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Objectives

- CICSPlex SM Workload Management can be used to dynamically manage the distribution of work across the CICSplex according to predetermined criteria.

- The session will introduce:

  - *The role CICSPlex SM plays in Enterprise workload management*

  - *The concepts of CICSPlex SM Workload Management*

  - *How CICSPlex SM performs workload management*

  - *Real world example of application architecture impacts on WLM*

Complete your sessions evaluation online at SHARE.org/AnaheimEval
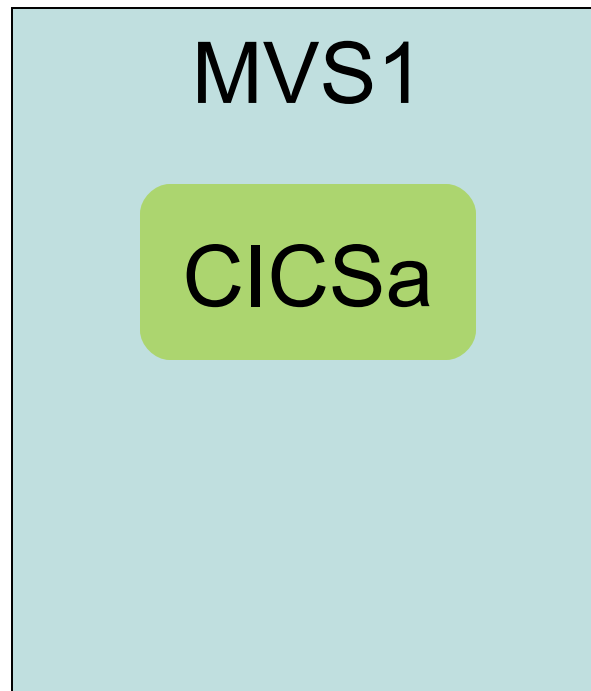
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Part 1: CICS Background

- In this section we will look at

  - Why Workload Management is needed

  - The role of CICSPlex SM Workload Management in the Enterprise

  - How CICS distributes work
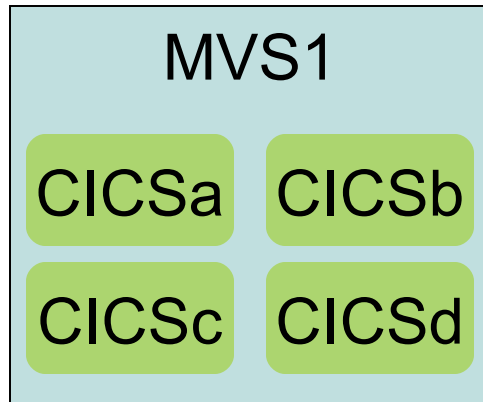
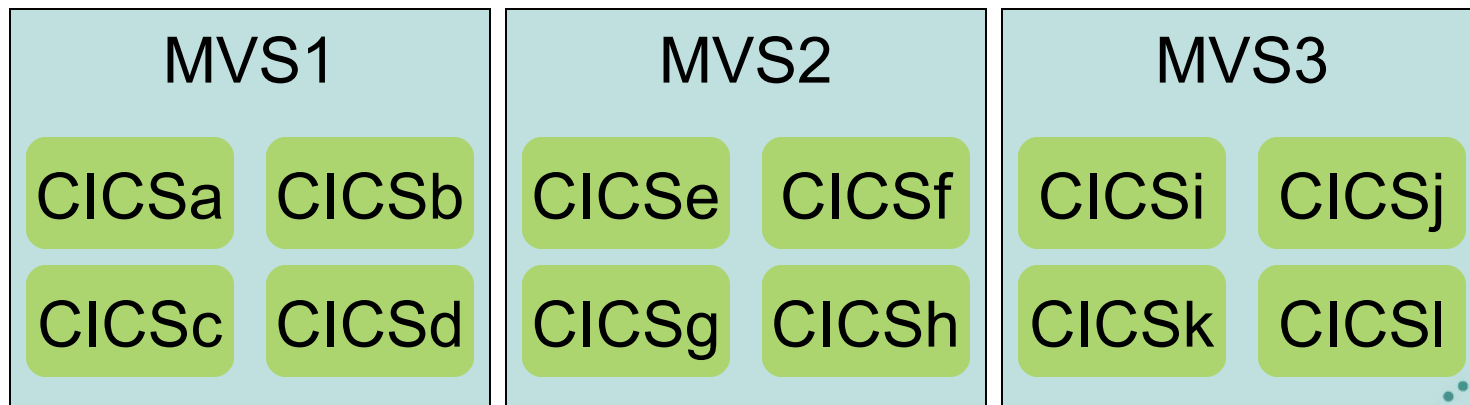# What's the problem?

In the beginning …

… things were simple ….

MVS1

CICSa

What's the problem?

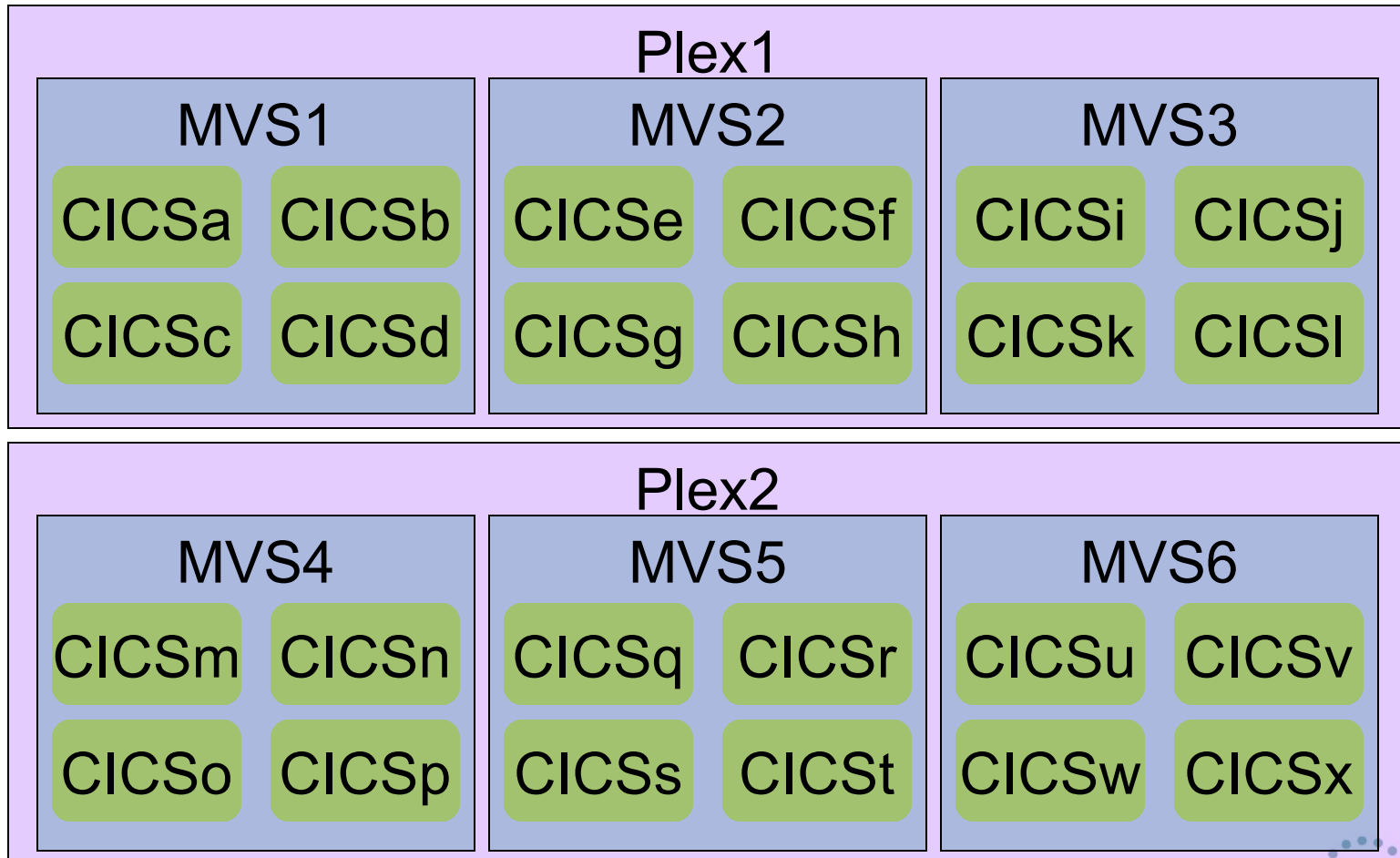But as things get more complex …

MVS1
CICSa CICSb
CICSc CICSd

…and then more complex still …

MVS1	MVS2	MVS3
CICSa CICSb	CICSe CICSf	CICSi CICSj
CICSc CICSd	CICSg CICSh	CICSk CICSl

What's the problem?

…and then more complex …

Plex1		
MVS1	**MVS2**	**MVS3**
CICSa CICSb	CICSe CICSf	CICSi CICSj
CICSc CICSd	CICSg CICSh	CICSk CICSl

| Plex2		
MVS4	**MVS5**	**MVS6**
CICSm CICSn	CICSq CICSr	CICSu CICSv
CICSo CICSp	CICSs CICSt	CICSw CICSx

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What's the problem?

…it all becomes more complicated to manage.

- Definitions managed & maintained locally

- Applications are statically routed

- Which leads to…

    - *Availability problems*

    - *Lower probability of meeting response time goals*

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What is the solution?

- Workload Management …

    - In the Network
        - VTAM Generic Resource
        - TCP/IP load balancing

    - In the Sysplex
        - z/OS Workload Manager

    - In CICS sub-system
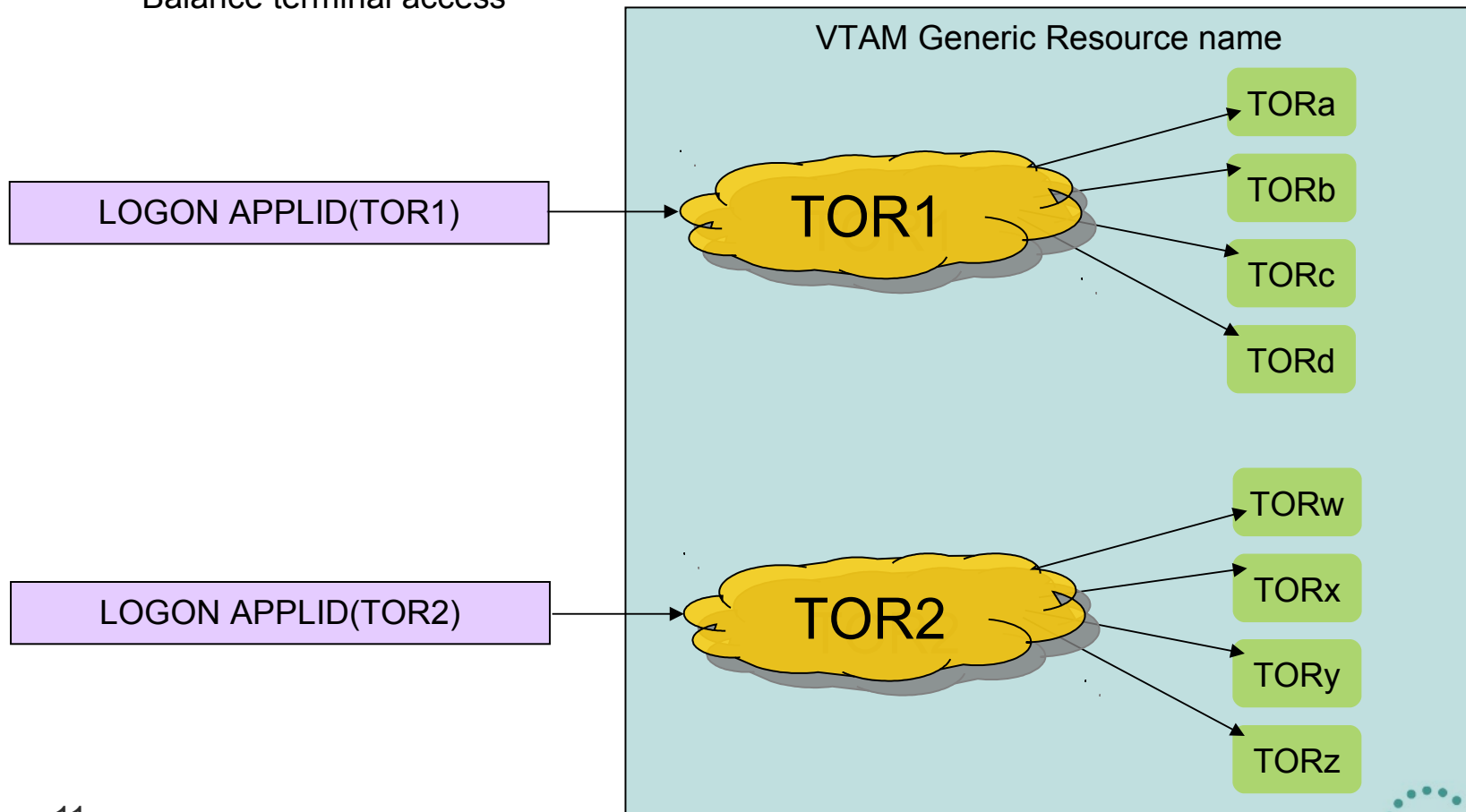   - CICSPlex SM Workload Management
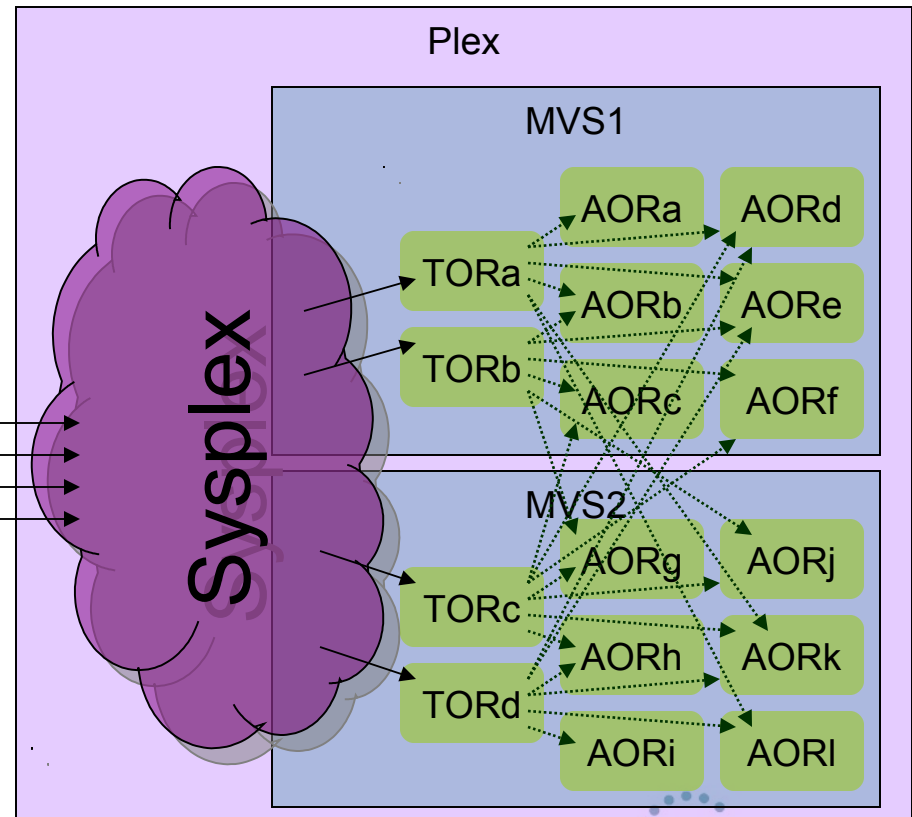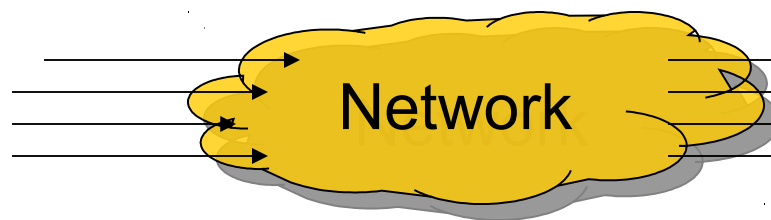
Workload management in the network

- TCP/IP balancing (balance web-services and CICS WEB clients)
  - Sysplex Distributor
    - Sysplex Distributor provides balancing of IP packets across multiple IP stacks.
  - Virtual IP Addressing (VIPA)
    - Dynamic VIPA provides non-disruptive rerouting around a failing network adapter.
  - DNS approach
    - DNS connection optimization, balances IP connections in a z/OS Sysplex IP domain. This is based on feedback from MVS™ WLM about the health of the registered applications. It is still supported for CICS use.
  - Port Sharing
    - TCP/IP port sharing provides a simple way of spreading HTTP requests over a group of CICS router regions running in the same z/OS image.

Workload management in the network

- VTAM Generic Resource

  – Balance terminal access

Workload management in the Sysplex z/OS WLM overview 1

- Works with z/OS System Resource Manager (SRM)

- Dynamically allocates resources
  - Processor Storage, IO Priority

- Service Definition
  - Contains 1 or more Service Policies

- Policy defined in terms of "Goals", not resources
  - Service Policy
    - One per Sysplex
      - *Can switch Policy when required*
  - Service Class
    - Describes performance objectives for part of workload

- Report Class

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Workload management in the Sysplex z/OS WLM overview 2

- Goals
  - Response time – How quick to run work
    - Average Response Time
      - *E.g. Average transaction response should be 2 seconds*
    - Percentile Response Time
      - *E.g. 95% of transactions should complete in 3 seconds*

  - Velocity
    - How fast work should run as a % of the time it's ready
      - *High Value – When work is ready, run it quickly*
      - *Low Value – When work is ready, can wait to run*
    - Used to get CICS active

  - Discretionary – Work with no goals

2012

Workload management in the Sysplex z/OS WLM overview 3

- Report Class

- Classification Rules
  - How work get classified to Service Class

  - Some Classification Rules available for CICS:

    - *SI – SubSystem (Applid)*
    - *UI – Userid*
    - *TN –Transaction Name*
    - *LU – LUName*

Workload management in the Sysplex z/OS WLM overview 4

- Goal Importance

  - Associated with Service Class

  - 1-5 : 1 = Very important, 5 = Not important

- Performance Index (PI)

  - Used to compare Goals

  - How well is work meeting it's Goal
    -
    - *PI = 1 : Meeting the Goal*
    - *PI < 1 : Over-achiever (beating the goal)*
    - *PI > 1 : Under-achiever (Not meeting the goal)*

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z/OS WLM and CICS : 1

- When CICS starts, as job or Started Task,
  - uses JES or STC classifications

- Once CICS is active,

  - CICS connects to z/WLM
  - CICS Sub-System related Service Classes are used

- At CICS startup, CICS will allocate a Pool of Performance blocks based on MAXTASKS

  - Sampled at regular intervals, e.g. every 250ms
  - Communicates transaction state to z/OS WLM

z/OS WLM and CICS : 2

- When a Task starts:

  - Performance block associated with Transaction
  - Transaction Classified (New, or passed via MRO)
  - Set-up Performance Block

- A Task executes

  - Dispatcher updates Performance Block

- Task ends:

  - Report transaction Complete or …
  - Notify of partial transaction complete (e.g. in AOR via MRO)

z/OS WLM and CICS : 3

- Using z/OS WLM and CICS

  - Work distributed to the CICS System 'best' able to perform the work within the Sysplex
    - Based on z/OS WLM goals

  - z/OS WLM controls which Requesting/Routing (TOR) CICS Regions receive the work to be routed under CICSPlex SM criteria
    - Regions in bigger/more powerful LPARs may be favoured
   - CICSPlex SM will favour local routing

z/OS WLM: Deciding how the work reaches CICS

- z/OS WLM controls which Requesting (TOR) CICS Regions receive the work

- z/OS WLM can also affect which AOR is chosen when using CICSPlex SM

- Once in CICS routed under CICSPlex SM criteria

    - Regions in bigger/more powerful LPARs may be favoured
    - CICSPlex SM will favour local routing

- Can give the impression of an "Unbalanced" Workload

- In reality more work goes to the System(s) best able to deal with the work

    - An uneven distribution may be an accurate reflection of the capabilities of the environment

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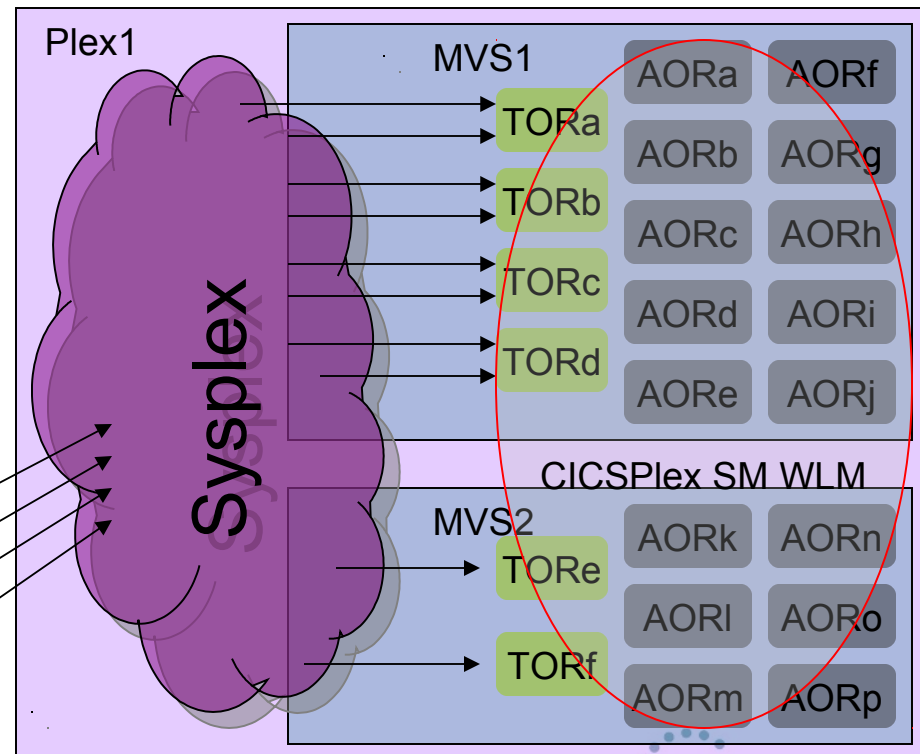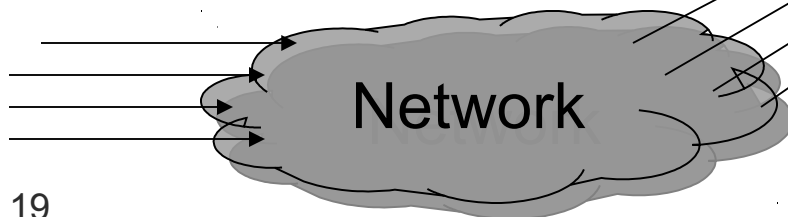
zWLM & CICSPlex SM Workload Management

- Uses z/OS WLM 'Average Transaction Response Times' to influence the 'LOAD'
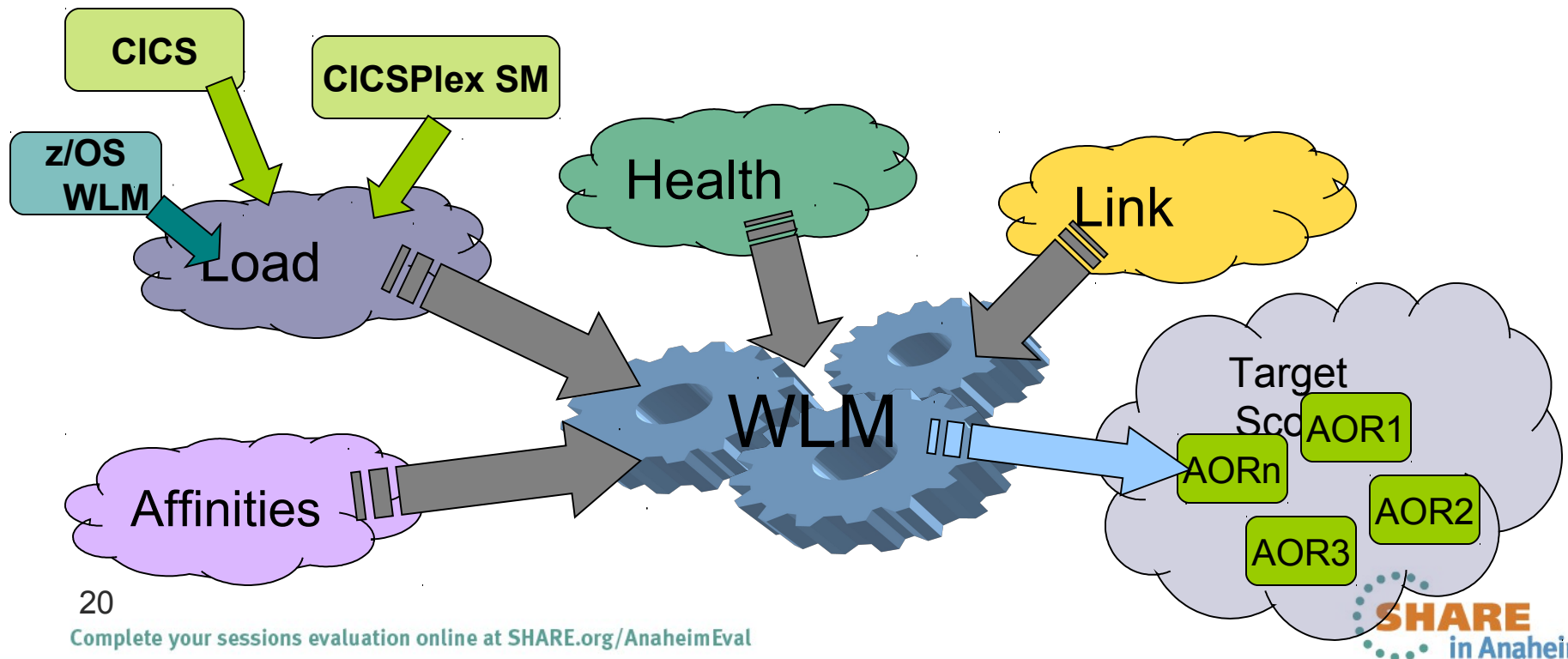
What can CICS do?: Dynamic

- Dynamic Routing

  - Transactions associated with a terminal

    - *Physically 'entered' at a terminal*
    - *Via an EXEC CICS START TERMID command*

  - Dynamic Program Link (DPL)

    - *EXEC CICS LINK PROGRAM command*

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What can CICS do?: Distributed

- Distributed Routing

    - Non-Terminal initiated STARTs (NTIS)

        - *i.e. EXEC CICS START with no TERMID*

    - CICS BTS

    - Enterprise Java Beans (EJBs) & IIOP

    - Inbound WebServices

        - *if modified to make them routable*

How does CICS do this?

- CICS uses 'user replaceable' programs
  - One for Dynamic Routing
  - One for Distributed Routing

  - CICS …
    - … calls the appropriate program to decide where to route to
    - … passes the program the DFHDYPDS commarea

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When is the Dynamic Routing Program called?

- Program
    - If defined: DYNAMIC(YES)

    - If not defined: Program not defined and the program is not autoinstalled

- Transaction
    - If defined: DYNAMIC(YES)

    - If not defined: SIT - DTRTRAN={CRTX|name}

When is Distributed Routing Program called?

- Transaction Starts (Non-Terminal Initiated)
  - TRANSACTION defined ROUTABLE(YES)

- CICS BTS
  - PROCESS or ACTIVITY started by RUN ASYNCHRONOUS
  - TRANSACTION associated with PROCESS or ACTIVITY has DYNAMIC(YES) and REMOTESYSTEM is blank

- Enterprise Java Beans (EJBs)
  - REQUESTMODEL TRANSID defined ROUTABLE(YES)

- Inbound WebServices
  - Target program defined DYNAMIC(YES)
  - A program in the PIPELINE changes contents of
    - Container DFHWS-USERID
    - Container DFHWS-TRANID & referenced TRANID defined DYNAMIC(YES)

Complete your sessions evaluation online at SHARE.org/AnaheimEval

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Part 2: CICSPlex SM Workload Background

- Last section we looked at

  - Why Workload Management is needed

  - The role of CICSPlex SM Workload Management in the Enterprise

  - How CICS distributes work

- In this section we will look at

  - How & when CICSPlex SM Workload gets involved

  - Types of work CICSPlex SM WLM does: Balancing & Separation

  - How it make the decisions

  - The definition of a basic CICSPlex SM Workload

So what part does CICSPlex SM play?

- It supplies a program to act as both…

    - … the Dynamic Routing Program
        - *SIT - DTRPGM*
        - *SPI - SET SYSTEM DTRPROGRAM*

    - … the Distributed Routing Program
        - *In SIT - DSRTPGM*
        - *SPI - SET SYSTEM DSRTPROGRAM*

    - EYU9XLOP

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What does CICSPlex SM do when it's called ?

- Once called…

  - CICSPlex SM Workload Management facilities create a list of suitable, candidate, target CICS Regions, based on:
    - the transaction
    - the terminal id, luname, user id, or process type.
      - *Note:*
        - *CICSPlex SM does not do the routing, CICS does*

  - The list of candidate Target Regions is based upon the Workload to which the Requesting/Routing Region belongs.

What model does it use?

- The CICSPlex SM Workload Management model can be divided into 2 parts:

  - Workload Placement
    - The process which decides which of the Target Regions is considered to be the most suitable, the 'best', candidate to route to, assuming:
      - *Work 'could' be sent to any of the Target Regions*
      - *Work does not have an 'affinity' with a specific Region*

  - Workload Separation
    - How CICSPlex SM Workload Management allocates specific work
      - *to specific set(s) of Target Regions*
      - *for specific reasons*

Workload Placement/~~Balancing~~ 1

- What Workload Balancing is NOT!

  - It is NOT a means of EVENLY distributing work

  - It is NOT a way to CONSISTENTLY distribute work
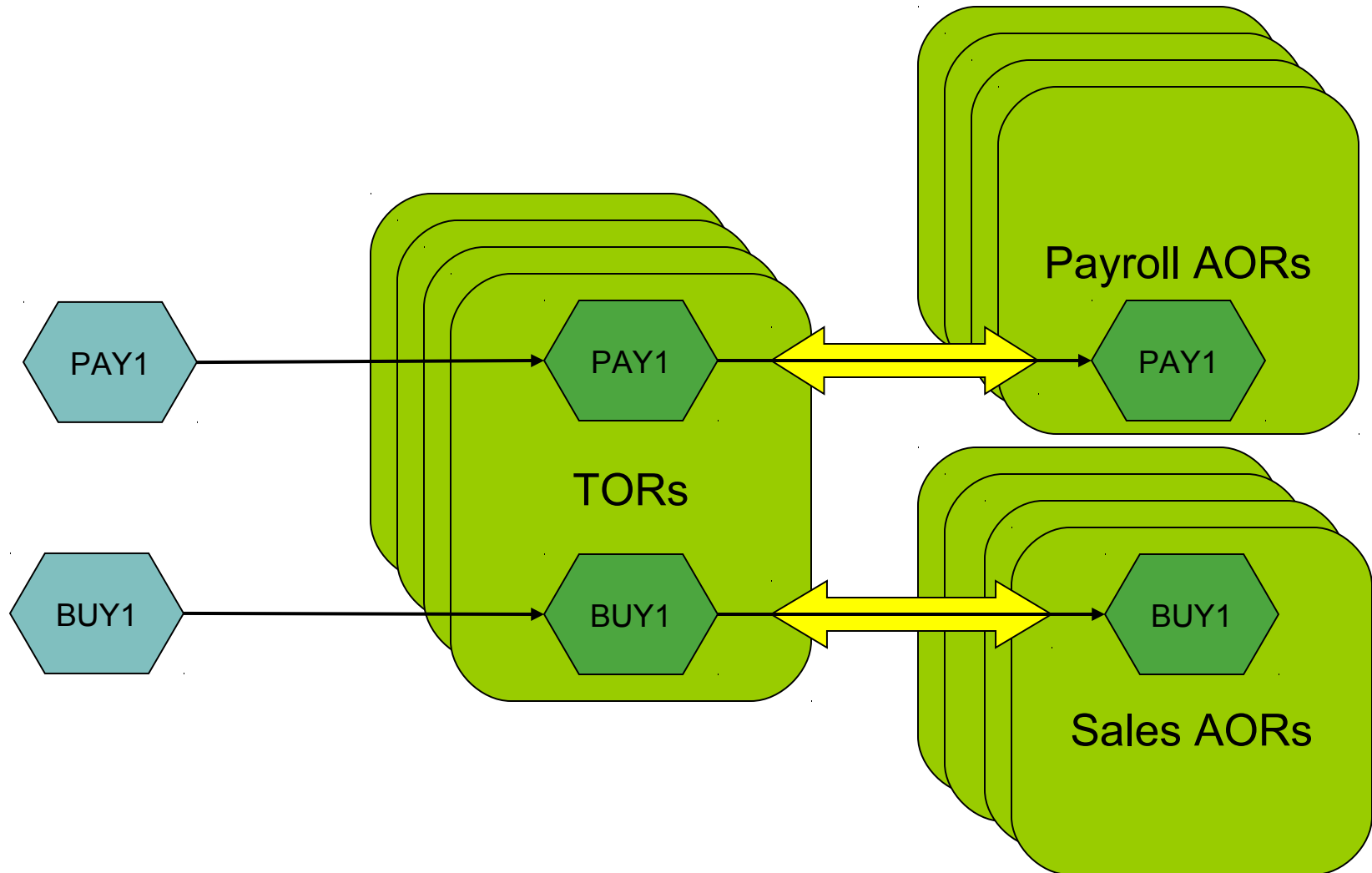
"Balancing" is a misnomer

… so what is it ?
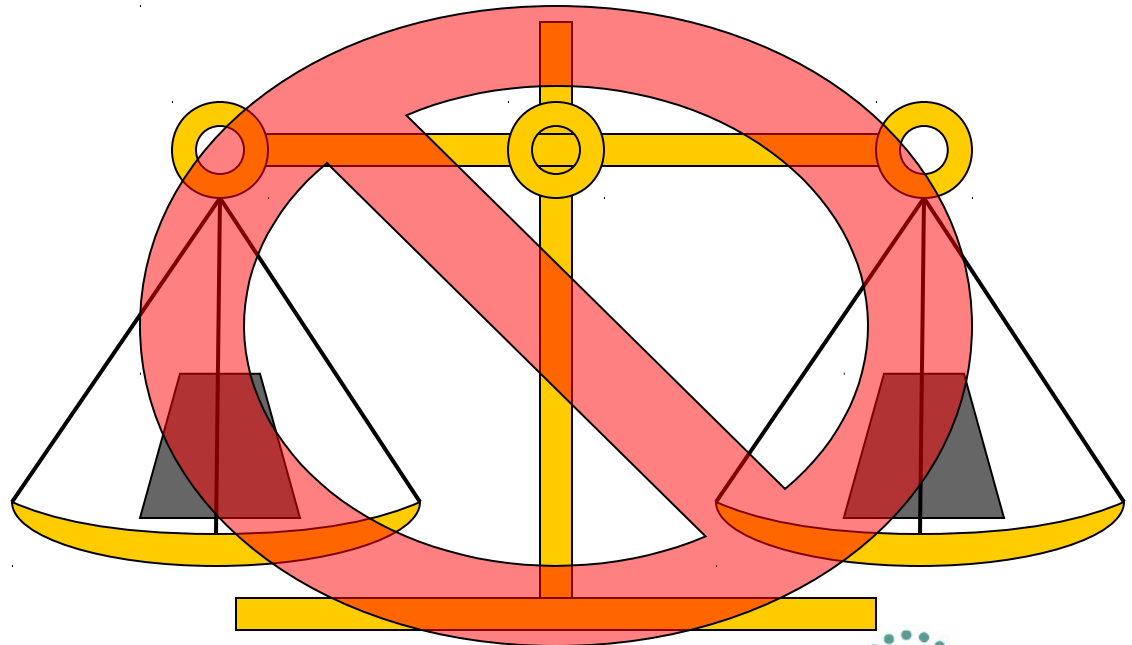
Workload Balancing 2

- Workload Placement/~~Balancing~~ is …

  - Providing CICS with the 'best' Target Region, at the moment the request was made, from all of the possible candidates.
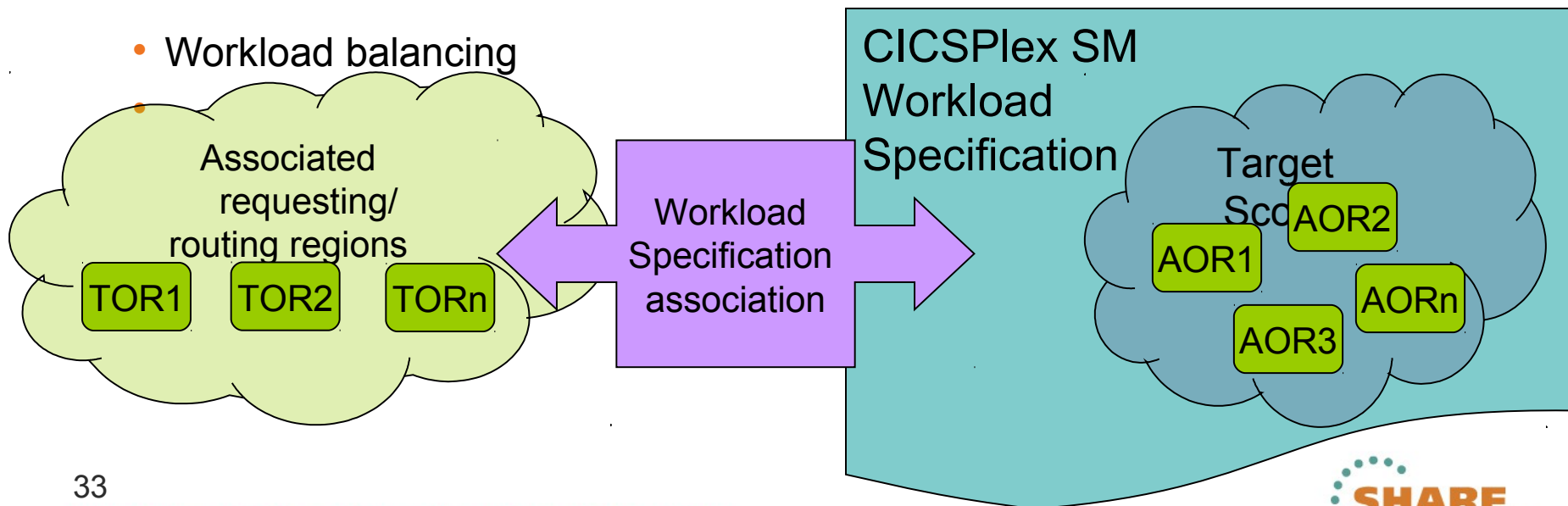
- How does it know which the 'best' is ?

Workload Separation

Complete your sessions evaluation online at SHARE.org/AnaheimEval
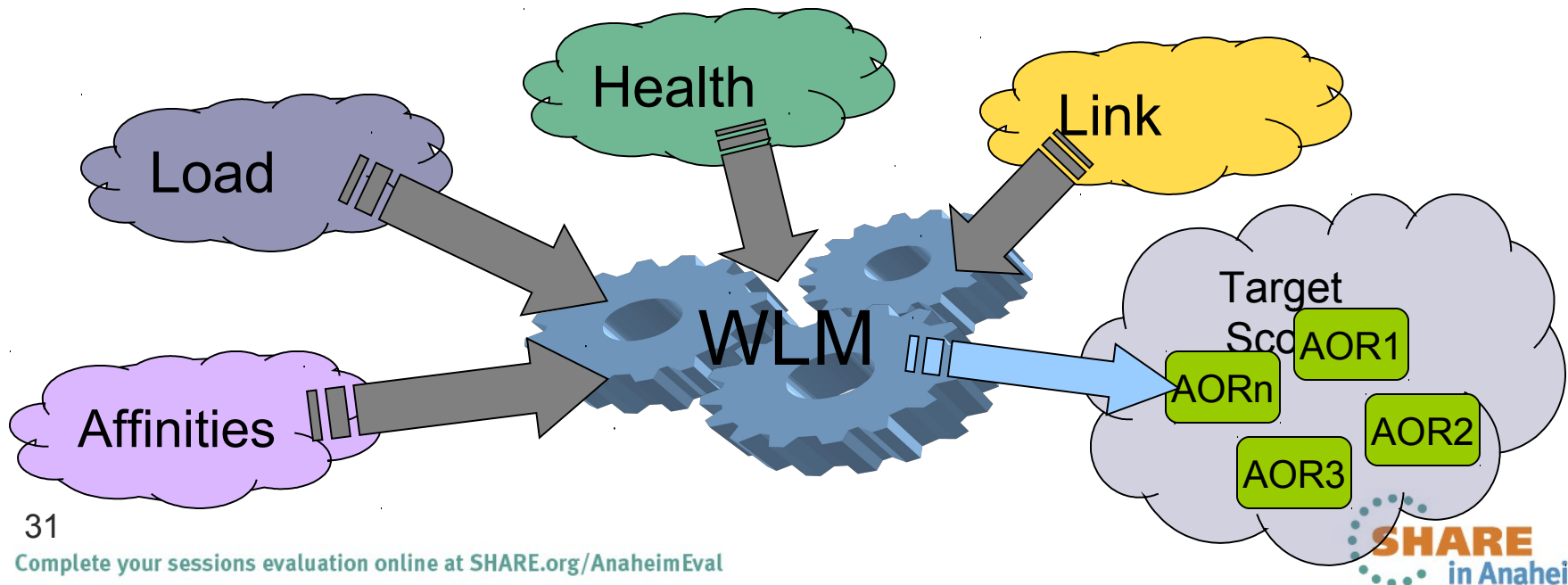
What is a CICSPlex SM Workload?

- At its most basic
  - One or more Requesting/Routing Regions

  - One or more Target Regions

  - One Workload Specification

  - Workload balancing

Associated requesting/ routing regions

TOR1 TOR2 TORn

Workload Specification association

CICSPlex SM Workload Specification

Target Scope

AOR1 AOR2 AOR3 AORn

Workload Balancing – Workload Specification 1

Associated requesting/ routing regions

TOR1 TOR2 TORn

Workload Specification association

CICSPlex SM Workload Specification
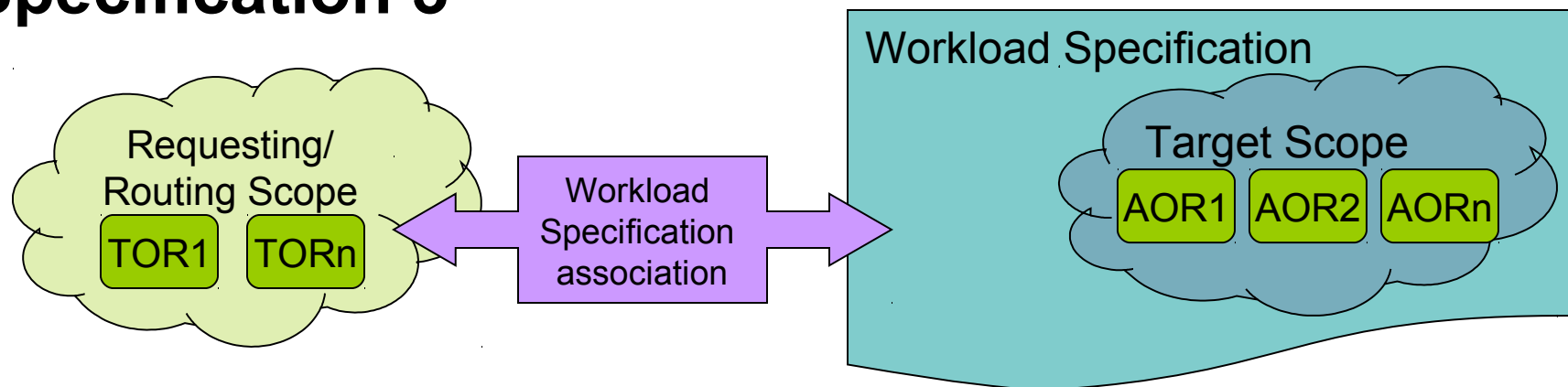
Target Scope

AOR1 AOR2 AOR3 AORn
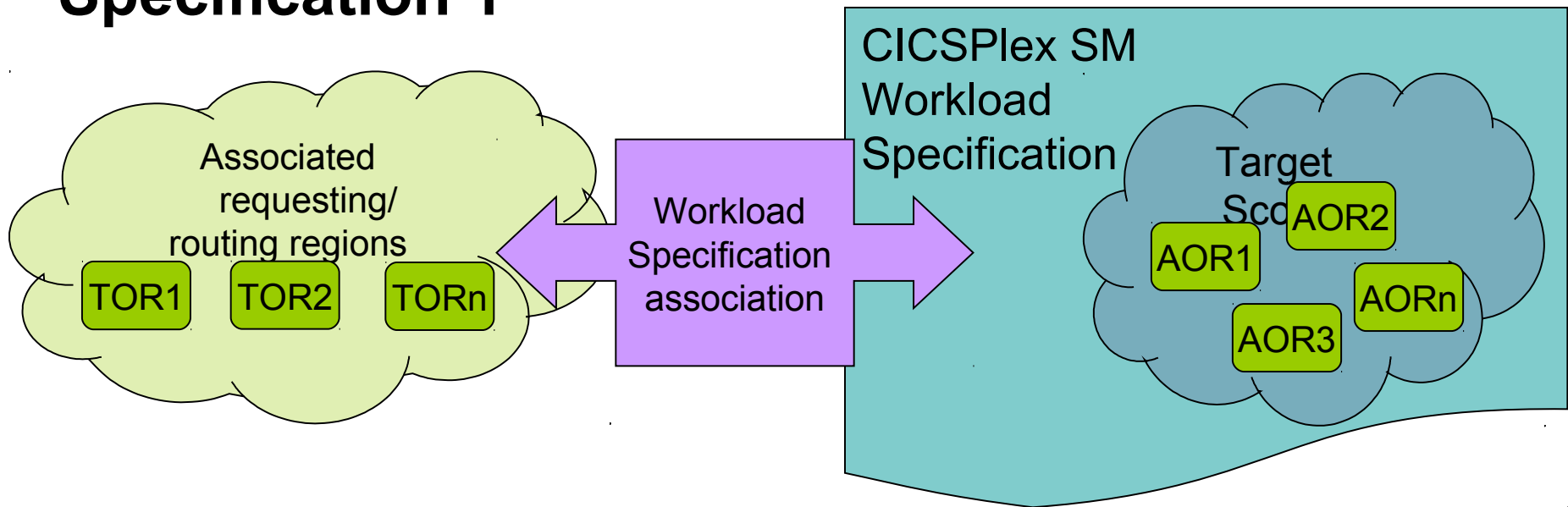
- Workload Specification resource (WLMSPEC)…
  - Defines a Workload

    - The Workload must be "associated" with …
      - *… Requesting/Routing Region(s) (Dynamic & Distributed)*
      - *… Target Region(s) (Distributed only)*

Workload Balancing – Workload Specification 2
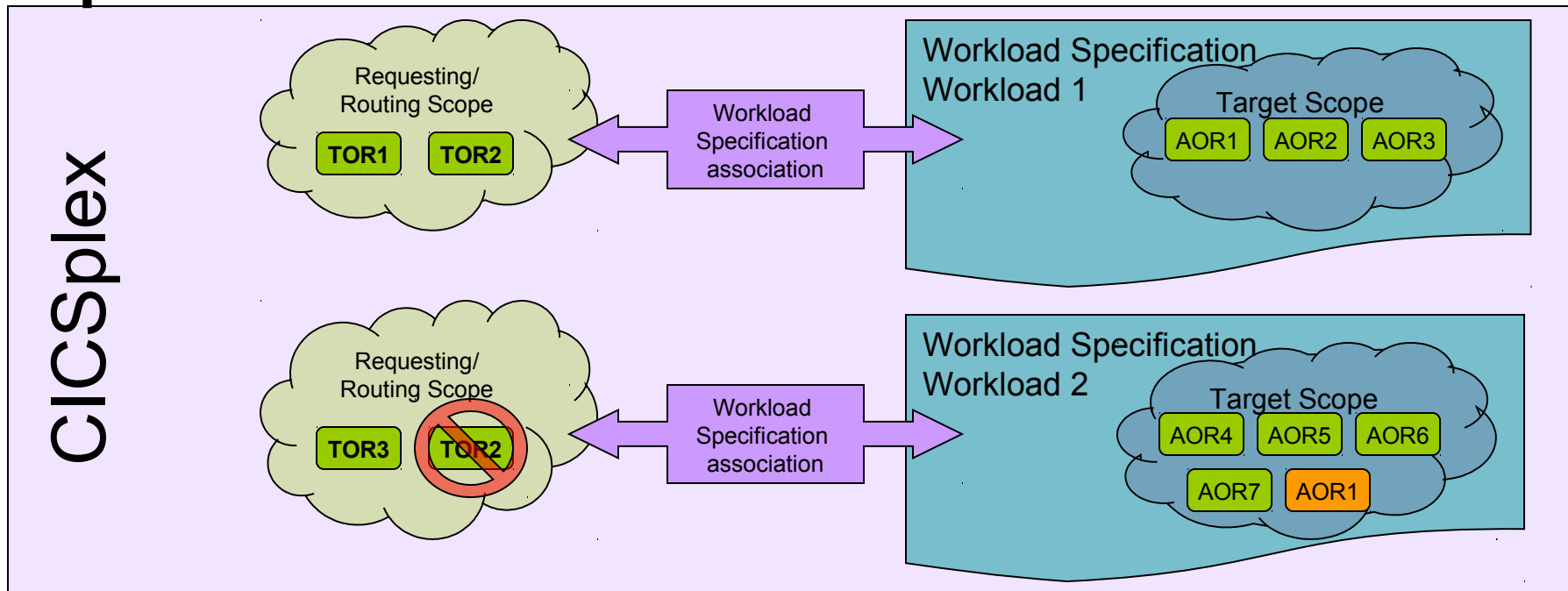
- There can be multiple Workloads within a CICSplex
- A Region can be a Target for multiple Workloads
- A Region can be BOTH a Requesting and a Target Region
- But… Requesting/Routing Region can ONLY be associated with 1 Workload
- While you might not be using distributed today, don't have your target regions as target scopes in more than one workload

Workload Balancing – Workload Specification 3

- Associated with your requesting/routing regions
  - systems (CSYSDEF) and system groups (CSYSGRP)

- Specifies default target scope
  - a CICS Region (CSYSDEF)
  - a Group of CICS Regions (CSYSGRP)

- Specifies the algorithm type
  - QUEUE or GOAL

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Summary –What has actually been covered?

- Concepts:
  - *Why Workload Management is needed*
  - *The role of CICSPlex SM Workload Management in the Enterprise*
  - *How CICS distributes work*
  - *How & when CICSPlex SM Workload gets involved*

- How it works:
  - *Types of work CICSPlex SM WLM does: Balancing & Separation*
  - *How it makes the decisions*

Complete your sessions evaluation online at SHARE.org/AnaheimEval

Changes to evaluation of "best fit" target region

- **In CICS TS Version 4 a significant number of changes have been made to how Workload Management decides which Target Regions are eligible and which is the most effective to route work to.**
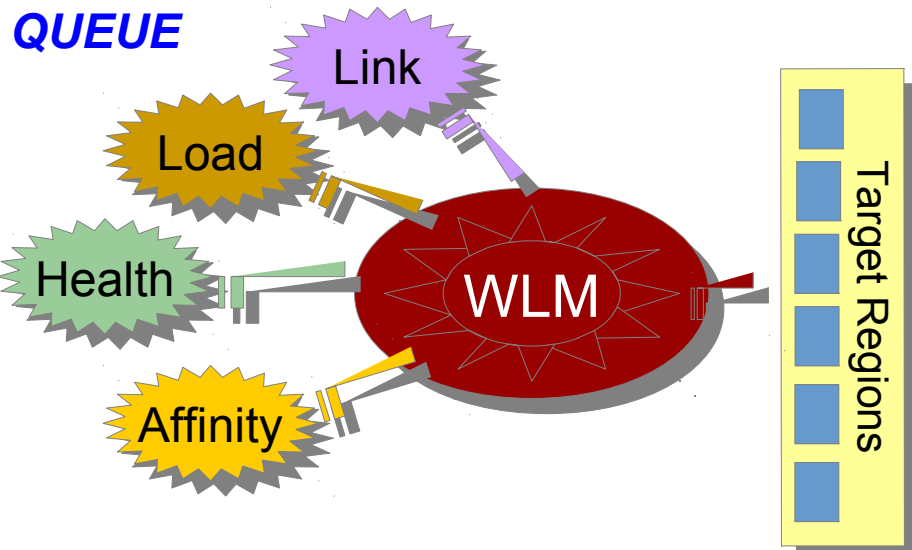
  - *Changes:*
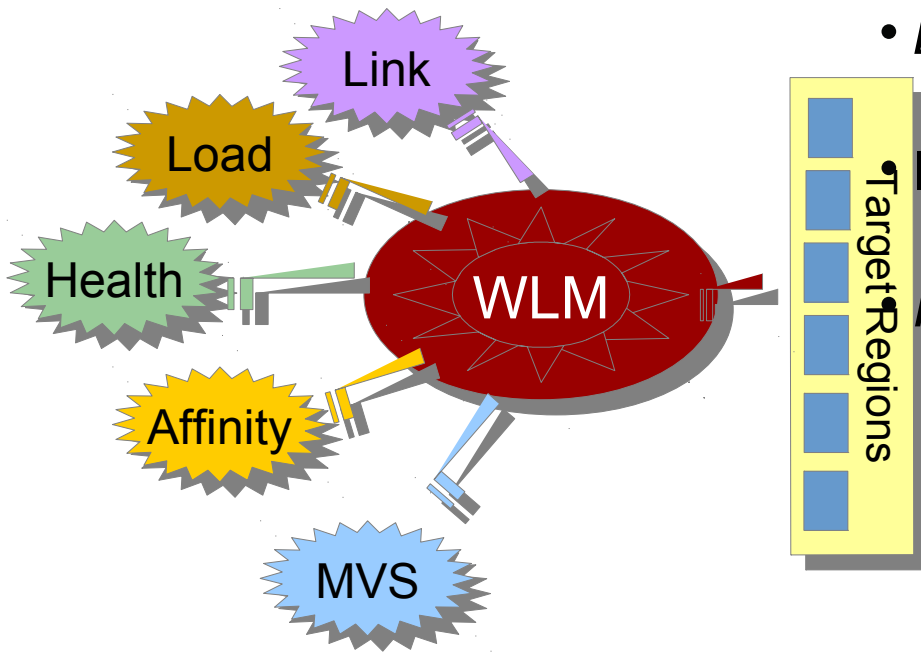
- *Extended coverage of what is evaluated and how*
- *Improved granularity and efficiency of routing decisions*
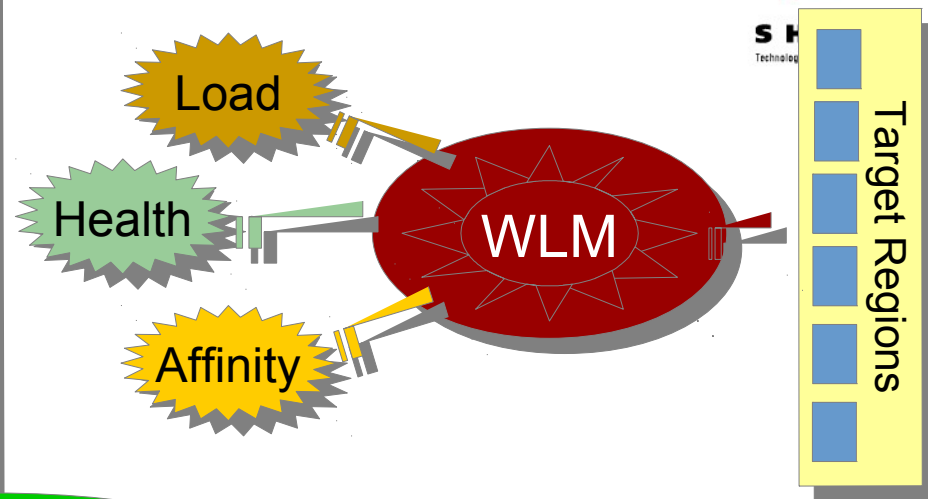- *Improved reporting, managment and analysis of workloads*

Link
Load
Health
Affinity
MVS
WLM
Target Regions

Changes to Link evaluation

- Link evaluation has been changed to:
  .

  - Support extended IPIC Connection support
    - Weightings changed to favour IPIC over Lu6.2
    - Same-LPAR IPIC favoured over remote-LPAR IPIC
    - Weighting Priorities in 4.2:
      - *Local -> MRO (XM) -> MRO (XCF) -> IPIC (same LPAR) -> IPIC (remote-LPAR) -> APPC -> Indirect*

  - Support for "Link Neutral" algorithms:
    - LNQUEUE and LNGOAL
    - Can include or ignore influence of Link priorities on routing decisions
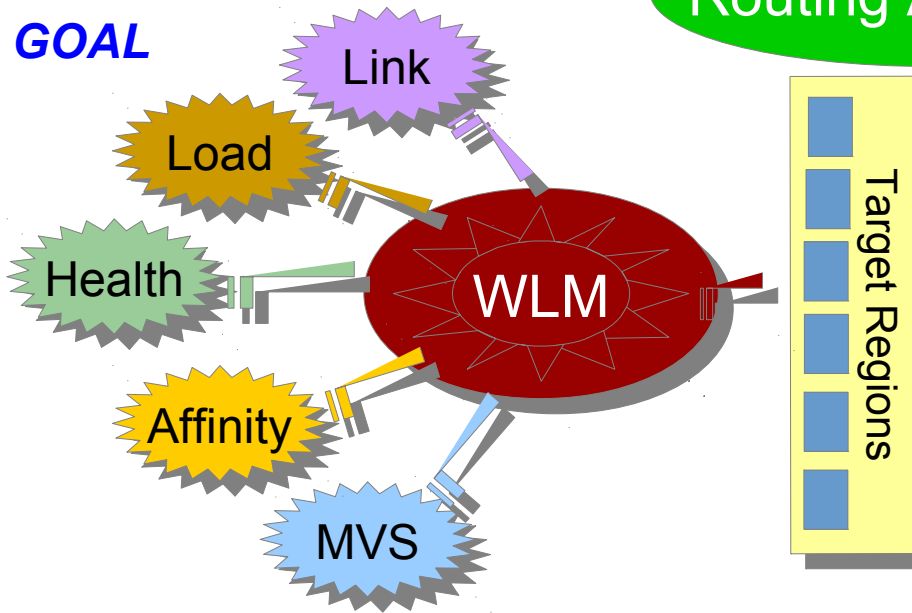
Routing Algorithms

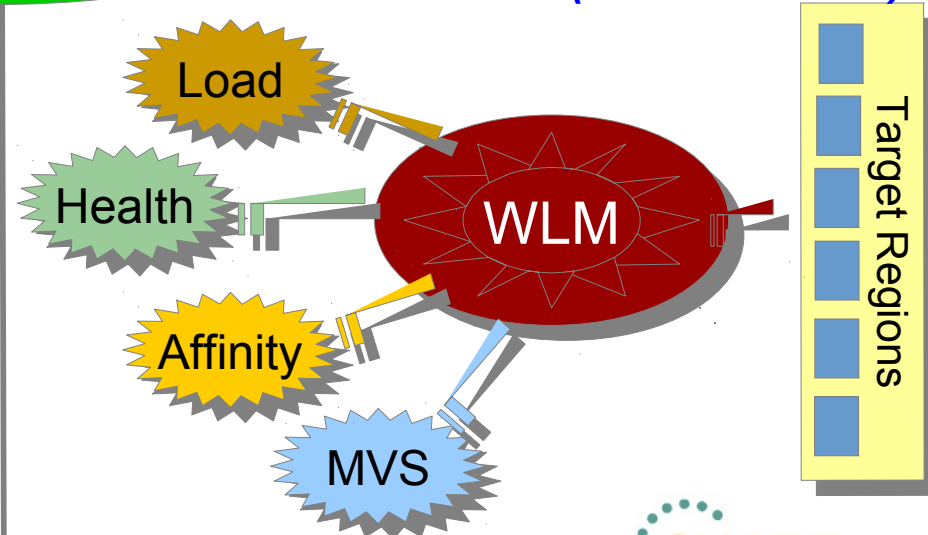QUEUE — Link, Load, Health, Affinity → WLM → Target Regions
LNQUEUE (Link Neutral) — Load, Health, Affinity → WLM → Target Regions
GOAL — Link, Load, Health, Affinity, MVS → WLM → Target Regions
LNGOAL (Link Neutral) — Load, Health, Affinity, MVS → WLM → Target Regions

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Transaction Level Control of Routing Decisions

- Significant change to granularity of Routing
  - Pre-CICS TS Version 4
    - Routing Algorithm could only be applied at the Workload (WLMSPEC) level.
    - Workload Separation differentiated where work went but not type of algorithm to be used.
  - CICS TS Version 4
    - Can apply Algorithm at Workload Separation level (WLMDEF & TRANGRP) as well as the Workload
      - *Makes it possible to:*
        - *Use different routing algorithms for different types of application*
        - *For example to handle high & low priority work differently*
        - *Dynamically replace a 'live' workload by activating at Transaction Group level*
        - *Change behaviour of exisiting Workload Separation*
        - *Override the default WLM Specification behaviour without restarting Workload*
        - *By default Transaction Group will INHERIT the Algorithm of the Workload*

Example Transaction Level Routing using different routing algorithms:

AOR (blue)	**Workload defines default algorithm: QUEUE** •**Standard CICSPlex SM routing algorithm** **High priority work: GOAL**
AOR (green)	•**to exploit z/OS workload management goals** **Low priority work: Link Neutral Queue.**
AOR (yellow)	•**Speed not priority, efficiency of system load more important.**

CMAS ←→ CMAS

CICSplex

QOR   QOR

Workload

AOR AOR AOR AOR AOR AOR
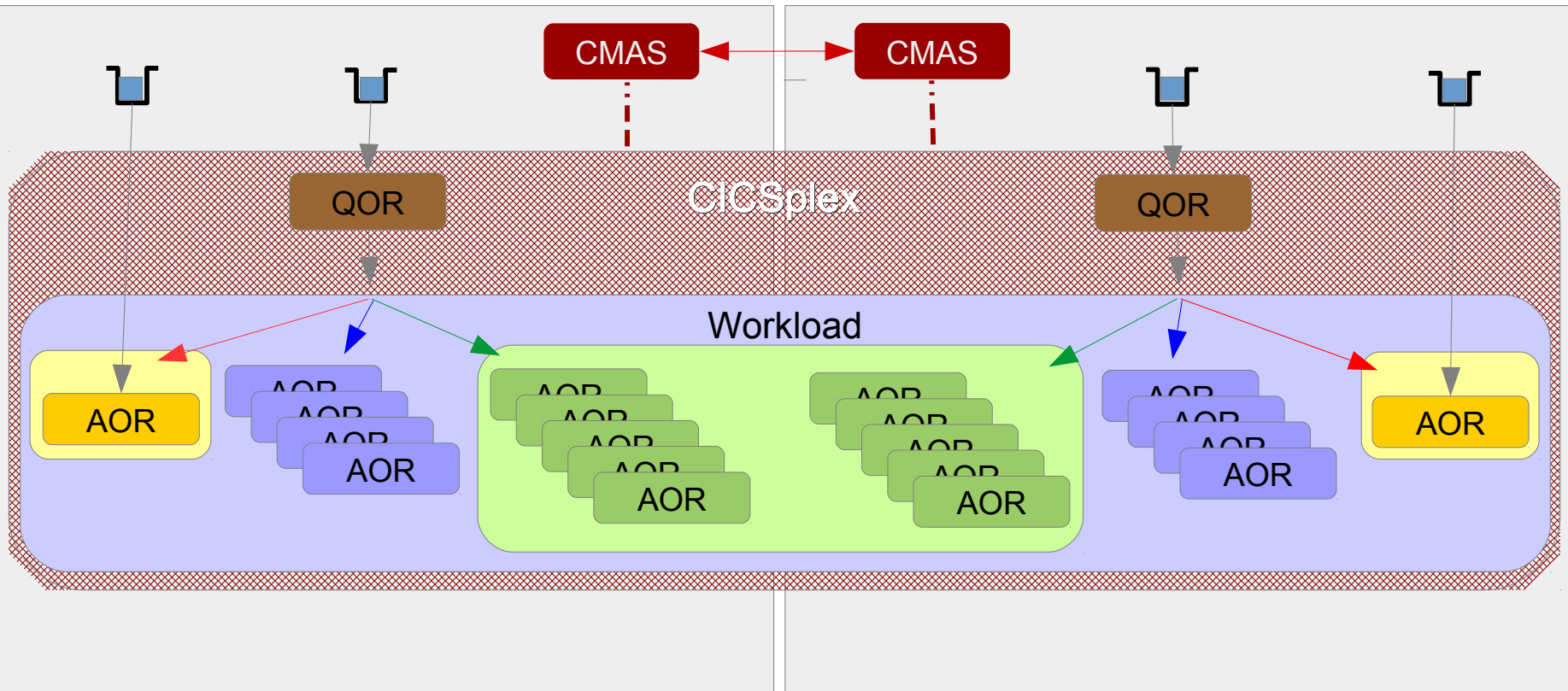
Changes to Health evaluation

- Health based on evaluation of:
  - CICS states:
    - Maxtasks
    - SOS
    - System & Transaction Dumping
  - CICSplex SM states:
    - CICS Stalled
    - MAS is Non-Responsive
      - *CICSPlex SM detects that an active MAS has lost contact with its managing CMAS*
      - *Low priority*

Changes to MVS (Goal mode) evaluation

- Goal mode enhanced by improved use of z/OS Workload Manager goals:
  - Pre CICS TS 4.1
    - Average response-time goals
    - Percentile goals ignored
  - CICS TS 4.1
    - Average response-time goals
    - Percentile goals honoured
      - *A percentile goal sets the percentage of transactions to be completed in the target response time.*

    - Note: If an existing workload already uses Goal mode & z/OS Workload Manager percentile goals the percentile goals will automatically be honoured, resulting in changed workload routing behaviour.

Changes to handling of Affinities

Affinity

- Unit of Work Affinity
  - Manages Dynamic DPL requests within same UOW.
  - Programs with this type of affinity are routed to the same target region for the duration of a unit of work.
  - These affinities are defined with an affinity relation of LOCKED and an affinity lifetime of UOW.

  - Resolves the following problem:
    - Multiple invocations of same dynamically-routed program in a UOW can access a common resource. If one program link locks the resource, and the subsequent program link is routed to a different region, a deadlock can occur.

Changes to evaluation of Load

- Most significant change to CICSPlex SM WLM:
  - Optimized Workload Management
    - Improves efficiency of workload distribution
    - Addresses issue of "Batching" in heavy workloads spread across multiple LPARs
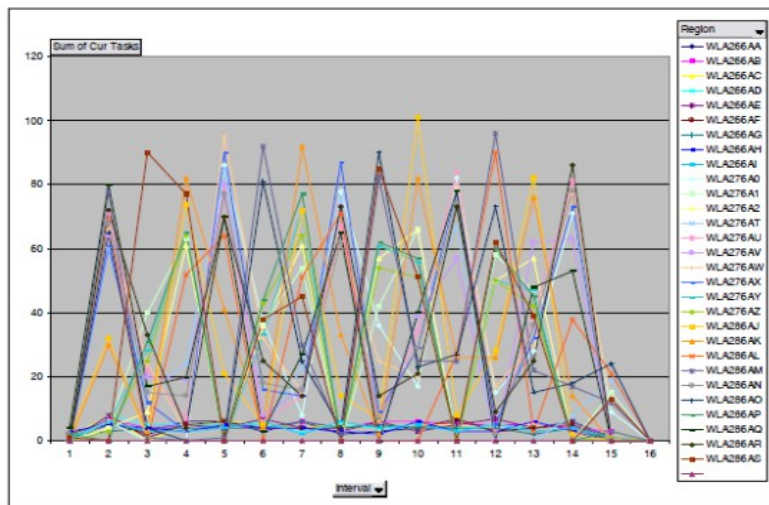
Figure 1: The Lifetime of an Unoptimized Workload of 10,000 Started Tasks Initiated From a Single Routing Region
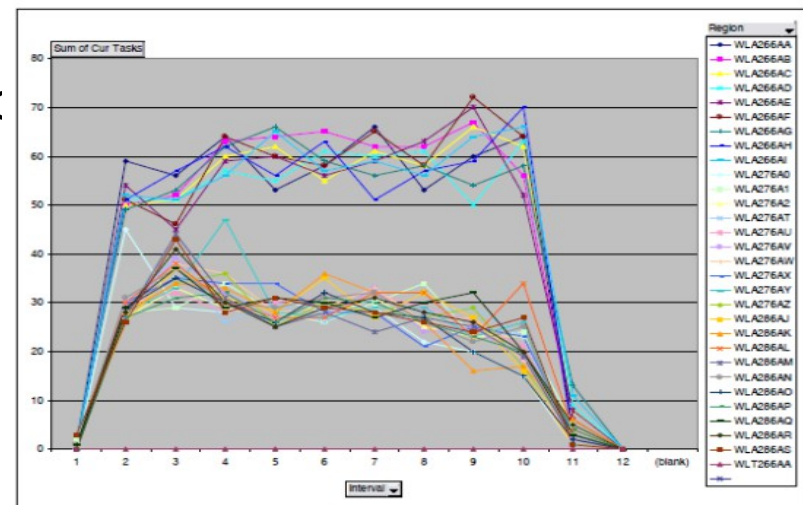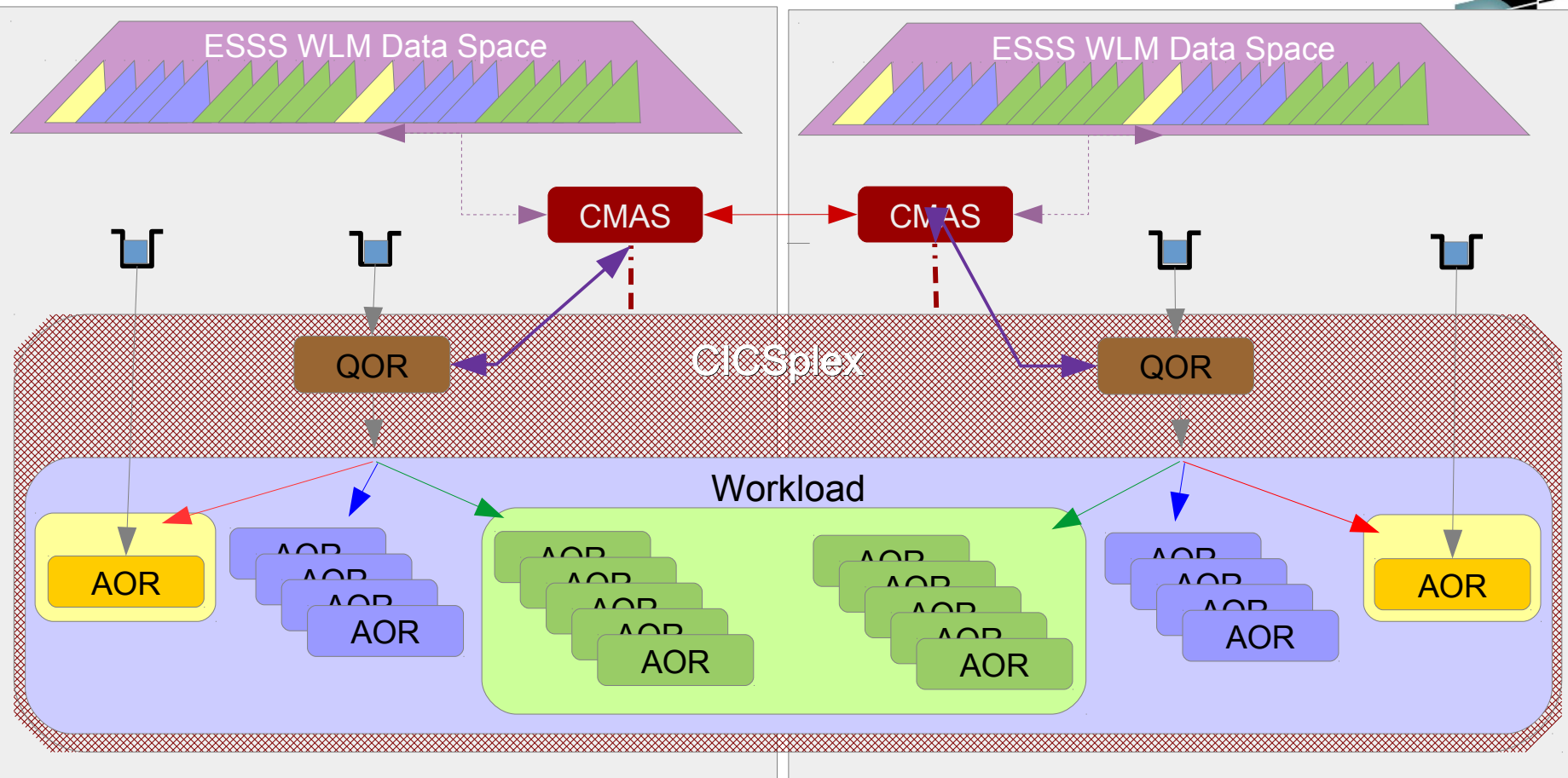
Figure 2: The Same Workload as Shown in Figure 1 but With Sysplex Optimization Activated

Existing (pre-Version 4) Environment
- The Batching Problem
- Routers (QOR) get load based on local CMAS data. AORs & Remote CMASs use 15 second heartbeat to keep in step. Routers & Targets managed by different CMASs - especially if high traffic and utilise the DSRTPGM exit (e.g. non terminal triggered transactions initiated by MQ triggers) - unaware of "maxtask" situations in interval.

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New Workload Optimization:
Local CMAS data spaces replaced by RS Servers utilizing Sysplex-wide Coupling Facility tables.
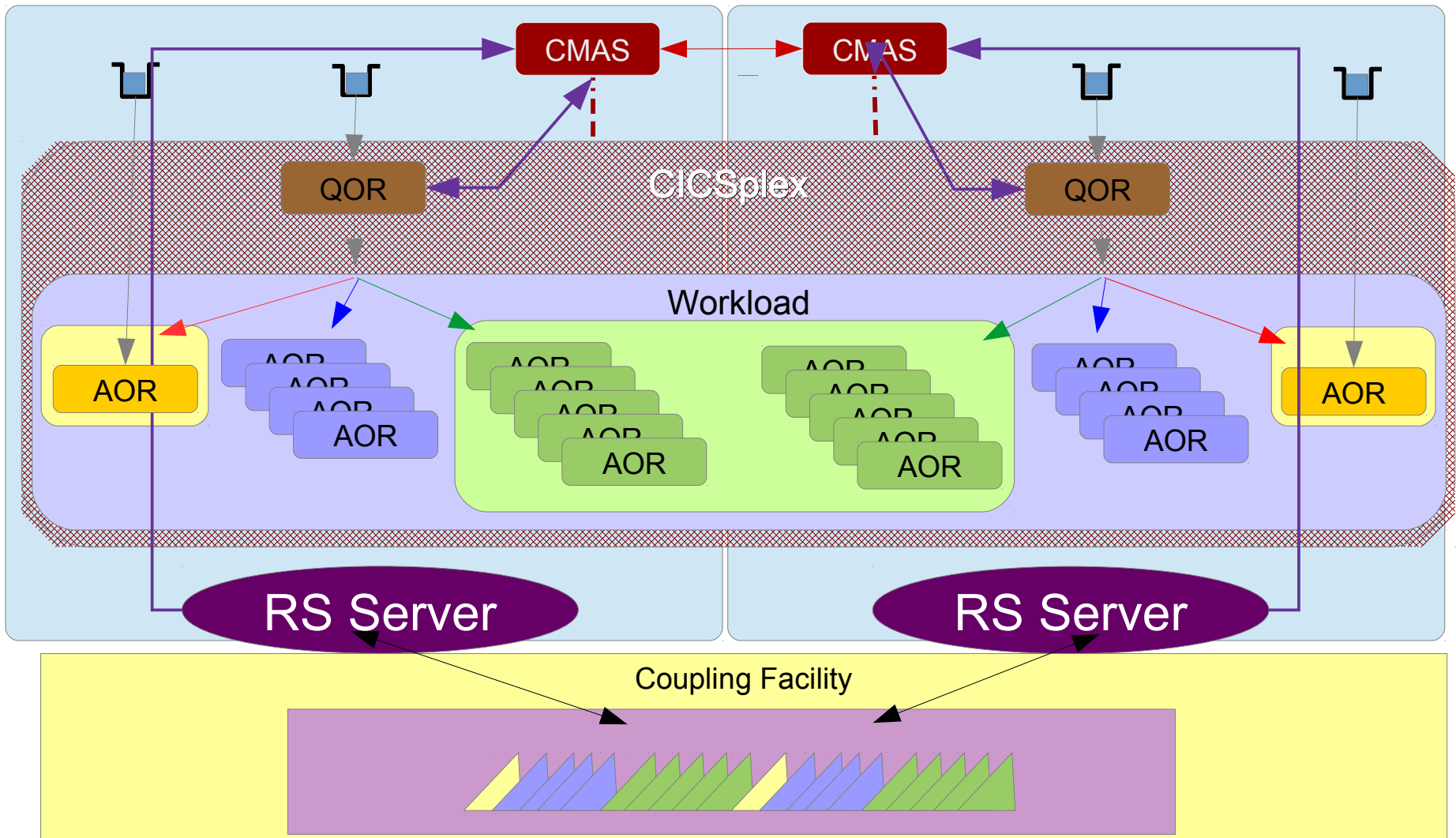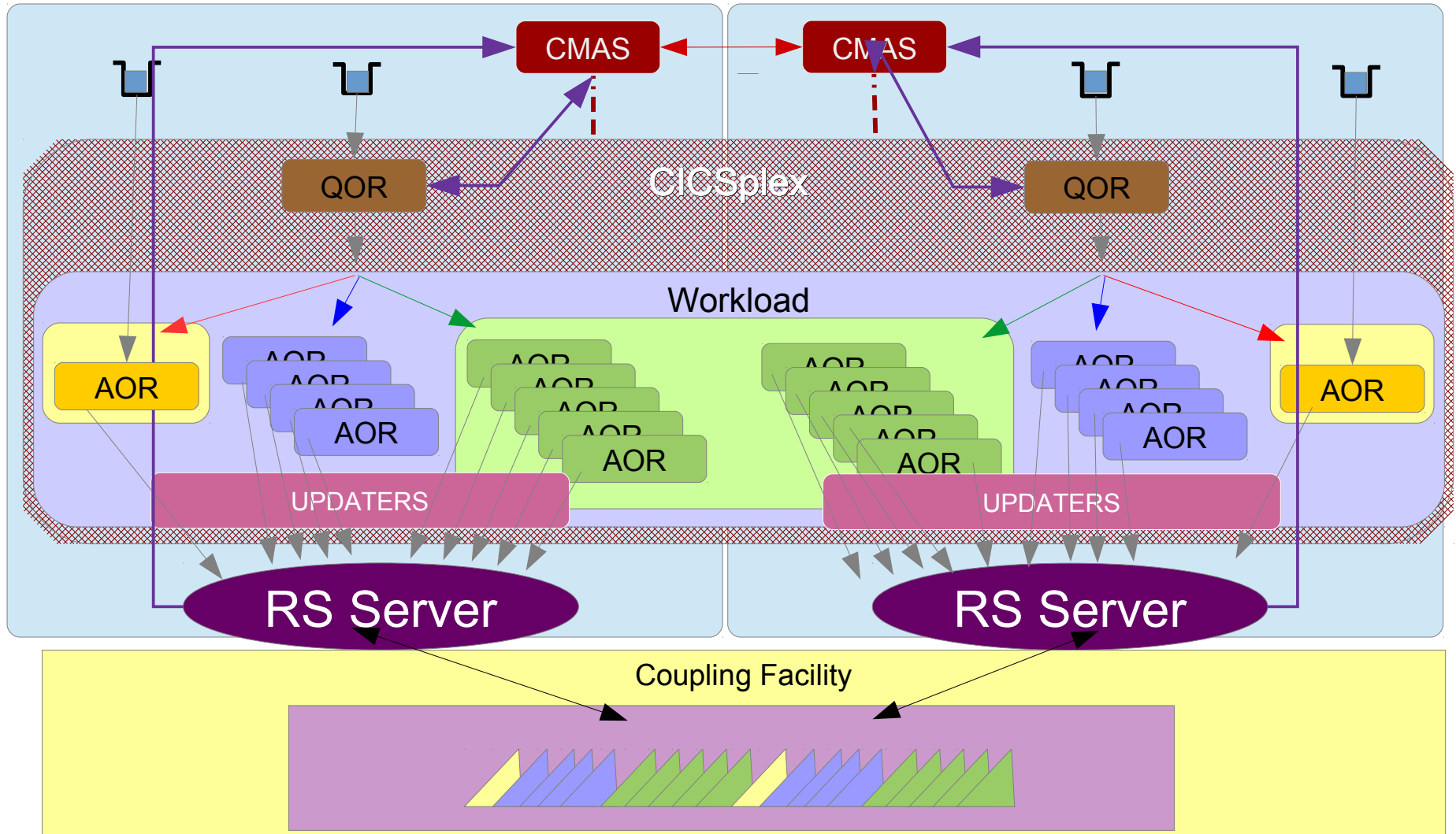
Coupling Facility: RS Server

- Data tables held in coupling facility structures managed by a Coupling Facility Data Table (CFDT) server

- CICS region status broadcast to sysplex using data table named after the CICSplex to which the region is assigned.

    - As name of CICSplex is used for the CFDT should:
        - Avoid sharing the RS server with other non-WLM application activity as may impede optimized workload processing
        - Ensure that is unique within the RS server
        - For example if 2 CICSplexs, with the same name, exist in the sysplex they must have different pool names to avoid data from the different CICSplexes contaminating the Optimization processing.
            - *Note: This is a settable in both CICSplex definition & operational tables but only effective once entire CICSplex recycled*

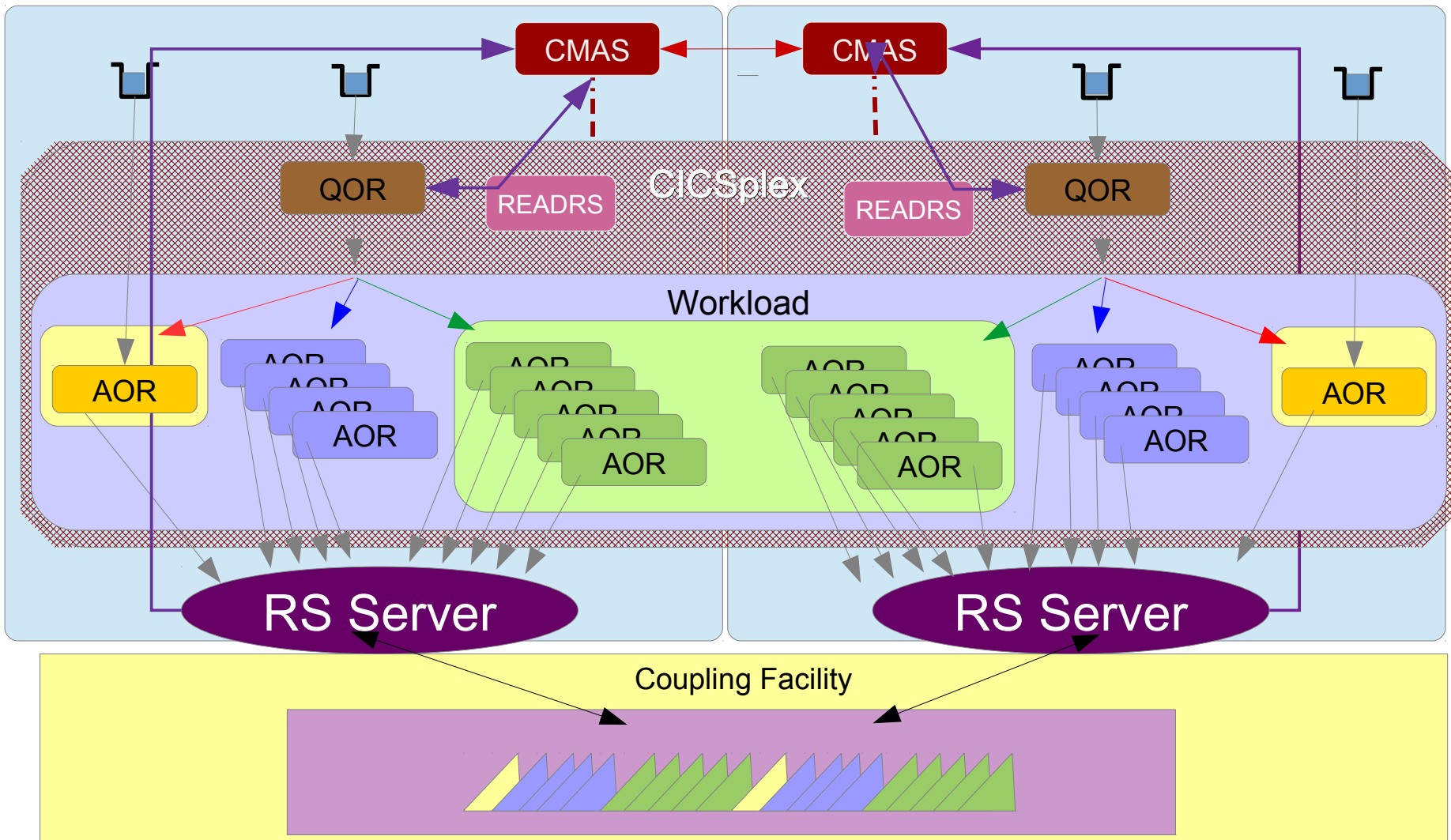# Coupling Facility: RS Server

- Use of RS servers feeding to Coupling Facility pool means:
  - Same data available to all Routers in the Workload
  - Control of updates to, and reads from, the Servers can be tailored (UPDATERS, READRS, TOPRSUPD, BOTRSUPD) at both CICSplex and individual CICS Region level.
    - (frequent enough to be accurate, not so frequent it overloads the CF)

  - Each region recorded in record in the data table
    - A region status record is approximately 40 bytes long.
    - For example, if PLEX1=100 regions then required structure is:
      - Poolname = DFHRSTAT, Table name = PLEX1, 100 regions x 40 bytes = 4000 bytes total
      - For an accurate estimate of storage requirements, use the IBM CFSizer tool available at http://www.ibm.com/systems/support/z/cfsizer/.

Target regions maintain task count using CICS transaction manager
 - all tasks in region (not just routed)
 - (tailorable) periodic broadcast of load value broadcast with basic health status to Coupling facility

Routing regions (regardless of CMAS managing them) all access the same status data for potential targets. Data refreshed between 2 seconds to 1 millisecond, default 200 ms
The more frequent Refresh = more accurate load measure *but* heavier Coupling Facility usage

Coupling Facility RS Server Tailoring

- READRS
  - period which region status is cached by a routing region before asking for a refresh.
  - READRS value
    - 0 = Routing region requests a refresh of the status data for a target region every time a target regions is checked to see if eligible for routing. 1-2000 = interval to limit frequency which target region is checked
- UPDATERS
  - Frequency RS server modifies the task load value
    - 0 = RS server not notified of task load changes
    - 1-25 %-age of MAXTASKS used as threshold which will drive calls to RS server.
      - *e.g. MAXTASKS=120 & UPDATERS=20 when task count moves between 20% of 120 (23-24 tasks), 40% of 120 (47-48) etc. to 100%*
    - Lower value = more frequently boundary is crossed and therefore data updated ... increases quality of QUEUE mode decisions but utilization of RS server also increases as does the z/OS Coupling Facility.
    - Default 15
- TOPRSUPD
  - RS server top-tier tuning parameter controls workload when WLM max health
    - When MAXTASKS reached must fall below this value (as %-age of MAXTASKs) before switched off.
- BOTRSUPD
  - Task load %age of real task count
  - When task load below this value task load is broadcast every task
    - When task load = value RS server update frequency task rule is reapplied
    - 1-25 (1=default)

Improved diagnostics and management of WLM

- New & Updated CICSPlex SM base tables to handle the extended routing values in Optimized Workload Routing:
  - WLMATARG :
    - New resource table
    - Full status & statistics for Target regions (including Optimized Workload values)
    - Tailored views added to default active WLM Menu in WUI
  - CICSplex resources (CPLEXDEF, CMASPLEX, CICSPLEX) and CICS system resources (CSYSDEF and MAS) updated to include new Optimization status and control values.

Improved diagnostics and management of WLM

- Basic Workload Management resources included in CICS Explorer:
  - Routers and Targets added to "CICSplex Explorer"
  - WLM operational views addedd to new "SM Administration" perspective
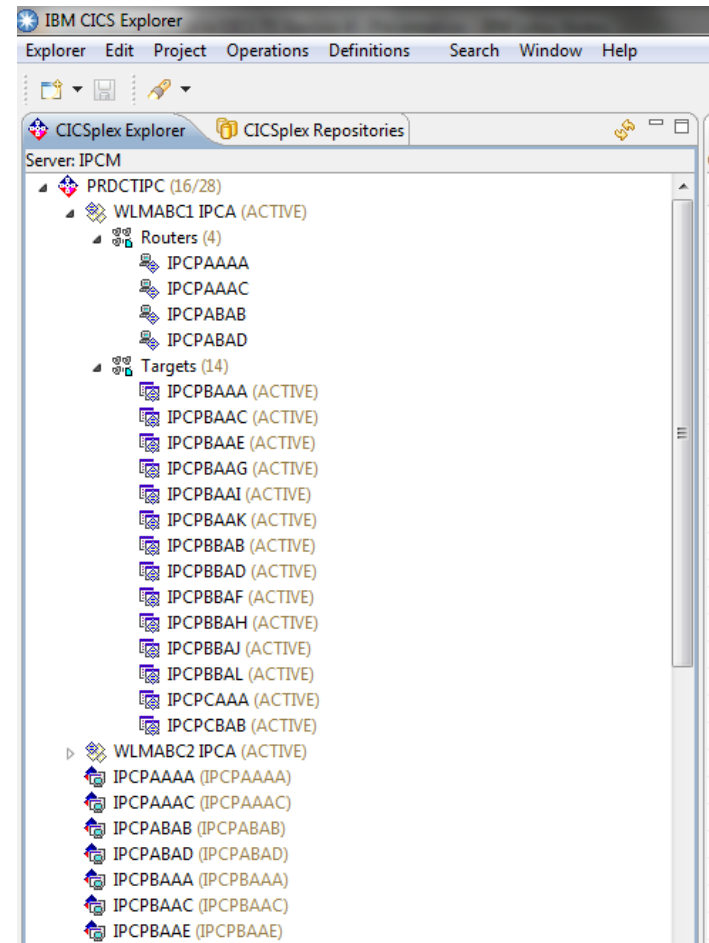
Application Design and WLM

Customer example

- Customer migrating from SNA LU0 to TCPIP
- Architected with Comms Server Socket API for CICS and remote starts
  - Examine the WLM and queuing characteristics
    - Local vs Remote Starts
- Compare with CICS HTTP support and DPL

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Basic Architecture

Comms Server TCPIP Stack

1

9

Long Running Child Server

2 START

CSMI 3 Business Logic

DPL

8

7

ECB

TDQ

6

5 4

CSMI

TOR

AOR
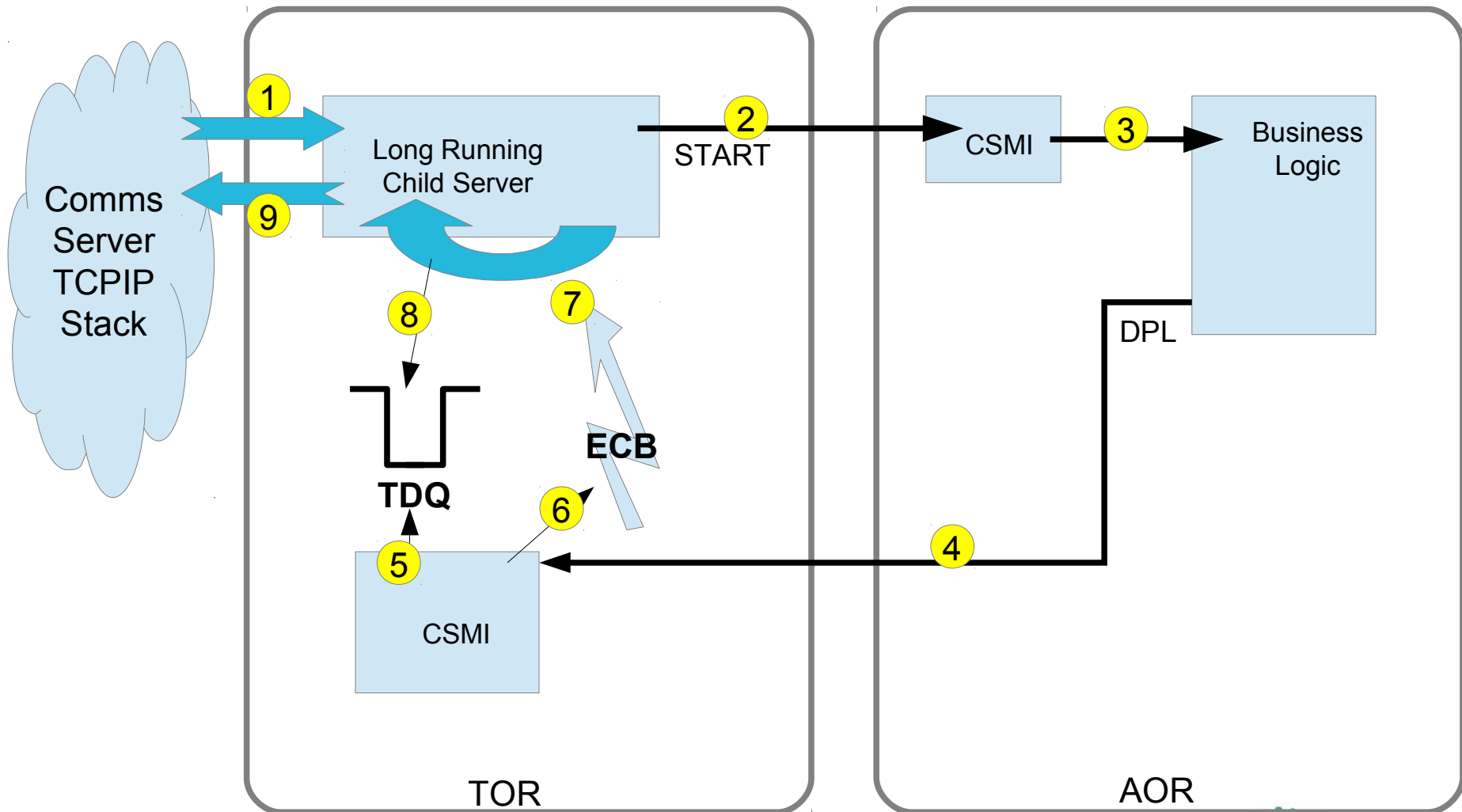
Remote asynchronous design
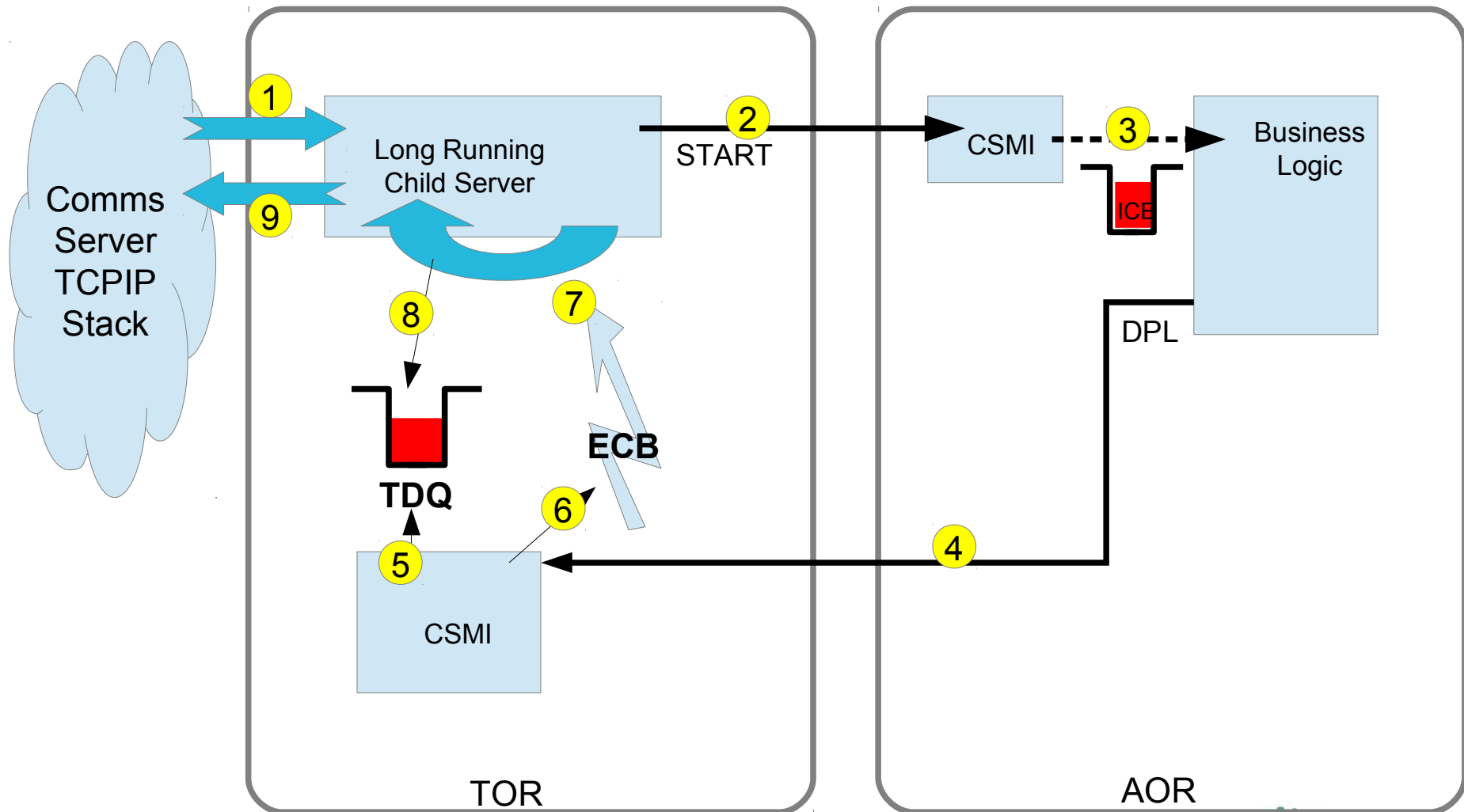
Remote Asynchronous Design Notes

- EXEC CICS START dispatches asynchronous execution of the business logic
- Remote START requires the command to be shipped – incorporating a WLM opportunity, and a queue of ICEs in the AORs
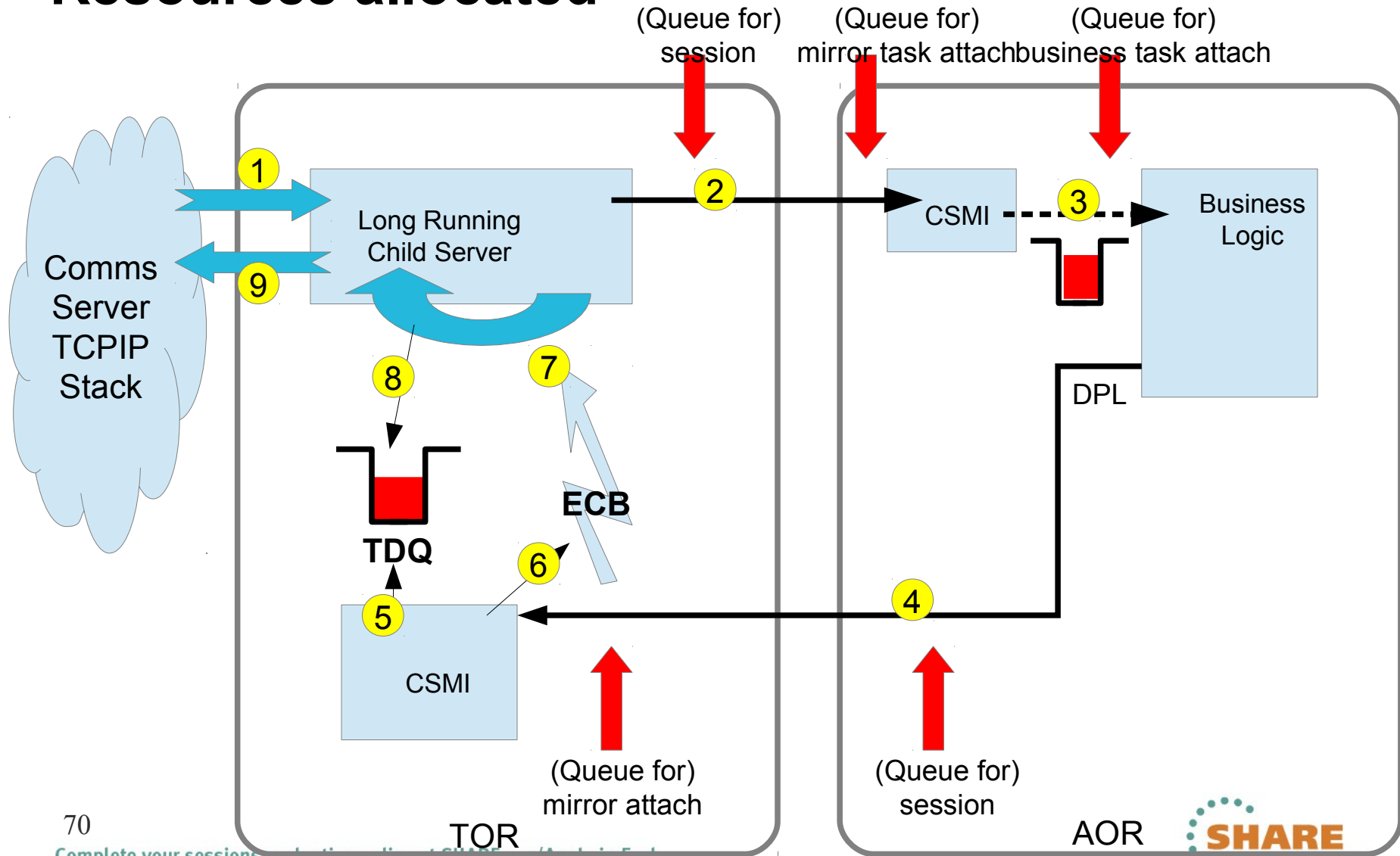 - WLM selects AOR and synchronously ships the START request
  - Queues of requests in the AOR
- WLM selects the AOR before the START is shipped, but execution is tracked once the business task is attached in the selected AOR – there is a time gap between decision and when resources are allocated
- AORs execute mixture of mirror tasks and business tasks
  - (How are these classified relative to each other?)
- Data is returned via a DPL, a TDQ and posting an ECB
  - Queues of responses in the TOR

Resources allocated

(Queue for) session

(Queue for) mirror task attach business task attach

Comms Server TCPIP Stack

1 → Long Running Child Server

9 ←

2 → CSMI ⇢ 3 ⇢ Business Logic

8 → TDQ

7 **ECB**

DPL

6

5 CSMI

4

(Queue for) mirror attach

(Queue for) session

TOR

AOR

Resource allocation notes

- Resources consumed in shipping the START include...
  - A session to communicate with the selected AOR
  - A Task to receive the START request and add it to the AOR's Interval Control chain (ICE chain)
  - A Task to run the business logic
- Resources consumed in shipping the data back...
  - Session to communicate with the TOR
  - Task to run the infrastructure logic to put data on the TDQ and post the ECB
- Thread may have to queue for each of these resources
- Child server must prioritise reading new work from the socket vs sending replies from the TDQ – this is flow control
  - TOR mirrors vs child server dispatch priority

Remote asynchronous dispatching – improvement opportunities

- Workload classification and separation
  - Safeguard critical work
  - Route work to dedicated AORs – CPSM may be doing this automatically
  - Simple "High", "Medium" and "Low" scheme would give benefits
- Multiple reply TDQs with different priorities
  - Single TDQ allows no prioritisation of response processing
  - Use same "High", "Medium" and "Low" scheme as for requests

Parallel Work – in a region
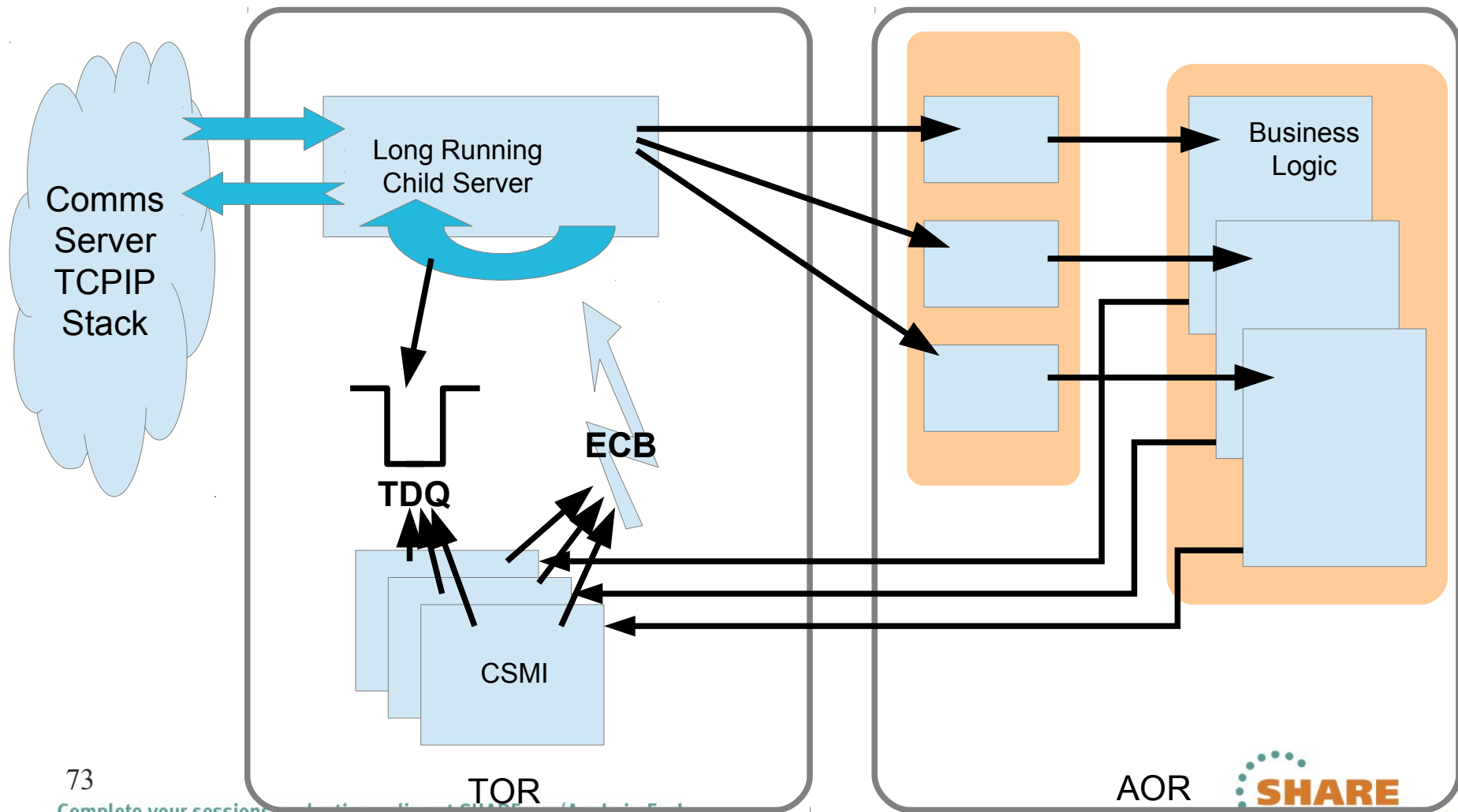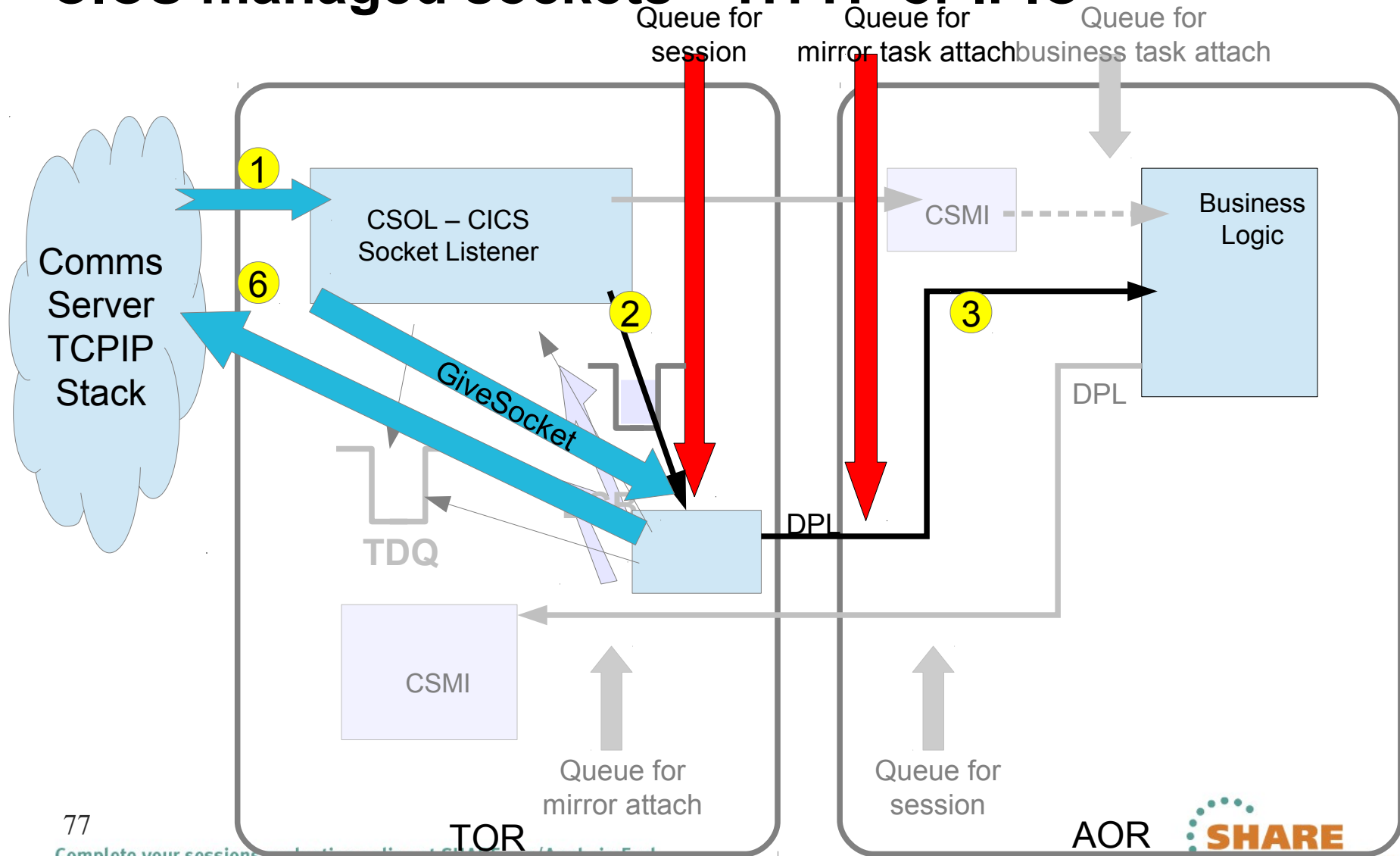
Parallel Work – in a plex

Local START with DPL
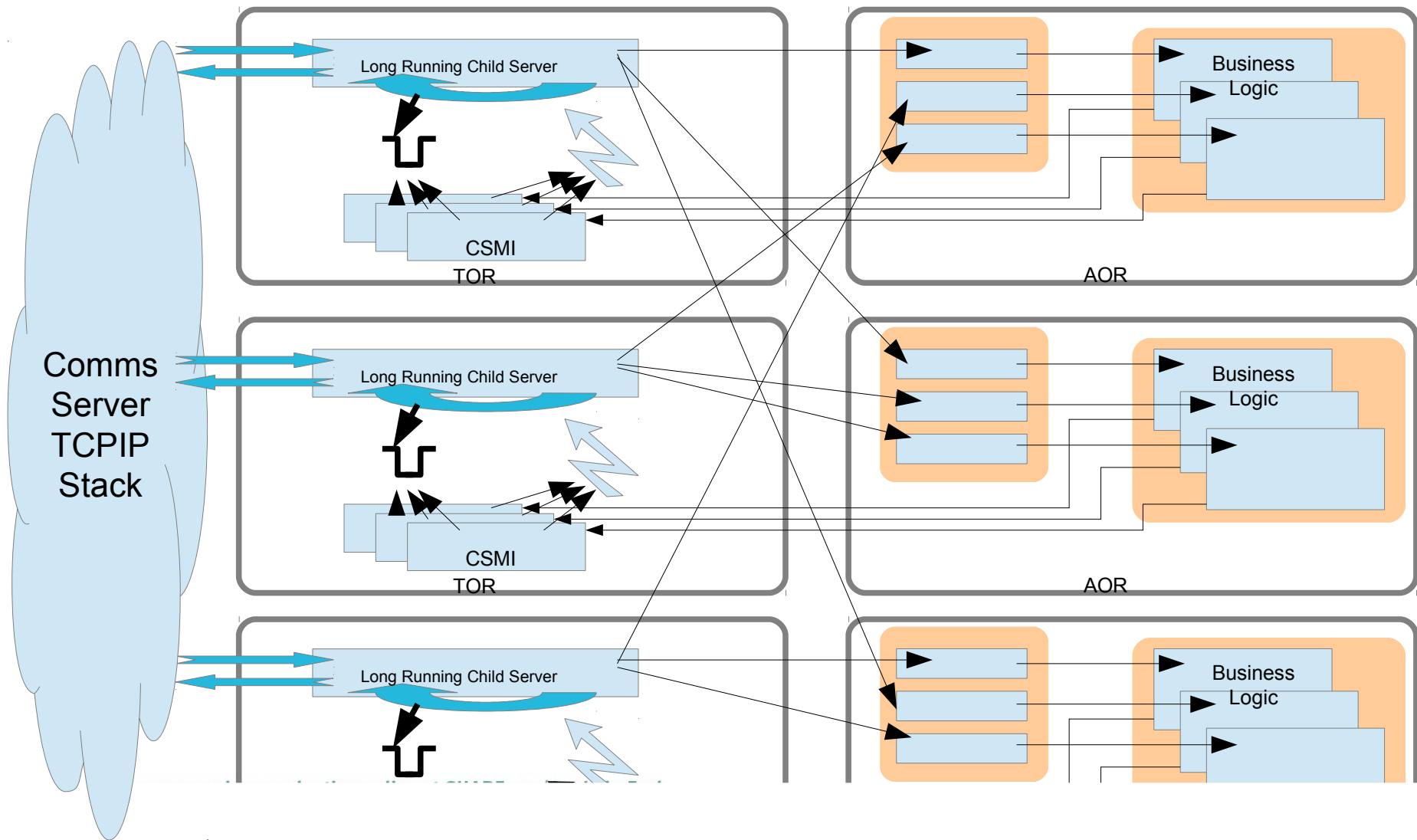
Local START notes

- Local START puts small, predictable load in TOR
  - Consumes a task in the TOR
- No need for WLM routing decision until DPL
  - Z/OS WLM Classification performed in TOR and propagated to the AOR
- Resources consumed in DPL to AOR
  - Session to communicate with AOR
  - Task to run business logic
- Three, rather than five, points where resources are consumed
  - Two fewer tasks attached (the start-shipping mirror and the DPL mirror)

Complete your sessions evaluation online at SHARE.org/AnaheimEval

CICS managed sockets – HTTP or IPIC

Queue for session

Queue for mirror task attach

Queue for business task attach

Comms Server TCPIP Stack

① → CSOL – CICS Socket Listener

⑥

GiveSocket

TDQ

CSMI

DPL

②

③

CSMI

Business Logic

DPL

DPL

Queue for mirror attach

Queue for session

TOR

AOR

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CICS managed sockets - HTTP

- CICS Sockets Domain (part of CICS, not Comms Server) manages connection requests and task dispatching
  - Multiple connections managed concurrently by one dedicated TCB per region
  - Uses internal task attach – no ICEs
  - Manages the sockets' association with tasks – no need for TDQ and ECBs, data can be returned directly from the application tasks
  - IPIC and HTTP default to persistent connections – CICS manages these across multiple application tasks

Summary: What were the objectives?

- – The Objective of this session was to introduce:

  - –*The role CICSPlex SM plays in Enterprise workload management*

  - –*The concepts of CICSPlex SM Workload Management*

  - – *How CICSPlex SM performs workload management*

  - – *Real world example of application architecture impacts on WLM*

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The End

- Questions?

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