WebSphere Application Server
Version 8
High Availability Enhancements

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IBM

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Session Number 9484
# WebSphere Application Server Sessions

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First Consideration -- What Constitutes an "Outage?"
This is key -- know what you're trying to plan to protect against. This will keep you from under-engineering as well as over-engineering.

- **Hardware Availability**
  - Proven stable designs
  - Duplication of physical assets
  - Hot swap of components

- **Operating System Availability**
  - Proven stable designs
  - Cluster of OS images
  - Integration with duplicated HW

- **Middleware Availability**
  - Multiple instances of middleware
  - Workload distribution between instances
  - Common data sharing or replication

- **Application Availability**
  - Multiple instances of applications
  - Maintain access to data resources
  - Maintain user affinities where they exist
  - Manage application updates

- **User Connection Recovery**
  - Maintain HTTP objects

- **Transaction Failure and Recovery**

- **Fault Awareness and Re-routing**

- **Continuous Availability**

Proven stable designs
Integration with duplicated HW

What Does System z and z/OS Bring to the Table
This is where WAS z/OS starts its HA journey ...

1. Hardware
A strong story about designed-in redundancy, hot-swappable components and mean time between failure measured in years.

2. Hipervisor
The virtualization layer that allows multiple logical partitions (LPARs) to be hosted on top of the physical hardware resources. Extremely stable with sophisticated dynamic qualities.

3. Coupling Facility / Parallel Sysplex
This is the heart of the HA story ... this is what provides the shared data, rapid signaling and clustering at the OS level.

4. Other CECs
Parallel Sysplex is not limited to a single CEC. Multiple CECs may be joined. The physical distance between the machines in the Sysplex may be expanded to span buildings or cities.
z/OS Middleware Components that Exploit the Parallel Sysplex

Let's do a quick survey of the key middleware components that are "Sysplex Aware" ... this then sets the stage for the discussion of WAS z/OS that rides on top:

1. Redundant z/OS images
   And possibly redundant CECs as well
2. Centralized Clustering
   The CF provides a mechanism for data sharing, data locking and fast signalling
3. Exploiting Middleware
   Designed with Parallel Sysplex in mind
4. WAS z/OS
   Riding on top
The Split JVM Model -- Redundant JVMs Behind the Listener Ports

This is the first line of defense * -- redundant JVMs per application servers provides nearly seamless protection against JVM outages:

1. Controller
Consider this IBM plumbing code. It's primary role is summarized by the bullets to the left

2. WLM Work Queues
The controller makes use of WLM work queues between CR and SR. This provides a way to segment by classification as well as a queuing point to buffer against overruns.

3. Servant(s)
This is where the applications run. Multiple concurrent servants is possible and is what provides the redundancy.

4. User Session Objects
Not replicated to each servant, which means no unnecessary usage of heap. Sessions maintained in z/OS data spaces, so lost servant does not mean lost sessions.

5. Auto Restart
WLM will automatically restart any failed servant regions

* One could say that the System z hardware and the z/OS operating system are the true first lines of defense against outage
Clustering Across LPARs -- the Second Line of Defense

Clustering is a feature available on all platforms of WAS. The difference is the access to the Sysplex-enabled middleware components:

1. WAS Clustering
   Multiple application servers organized into a logical single deployment target

2. Duplicated Applications
   WAS propagates application binaries to all members of the cluster.

3. Redundant Sysplex-aware Middleware
   Physically separate from other LPARs but sharing common data structures in the CF.

4. Shared Data and Locking
   That's what the CF does.

5. TX Syncpoint Coordinator
   Resource Recovery Services (RRS) is a transaction syncpoint coordinator. All the major z/OS subsystems make use of it to coordinate 2PC processing.
Routing from Outside In

WAS cluster members represent physically separate application servers hosting separate TCP ports. So *something* has to be "out front" routing:

There is a great deal to consider in this space:

- Does it terminate the SSL connection?  
  This allows for a more flexible routing to the backend.

- Do server affinities need to be honored?  
  The most common is affinity based on session object location.

- Where does this routing function reside -- inside the DMZ or behind the secure firewall?  
  Inside the DMZ suggests a minimum of protocols and ports punching through the back secure firewall.

- How much knowledge of the environment do you desire the function to possess?  
  Server up or down? Or more -- J2EE application status?

- How intelligent do you want the routing to be?  
  Three basic levels -- pure round robin; weighted round robin, intelligent placement based on advice.

- Plus other criteria not listed above
Four Topics to Consider

They are ...

Server Affinities
The most common are the result of creating HTTP session objects. Affinity restricts request routing flexibility

Data Access Approaches
It's a trade-off ... the benefits of co-location vs. the flexibility of IP-based re-routing.

Other Application Dependencies
The application may be up and accessible but not "working" because of some other element in the design not available. What do you do about this other than keep close tabs on the relationships and enforce careful change control?

Transactions and Transaction Recovery
WAS has a mechanism to roll back in-doubt transactions. RRS is central to this.

This is also why it's really important to lock down the definition of what constitutes an outage. It may well be that user access to a part of the functionality is acceptable.
Server Affinities
The most common is HTTP session affinities, which are used to hold transient data. But without planning can create a need to route users back to the initial server.

1. Session Object
Created by application if designed to do so. It is a data object in JVM memory.

2. Affinity Routing
One option is to provide affinity routing. WAS Plugin does this, as does Proxy. Sysplex Distributor does not.

3. Within Appserver
If the servant in which a user object resides goes down, WAS z/OS automatically takes care of that and places user into a surviving servant.

4. Replication Domain
A feature of WAS across platforms. This serializes the object and copies it over the network to other servers in the defined domain.

5. Session Persistence
Object persisted to DB2 and fetched back as needed.

Key Points:
- Combination of affinity routing and replication or persistence is common.
- On z/OS persistence performs as well or better than replication.
- Create affinities only where necessary; be careful of object size.
Data Access Approaches - The T2 vs. T4 Debate

You gain a degree of flexibility with an TCP-based connection but lose some of the advantages of a local cross-memory connection:

1. **Local Connectors**
   - Uses the cross-memory native interfaces. Available for DB2, CICS, IMS and MQ.
   - **Advantages**: Speed, avoid serialization, assert identity, single thread of execution, propegate enclave for DB2.
   - **Disadvantages**: Loss of data system means application has no access to data unless alternative connections are made available. Routing function may not know backend data system is gone.

2. **TCP-based Connectors**
   - Uses the TCP network to flow requests to target listener. Available for DB2, CICS, IMS and MQ.
   - **Advantages**: Loss of TCP connection typically signals retry; SD will connect to surviving member. DB2 T4 takes this even further.
   - **Disadvantages**: Potential loss in performance, generally implies alias ID and PW.
   - Data locks may exist ... other work may proceed but work related to held data can not until failure subsystem restarted so locks can be freed.

3. **What is Being Protected Against?**
   - If you are concerned about loss of data system while WAS server stays up, then the TCP based with intermediate routing is a consideration.
   - If your primary concern is loss of the LPAR "tower" then the use of TCP connectors becomes less important.
New in Version 8
Terminology

Connection Management

The component of WAS that keeps track of connections

Connection Pool

A group of connections to a particular resource manager

Resource Adapter

The code supplied by the resource manager that is used to access it. Supplied in a .rar file

Connection Factory

Defined for a particular resource adapter. Applications look up a connection factory to get connections to a particular resource manager. Connection information can either be configured with the factory or provided by the application.
Resolving Resource References

Servant Region(s)

Application

java:comp/env/jdbc/ABC

Connection Factory
JNDI: jdbc/ABC

Connection Pool

Local T2

Resource Manager

Connection returned from factory

WAS resolves
A Typical Clustered Environment with Type-2 Connectors

Just using DB2 as an example..
When something bad happens....

The router doesn't know and requests to this LPAR fail.
Use Type-4 Connectors and Sysplex Distributor to eliminate close coupling between WAS and DB2... But this surrenders the value of co-location!
For Version 8 we asked three questions:

1) Can WAS tell when a back end resource manager has failed?

2) What can we do once we know?

3) Can we tell when the resource manager is back and undo what we did?
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   YES! Connection Management already has the ability to recognize a failed resource manager and eliminate 'stale' connections from the pool.

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   We already tell customers to use the PAUSELISTENERS function to stop the server from taking new work. The server could automatically pause. Maybe there are other things......

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3) Can we tell when the resource manager is back and undo what we did?

   Maybe. With DB2 we can just try to get a new connection using the attributes in the Connection Factory configuration. We can use RESUMELISTENERS to undo the pause.
### The Basic Flow

**Detect**
Determine there is a problem based on existing reporting of failures and a configured threshold of concurrent failures
(Connection Pool property 'failureThreshold')

### Take Action
Take some configured action
(more on this coming up)

### Monitor
Monitor the resource manager by testing at an interval until we recognize it is available again
(Connection Pool property resourceAvailabilityTestRetryInterval

- Relational – try a new connection (DB2, other JDBC)
- Non-Relational – testConnection method on the adapter
  (Implemented by WOLA)

### Undo
When the resource manager is back...
Undo whatever action we took
Taking Action: FAILOVER

- Define an alternate connection factory
  - Connection Pool attribute alternateResourceJNDIName

- When the resource manager can't be reached, hand out connections from the alternate..

- In flight transactions with the 'primary' resource manager will fail
  - naturally, they were in-flight when the RM they were working with died
  - In-doubt transactions will wait for the primary to come back to resolve

- When the 'primary' comes back, use it for new connections

- Connections from the alternate pool will be returned when the current user finishes

- The alternate factory must be reachable
  - e.g. defined in the same Node

- The alternate factory can not be actively used
  - just for backup
Suppose we configure both connectors...

And the Type-4 connector is the 'alternate' for the Type-2.
Then something bad happens....

New application connection requests use the Type-4 – AUTOMATICALLY!
WAS will also 'watch' for DB2 to come back....
When the bottom DB2 is back...

Use of the Type-4 quiesces and we're back to normal.
WOLA Variation on This New Function

WOLA participates in this as well in that a backup registered external address space now be used in the event the primary is lost:

WOLA is by definition “same LPAR,” and this gives you a degree of availability by allowing routing to secondary registered external address space.

For example, imagine two CICS regions on the same LPAR.
You can also trigger the 'failover' action manually

- Use the MODIFY command:
  - MODIFY server,FAILOVER,'connection factory JNDI name'

- And manually 'fail back':
  - MODIFY server,FAILBACK,'connection factory JNDI name'

- Or use the MBean interface!

- Manual mode is useful for a planned outage

Are other actions available?

Yes! Configure failureNotificationActionCode on the connection pool
Action 1: Issue WTO BBOJ0130I

The WTO contains the server name and the connection factory JNDI name

Use automation to influence work routing away from that WAS server
Action 2: Pause Listeners

Request Routing Function

WAS z/OS Version 8 Application Server

Application

Type 2 Connection Factory

DB2

Data Resource Reference

LPAR

Work routers see the ports close and route to the other server(s)

Resume Listeners is issued automatically when DB2 returns
Action 3: Stop Affected Applications

Some work routers will detect this change and route to other servers.
A few other things...

- If your resource manager does not support the testConnection method (CICS)
  - Set enablePartialResourceAdapterFailoverSupport
  - Allows automatic failover, but requires manual 'failback'

- You can also disable/enable failover or failback by setting
  - disableResourceFailover
  - disableResourceFailback

- And there are Mbean and Modify command interfaces to disable/enable

- Improve performance at failover by setting
  - PopulateAlternateResource
  - Comes with some background overhead during normal operations
This is tricky stuff... Remember

TEST IT BEFORE YOU NEED IT