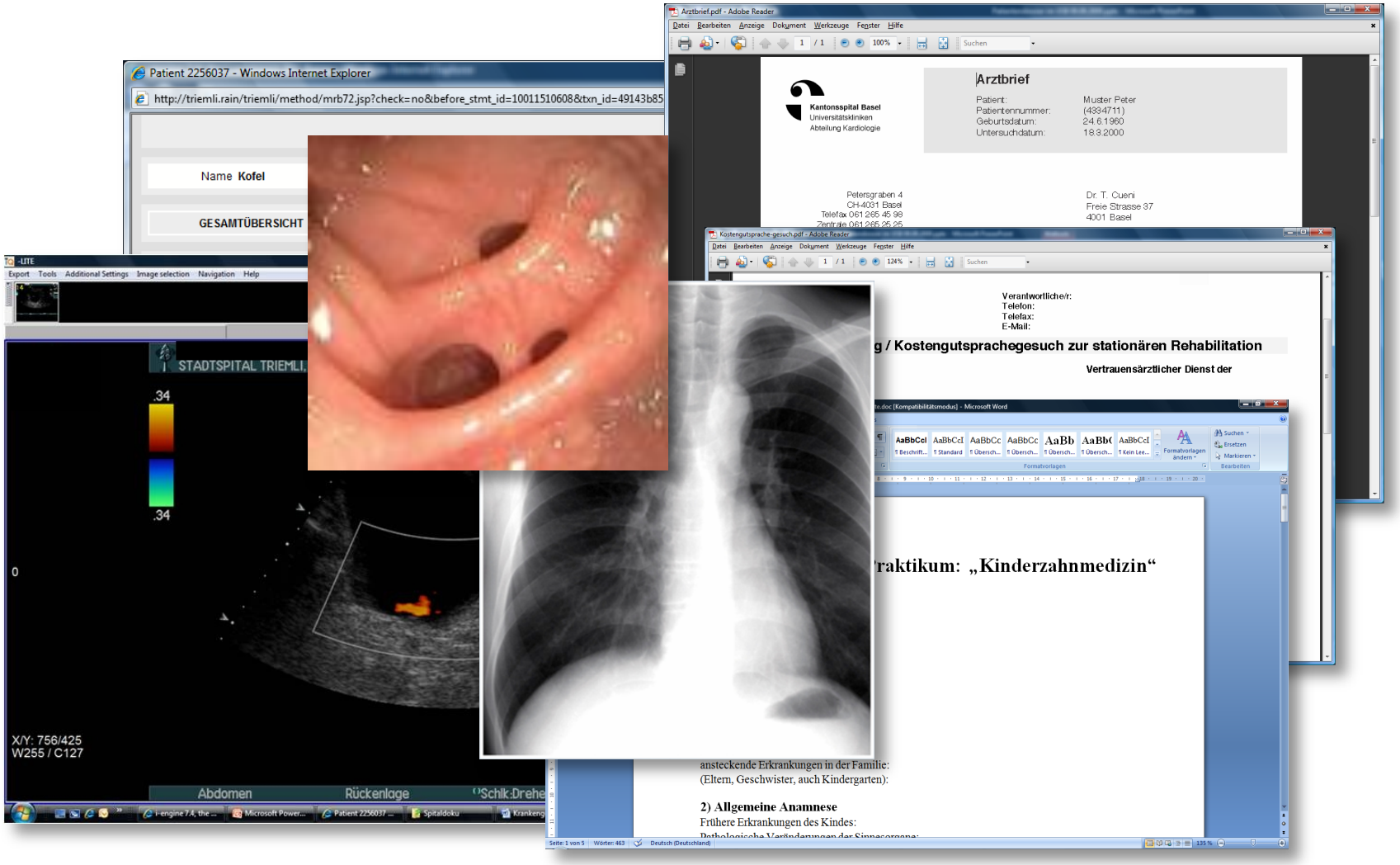
- **Oracle Database 11g**
  - Use of Secure Files for fast storage and retrieval
  - Storage of all data in the database, specifically DICOMS, files, …
- **Oracle Application Server 11g**
  - Java EE application
- Extensive use of **Oracle Multimedia DICOM**
  - Native support of Oracle DICOM (ORDDicom)
  - Extraction of Metadata
  - Conversion of DICOM into Web-friendly formats

The Health Engine – Client GUIs

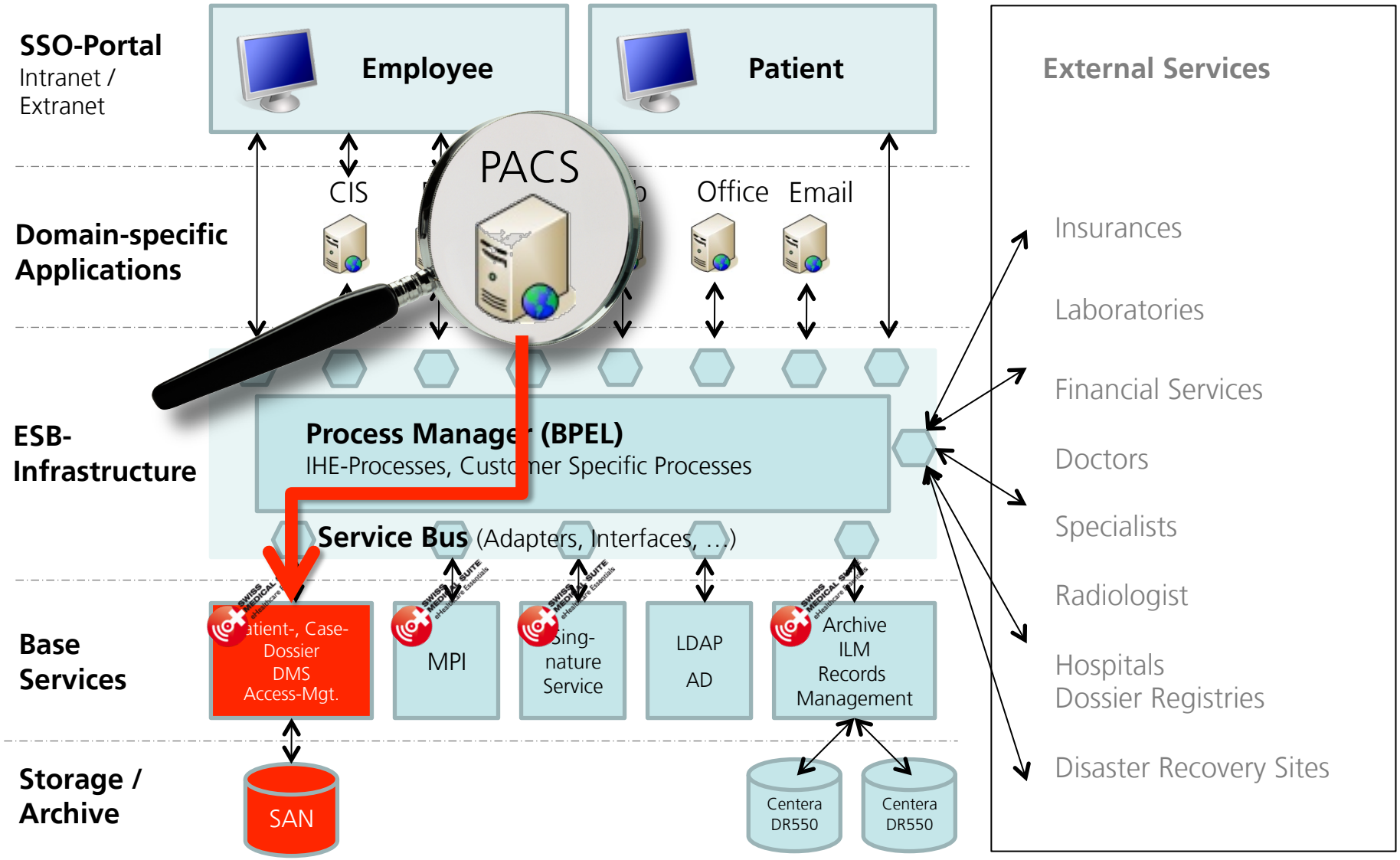
Technologies: Windows, HTML and Adobe Flex



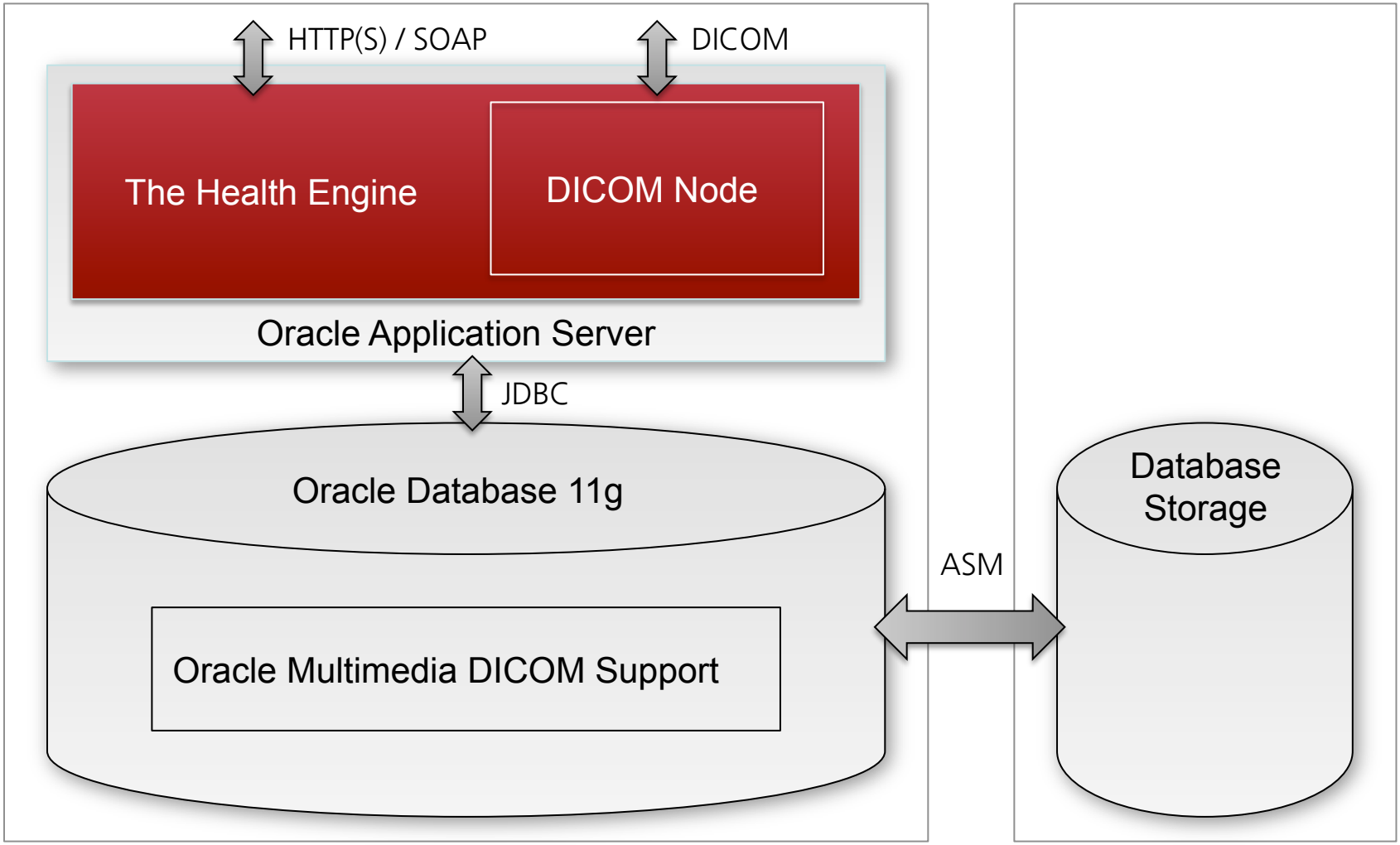
The Health Engine – Patient Record



The Health Engine – Typical Deployment



The Health Engine – Architectural Overview



The Health Engine – Goals

- Include images from PACS systems with other *Health Engine* patient data
  - Consistent storage of all patient data in one place
- Integration of PACS without media transfers
- Implementation based on well-established DICOM standard
- Transparent handling of DICOM objects within *Health Engine*
  - Store DICOM information in *Health Engine* Database

⇒Use of Oracle Database 11g Multimedia DICOM objects

Use of Oracle Multimedia DICOM

Advantages

- Full DICOM data object support on data-tier level
- Transactional access also on images (1-phase commit)
- Data consistency over all patient data
- Indexing and querying of DICOM metadata
- Sophisticated DB caching and optimizing technologies
- Well established and efficient data backup procedures
- Only database with native DICOM support (ORDDicom)

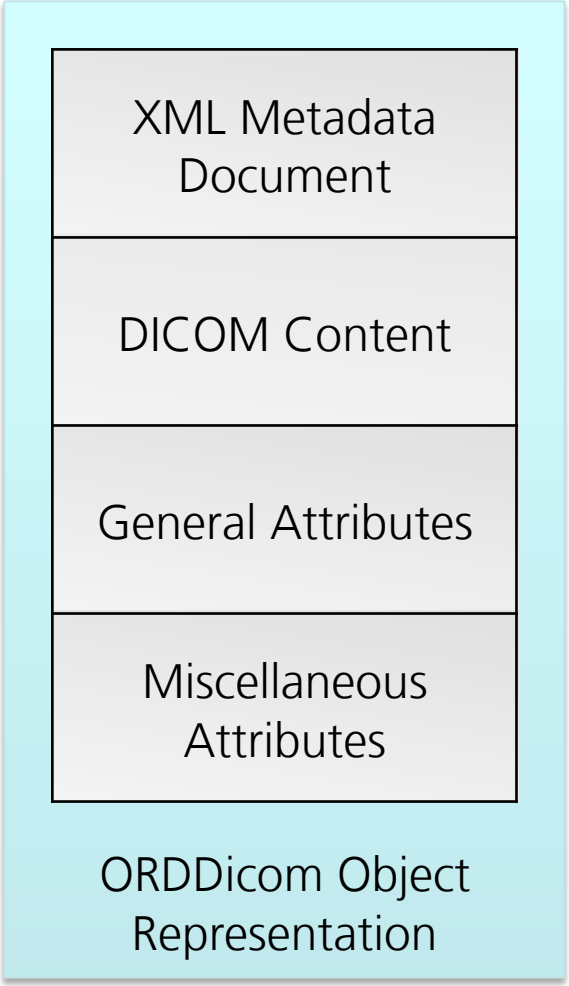
Challenges

- DICOM communication has to be provided extra
- Performance regarding DICOM object throughput

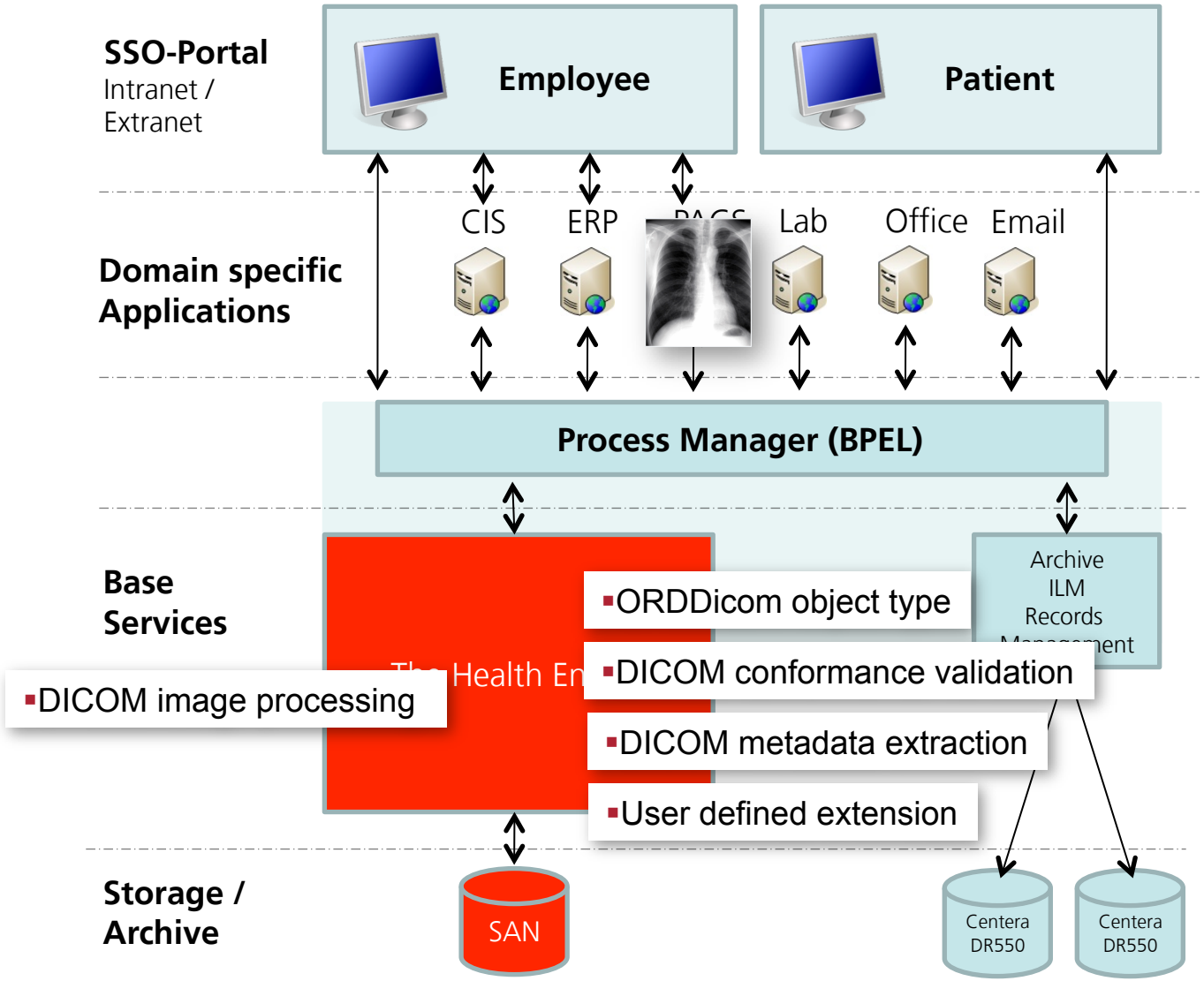
Use of Oracle Multimedia DICOM

Oracle Multimedia DICOM includes

- ☑ ORDDicom object type
- ☑ DICOM metadata extraction
- ☑ DICOM conformance validation
- ☑ DICOM image processing/compression
  - Making DICOM content anonymous
  - Creating content from images/metadata
- ☑ A run-time updatable DICOM data model
- ☑ User defined extension to standard DICOM model



Use of Oracle Multimedia DICOM



Use of Oracle Multimedia DICOM

- Performance was a huge concern on the part of our customers
- A lot of today's DICOM processing systems store DICOM information on proprietary file systems
- Customers challenged that storing DICOM objects in a standard database will meet with their requirements

- We defined a *performance measurement setup*
  - Use of commodity hardware found at our client's
  - Focus on image throughput and write performance
  - The goal is to be able to handle standard peak loads of a large (Swiss) hospital, which means storing approx. 300'000 images/hour

Performance Measurements – Configuration

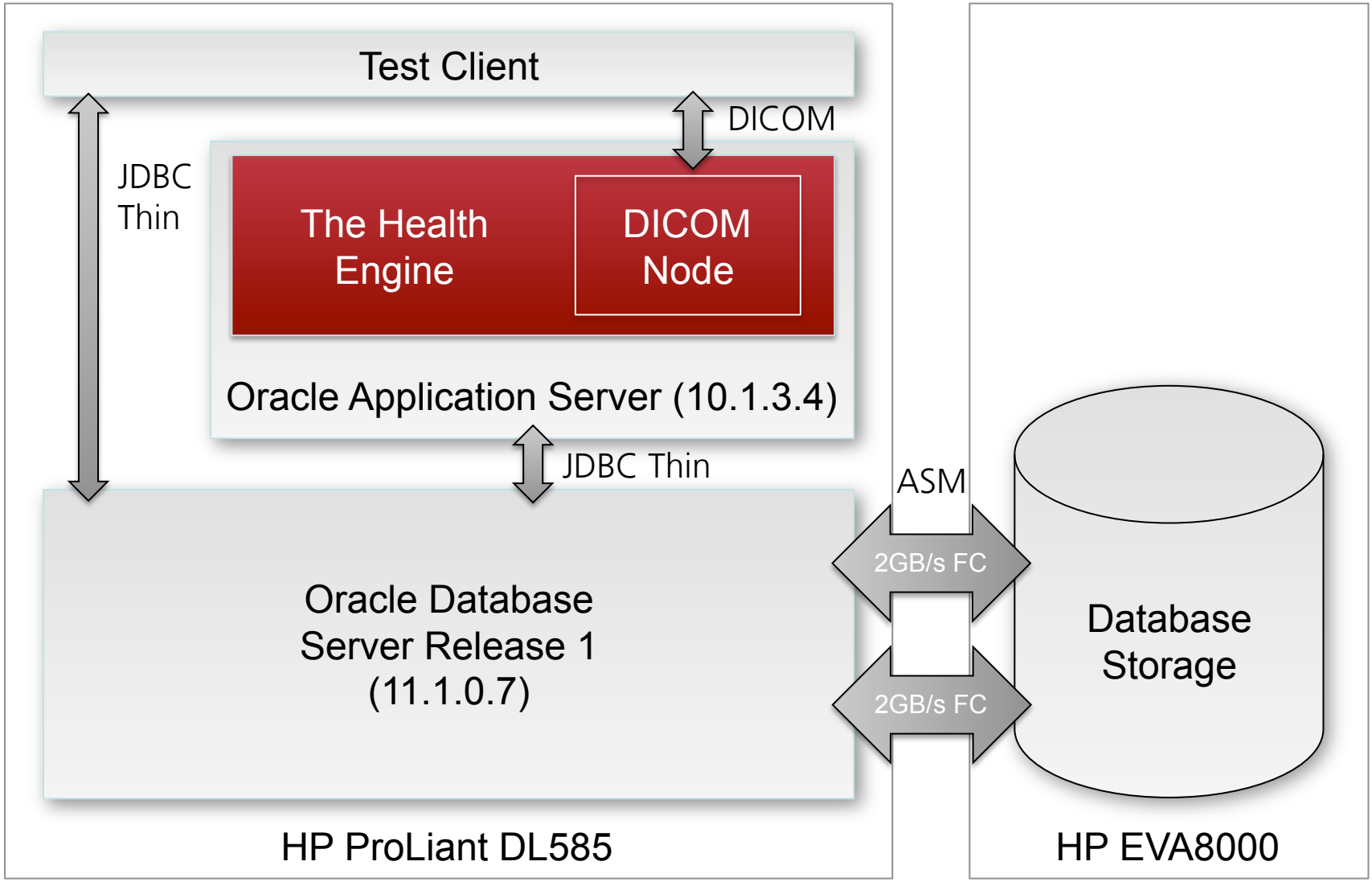
Application and Database Server

Server	HP ProLiant 585
Processor	4 x AMD Opteron, 2.4 GHz
Memory	32 GB
Controller	2 x Emulex 4GB PCI-e FC
Network	2 PCI Express 2.5GB/s Intel Pro / 1000 (4 ports)
OS	Redhat Server 5, 64-bit Linux 2.6.18-128.el5
Database	Oracle Database 11g Release 1 (11.1.0.7) Enterprise Edition

Database Storage

Server	HP StorageWorks EVA 8000
Disk	32 x 300GB FC 15k RPM HD
RAID	5
Cache	8192 MB
Interface	2 x 2GB FC ports

Performance Measurements – Setup

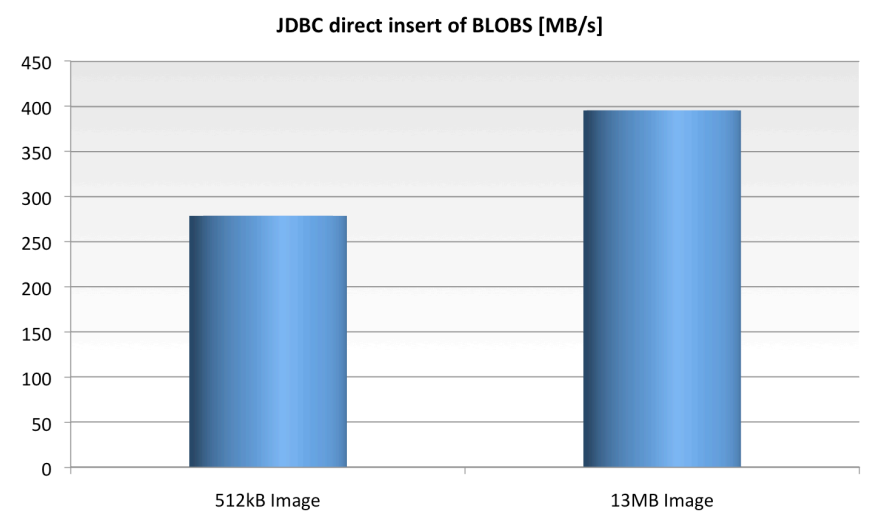


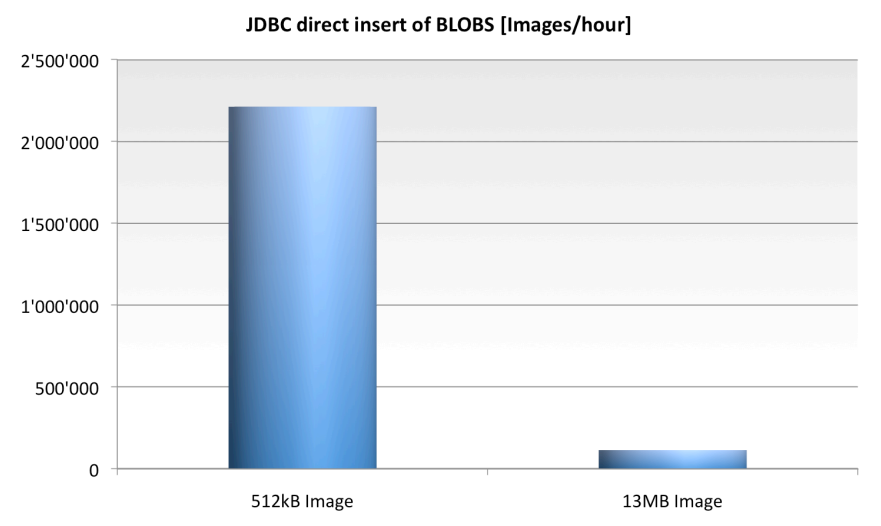
Performance Measurements – Scenarios

- Test scenarios
  - 1: JDBC direct insert of BLOBS
  - 2: JDBC direct insert of ORDDicom objects
  - 3: DICOM node insert of ORDDicom objects
  - 4: DICOM node insert of ORDDicom objects (optimized)
- Test data
  - Small: 512kB medical images
  - Large: 13MB medical images
- Load generation
  - Multithreaded, no think time

Performance Measurements – Scenario 1

- JDBC direct insert of DICOM objects as BLOBS

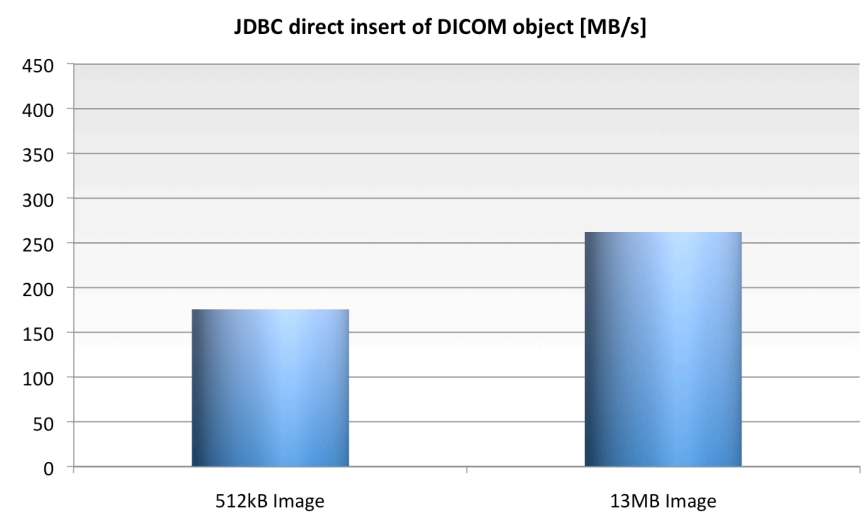


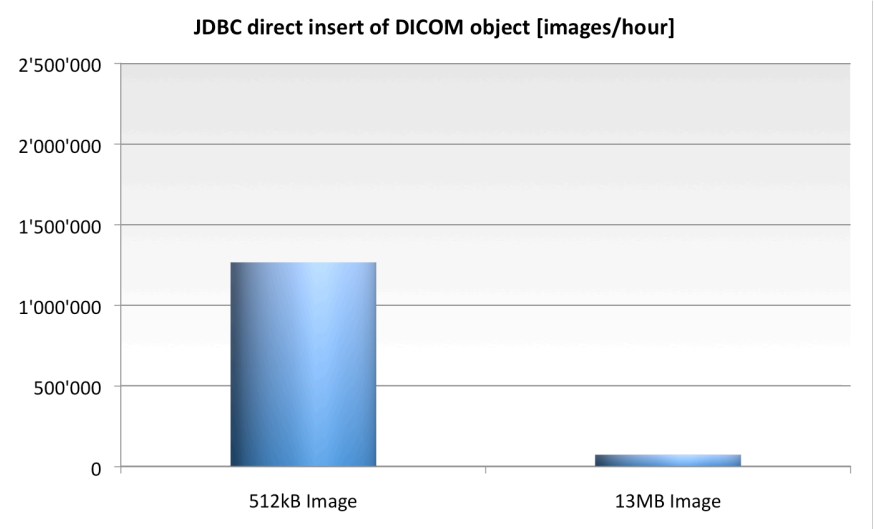


- Results
  - Acceptable throughput with 512kB and 13MB images
  - Close to direct I/O of attached SAN
  - Good-natured scaling behavior up to 200 parallel threads
  - *> 2 Mio images / hour* (512kB) resp. 113'000 images / hour (13MB)

Performance Measurements – Scenario 2

- JDBC direct insert of DICOM images as ORDDicom objects (without metadata extraction)

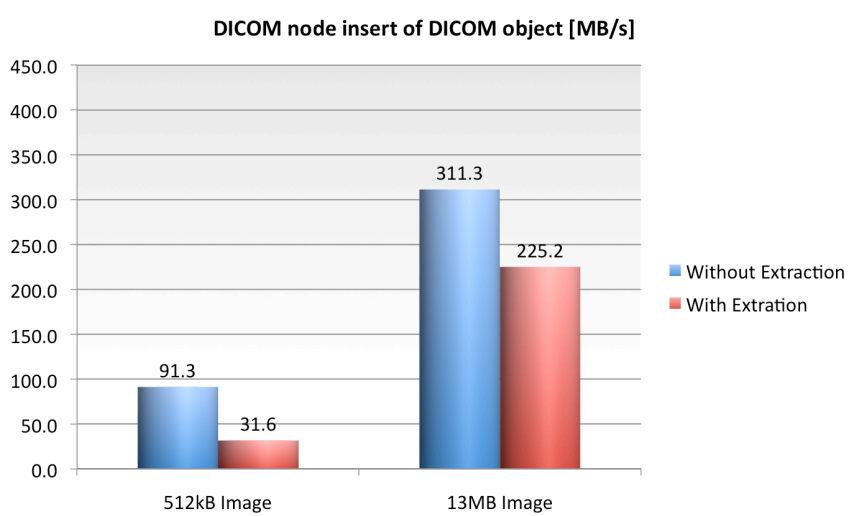


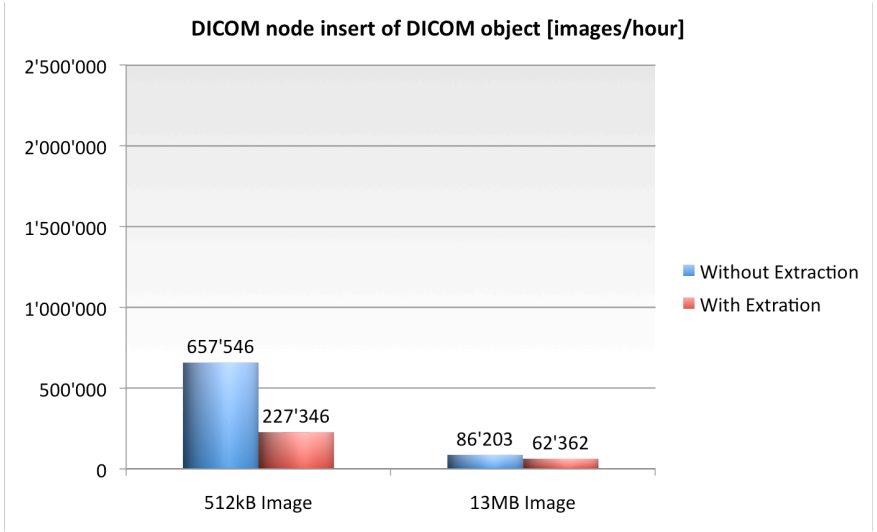


- Results
  - *1.3 Mio images / hour* (512kB) resp. 73'000 images / hour (13MB)
  - Still good-natured scaling behavior
  - Significantly lower performance (512kB) due to DICOM overhead

Performance Measurements – Scenario 3

- DICOM node insert of DICOM images as ORDDicom objects (with and without metadata extraction)

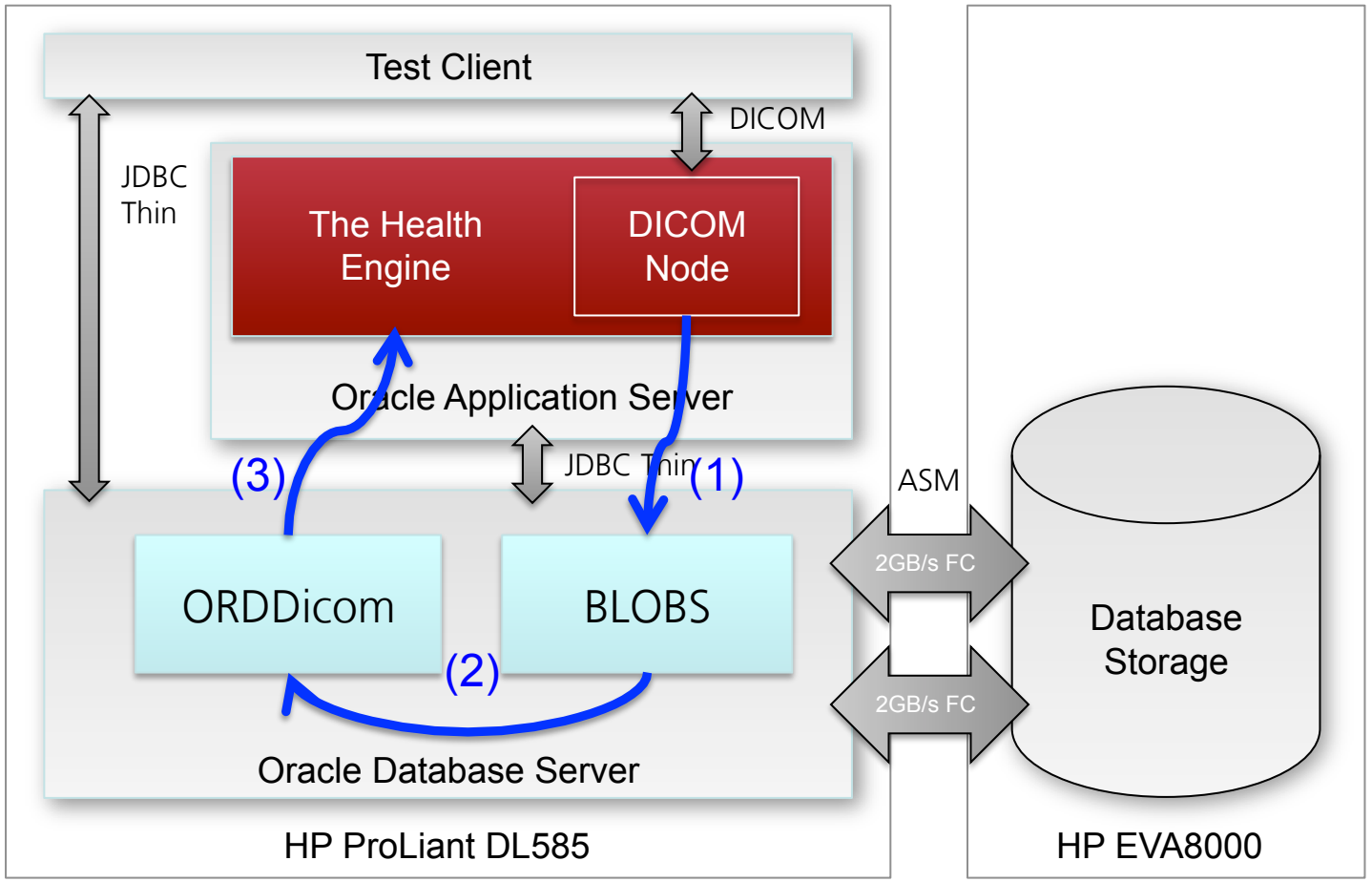




- Results
  - 658’000 images / hour (512kB) resp. 86’000 images / hour (13MB)
  - Dramatically reduced throughput with metadata extraction
    - only **227’000 images/hour** (512kB) resp. 62’400 images/hour (13MB)
    - **-66%** (512kB) resp. -28% images / hour (13MB)

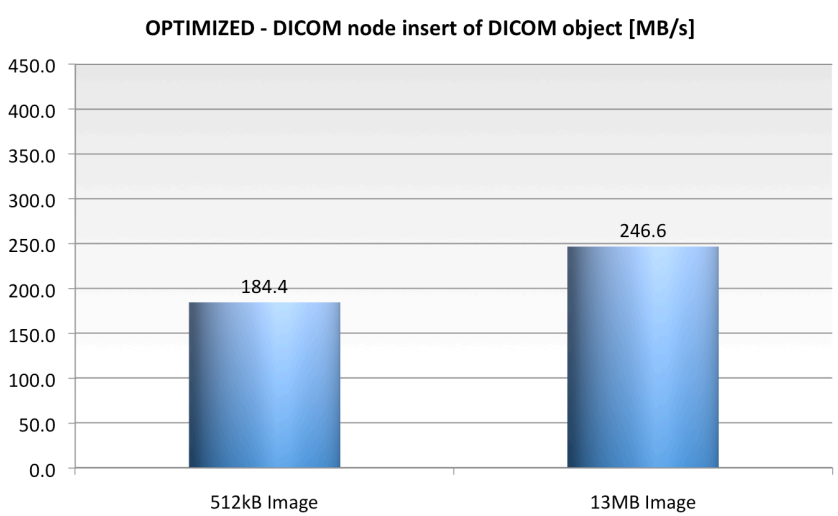
Performance Measurements – Scenario 4 I

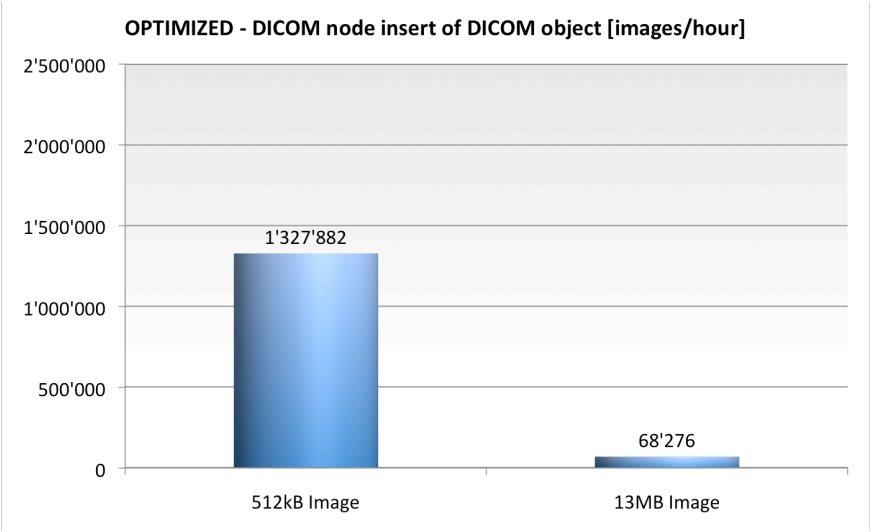
- Optimized writing of ORDDicom objects



Performance Measurements – Scenario 4 II

- Optimized DICOM node insert of DICOM images as ORDDicom





- Results
  - **1.3 Mio images / hour** (512kB) resp. 68'000 images / hour (13MB)
  - **5.8 x faster** (512kB) compared to non-optimized ORDDicom write
  - Excellent combination of BLOB performance and ORDDicom convenience

Outlook

- Customers are performance aware; push performance optimizations for fast DICOM write operations further
- Repeat performance tests with Oracle Database 11g Release 2
- Plan tests on new Exadata V2 system
- Enable Oracle Application Server to act as a DICOM node
- Go about business cases asking for large DICOM archives, such as:
  - Consolidated repositories for hospital networks
  - ASP/SAAS repositories serving several clients

Conclusions

- Position ***Health Engine*** as Meta-PACS/DICOM universal archive
- Showed key role of Oracle Multimedia DICOM
  - Position Oracle Database 11g as DICOM-Storage
- Functionality and easy use of ORDDicom object
- Verified performance when using Oracle Multimedia DICOM
- (Temporary) performance optimization for DICOM writes

⇒ Oracle Multimedia DICOM provides a crucial piece of technology to build large scale, integrative patient dossier systems like the ***Health Engine***.

Questions?

Contact Information

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More Health Engine and Oracle Multimedia DICOM

Wed., Oct. 14 11:45 a.m.	Oracle's Multimedia DICOM API: Next-Generation Platform for Medical Imaging Solutions	Moscone South Room 270
DEMOgrounds	Enterprise Multimedia Management and Medical Imaging	Moscone West W-021