Learning Objectives

As a result of this lecture, you will be able to:

- Identify single points of failure (SPOF) within your SAP system and know measures to eliminate them
- Know high availability options for databases
- Understand the basic principle of a fail-over cluster
- Know basics about recovery / disaster recovery
- Know reasons for planned downtimes and SAP’s approach to decrease them
- Know built-in load balancing facilities to make use of redundant components
- Know high availability configurations for SAP NetWeaver
- Find detailed information provided by SAP about high availability
Agenda

Overview

How to avoid unplanned downtimes
- Overview
- Points to be protected for SAP Web AS
- High availability for databases
- Clustering
- Standalone enqueue service
- High availability for SAP Web Application Server Java

Recovery

How to decrease planned downtimes

High availability configurations for SAP NetWeaver
- SAP Enterprise Portal
- SAP Exchange Infrastructure

Summary

Causes for Downtimes and Measures

Unplanned Downtime

- HW, OS failures, disasters 20%
- Operator errors 40%

Planned Downtime

- System and infrastructure maintenance
- Patches, upgrades, transports
- ...

Hardware, OS, environment failures, disaster impact to be avoided by eliminating Single Points of Failure (SPOF)

“Human errors” (= 80% of downtime causes) to be addressed by ease of system management and with improved change and problem management processes

To be avoided with scalable components which enable rolling maintenance

Improved upgrade processes

Proven correction and transport system

Source: Gartner Group
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  - SAP Enterprise Portal
  - SAP Exchange Infrastructure

**Summary**

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**Protecting Against Unplanned Downtime**

<table>
<thead>
<tr>
<th>Business Applications Technology Platform</th>
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</thead>
<tbody>
<tr>
<td>Database</td>
</tr>
<tr>
<td>Operating System</td>
</tr>
<tr>
<td>Server</td>
</tr>
<tr>
<td>Storage</td>
</tr>
<tr>
<td>Network</td>
</tr>
</tbody>
</table>

- Cluster, Replication
- Cluster Technology
- Redundancy, Cluster
- Disc Mirroring & SAN Technology
- Redundant Network Topology
Network

- Redundant network provider connections. Redundant routers.
- Load balancing to access redundant servers. Load balancer has to be redundant.
- Redundant switches. Redundant network access for servers (cluster might be required).
- Hot standby firewalls.

Further network related services to be considered:
DNS, Mail, Directory Server, Domain Controller, ...

Storage Area Networks / Network Attached Storage

- HA related features of storage devices:
  - Mirrored disks
  - Server independence
  - Split mirroring
  - Remote copy / replication

- RAID (redundant array of inexpensive/independent disks) is used to protect the disks itself, e.g.:
  - RAID 1 – mirroring and duplexing
  - RAID 5 – independent data disks with distributed parity blocks
High Availability Features for Server Hardware

- Redundant power supply
- Redundant coolers
- ECC Memory
- Hot pluggable components
- Redundant boards
- Redundant bus
- Management capabilities
- Partitions, domains

... to protect the server itself

Overview of HA Options for Databases

One Database

- Cluster Node
- Cluster Node
- Shared storage

Two Databases

- DB
- Standby DB
- Replication

- Clustering alternatives:
  "shared nothing" vs.
  "shared everything"

- Replication on database level
- Replication on storage level

- Combination of the options
Oracle 9i Real Application Cluster

Oracle 9i provides a scalable, high availability architecture that provides transparent client fail-over capability:
- Little or no user downtime
- Applications and users are automatically and transparently reconnected to another system
- Queries continue uninterrupted

If a node fails, users will be migrated.

Highly available shared file system required for software and data files

2003:
Step-by-step platform release planned (pilots + controlled availability)

Pilot plans:
(current status, might be changed; see SAP note 527843 for details)
- Tru64: Q2/2003
- AIX: Q3-4/2003
- Linux: Q4/2003
- Solaris: Q1/2004
- HP-UX: Q1/2004
- Windows: Q1/2004

Oracle 9i Real Application Cluster

Highly available shared file system required for software and data files

Failover Cluster Example: MSCS Setup for SAP Systems

One node runs the database, the other node runs the central instance.

The applications are accessed via virtual IP addresses and host names.
**Scenario: Complete Failure of the CI node**

1. The CI node fails.
2. The cluster SW detects the failure.
3. Node B is configured with the virtual address of the cluster and the CI and gets access to the required disks. Then the CI will be restarted.

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**Scenario: Complete Failure of the DB node**

1. The DB node fails.
2. The cluster SW detects the failure.
3. Node A is configured with the virtual address of the DB and gets access to the required disks. Then the DB will be restarted.
4. The application servers can automatically reconnect to the new DB host (using the virtual IP address).
### Cluster – Summary

<table>
<thead>
<tr>
<th>What a cluster provides…</th>
<th>Where a cluster does not help…</th>
</tr>
</thead>
<tbody>
<tr>
<td>■ Mask server hardware failures</td>
<td></td>
</tr>
<tr>
<td>■ Mask OS errors on one node</td>
<td></td>
</tr>
<tr>
<td>■ Automatic restarts</td>
<td></td>
</tr>
<tr>
<td>■ Automatic failure detection</td>
<td>■ Move running applications without disturbance (only stop/restart)</td>
</tr>
<tr>
<td></td>
<td>■ (Disaster recovery - …requires two locations)</td>
</tr>
<tr>
<td></td>
<td>■ HA for horizontally scalable components (e.g. SAP application servers)</td>
</tr>
<tr>
<td></td>
<td>■ HA for disks (RAID required)</td>
</tr>
<tr>
<td></td>
<td>■ Logical data corruptions</td>
</tr>
<tr>
<td></td>
<td>■ Physical corruption of files</td>
</tr>
<tr>
<td></td>
<td>■ Having good knowledge in system administration</td>
</tr>
</tbody>
</table>

SAP recommends clustering for HA purposes.

No certification of cluster software by SAP.

Cluster software has to be supported by the respective vendor. (Exception: MSCS support by SAP)

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### High Availability for SAP Web AS

**No single point of failure.**

Further information: [http://service.sap.com/ha](http://service.sap.com/ha)
Standalone Enqueue Service with Replication

- Direct, parallel enqueue requests without Message Server bottleneck.
- Replication of requests to replication server.
- Replica table to restore the enqueue table after fail over.

Error detection and fail over by industry standard cluster solutions.

For details on the availability of the standalone enqueue service check SAP Note 524816.

SAP Web AS Java 6.20: Cluster Architecture

- Deployment to all J2EE Engines in a cluster group
- Distributed configuration database (for JNDI and security settings)
- Transparent fail-over for stateless JSPs/servlets (no state synchronization)
- No transparent fail-over for stateful conversation
**SAP Web AS Java 6.30: New Cluster Architecture**

**Design goals for the new Architecture**
- Better Scalability
- Better Performance
- Better Manageability
- Reuse of robust SAP base technology
- Better Integration with SAP Web AS ABAP

**New Cluster Components**
- SAP Central Services Instance (SCS)
  - Message Server
  - Standalone Enqueue Server
- J2EE Central Database

**New HA Feature**
- HTTP session failover (configuration option per application)

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**Recovery**
- How to decrease planned downtimes
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**Summary**
Overview of Recovery Technology

<table>
<thead>
<tr>
<th>Recovery Point Objective</th>
<th>Recovery Time Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Crash Point</strong></td>
<td></td>
</tr>
<tr>
<td>Weeks</td>
<td>Secs</td>
</tr>
<tr>
<td>Days</td>
<td>Mins</td>
</tr>
<tr>
<td>Hrs</td>
<td>Secs</td>
</tr>
<tr>
<td>Mins</td>
<td>Mins</td>
</tr>
<tr>
<td>Secs</td>
<td>Hrs</td>
</tr>
<tr>
<td>Periodic Replication</td>
<td>Asynchr. Replication</td>
</tr>
<tr>
<td>Clustering</td>
<td>Manual Migration</td>
</tr>
<tr>
<td>Tape Restore</td>
<td>Tape Restore</td>
</tr>
</tbody>
</table>

Backup
Replication
Clustering

To which point-in-time can I perform a recovery?
Who long do I need for recovery?

Backup / Restore in a System Landscape

Backup & restore of a single system component
- Prevent data loss
- Ensure recovery to current point in time (point of failure)
- Ensure data consistency between systems
- No impact on production systems caused by backup
- Fast backup/restore/recovery
- Easy handling

Consistent backup & restore of the complete system landscape
- Synchronization points
- Consistent system copies
- (not easy to achieve)

Further information:
http://service.sap.com/atg
Backup & Restore
Disaster Recovery – Sample Configuration

Disaster Recovery Data Center

Production Data Center

- Application Servers
- Storage device
- Node 1: Production
  - Prod. Mirror
  - Prod.
  - Prod. (Split) Test

- Cluster Interconnect

Disaster Recovery Data Center

- Application Servers
- Storage device
- Node 2: Failover / Test
  - Prod. Failover
  - Prod. (Split) Backup
  - Standby (x hours behind)

Possible distance: ~60 kilometers

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Summary
### Planned Downtime

#### High frequency

- **Weekly**
  - Offline backups with split-mirror
  - Kernel upgrades
  - Profile parameter changes
  - Transports
  - Support packages
  - Database reorganizations

- **Monthly**
  - Offline backups without split-mirror
  - Kernel upgrades
  - Profile parameter changes

- **Quarterly**
  - Transports
  - Support packages

- **Yearly**
  - Offline backups without split-mirror
  - Kernel upgrades
  - Profile parameter changes

#### Low frequency

- **Weekly**
  - Offline backups with split-mirror
  - Kernel upgrades
  - Profile parameter changes
  - Transports
  - Support packages
  - Database reorganizations

- **Monthly**
  - Offline backups without split-mirror
  - Kernel upgrades
  - Profile parameter changes

- **Yearly**
  - Offline backups without split-mirror
  - Kernel upgrades
  - Profile parameter changes

### Parameter Changes / Operation Modes

#### Profile Parameter Changes
- Profile parameters to configure SAP instances
- Held in shared memory since Rel 4.0 (which enables online changes)
- A lot of profile parameters can be changed online (e.g. timer values) – some changes require downtime (e.g. memory parameter)
- List of parameters to be changed online: note 102428

#### Operation Mode Changes
- Type of work processes can be changed dynamically, e.g. to adjust different work profiles (e.g. day vs. night – dialog vs. batch)
- Number of work processes is not changed
- Switch manual or scheduled without disturbance of current work
**SAP Web AS 6.10: “Soft Shutdown”**

Instance can be set to status “passive” with TA/command SMMS.

The application server can continue to process received requests or create requests itself.

However, no new requests will be sent to the server.

The purpose of this state is to "logically" remove a server that has to be stopped during productive operation of the system.

The server finishes processing its existing requests, but does not accept any new requests and can be terminated without having to interrupt any relevant requests such as updates or batch jobs.

This state can be changed to the "active" state.

**Benefit:**
Instance can be taken out of operation without disturbing users.

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**Applying Support Packages with Minimal Downtime**

<table>
<thead>
<tr>
<th>Uptime</th>
<th>Downtime</th>
<th>Uptime</th>
</tr>
</thead>
<tbody>
<tr>
<td>initial state</td>
<td>inactive import</td>
<td>switch of the report sources</td>
</tr>
</tbody>
</table>

1. Sources to be imported
2. active sources → active sources
3. inactive sources → active sources
4. obsolete sources

- **4.6D:** support package shadow import
- **Uptime:** Parallel import of new sources
- **Downtime:** DDIC import, main import, switch of sources to active state
- **Benefit:** All report sources (main part of SP) can be imported during uptime
- **Downtime decreased!** (saved up to 70% with report sources)
### Rolling Kernel Upgrades

**Prerequisites:**
- Application servers may not impose SPOF (requires standalone / replicated enqueue)
- Only switch of compatible kernels
- Different kernels only for short time

**Database Reorganization**

- Reorganization of DB objects (tablespaces, indices, tables) might be useful

**Causes:**
- Tablespace overflow (Measure: Increase tablespace in time)
- DB file fragmentation (Consider: downtime vs. space saving)
- Index fragmentation (Consider: downtime vs. performance increase)

**Goals** (performance increase, space saving) have to be considered vs. downtime
- New DB releases lower the need for reorganization
- Performance gain after DB file reorganization not always evident
- DB reorganization requires downtime (might be long!)

**SAP recommendations:**
- Avoid reorganization if possible
- Correct configuration
- Proper monitoring
- Documentation: SAP Help
New Upgrade Procedure: System Switch Upgrade (from Rel. 6.x)

Beside the downtime-minimized strategy, there is a resource-minimized strategy.

Downtime with System Switch Upgrade

No downtime extension caused by included Support Packages/Add-Ons

Package count: 32
16
8

Without packages

DDIC – data dictionary import
ACT – mass activation
PCON – phys. structure conversion
TABIM – main import
XPRA – ABAP execution after upgrade

SM207 – Upgrade with acceptable Downtime
10/02/03 – 12.00-13.00

SM261 – System Switch Upgrade – Monitoring and Troubleshooting
10/01/03 – 14.00-18.00
**Outlook: End of Daylight Saving Time**

- **Problem**
  - Switch back from daylight saving time to normal time causes "double hour" with non-unique time stamps
  - Problems (e.g. with batch jobs or generation of reports) might occur

- **Today**
  - SAP recommends to turn off the system during this time (that means 1..2 h planned downtime!)

- **The new way:** *Save time continuity by stretching system time in "double hour"*
  - For SAP Web AS 6.40 (with downward compatible kernel availability for all 6.x based systems)

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- **Summary**
**SAP NetWeaver: High Availability for SAP Enterprise Portal 6.0**

- **Database** – to be protected with **cluster**
- **Global file system** – to be protected with **cluster**
- **Portal application** on top of SAP J2EE Engine – **multiple servers**
- **Access to multiple servers** via **load balancer**

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**SAP NetWeaver: High Availability for SAP Exchange Infrastructure 2.0**

- **Integration server**: ABAP based – **DB and CI** to be protected with **cluster**
- **Mapping server**: J2EE based – **J2EE cluster**
- **XI Integration Directory, Repository, System Landscape Directory** – no SPOFs at runtime
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#### Summary

Eliminate Single Points of Failure using redundant components to avoid unplanned downtimes

All critical system components of SAP Web AS can be protected

Consider recovery / disaster recovery

Planned downtime can be reduced by several measures

SAP makes continuous improvements to decrease planned downtimes
Further Information

**SAP Service Marketplace:**
- http://service.sap.com/ha
- http://service.sap.com/upgrade
- http://service.sap.com/netweaver

**Related Workshops/Lectures at SAP TechEd 2003**
See hints in the slides.

Questions?

Q&A
Feedback

Please complete your session evaluation and drop it in the box on your way out.

Thank You!

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