Top WLM Analysis Exercises and Recommendations

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z/OS Performance
Education, Software, and
Managed Service Providers

Creators of Pivotor®

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Abstract

- **Top WLM Analysis Exercises and Recommendations**

  - During this webinar, WLM expert Peter Enrico will discuss some of his key analysis exercises to determine if your WLM is set up optimally. Along with these analysis exercises, ***Peter Enrico*** will provide a number of recommendations that are sure to benefit the performance and resource optimization of most z/OS environments. After you attend this webinar, be prepared to roll up your sleeves and get to work because this webinar will be full of useful and relevant information.

z/OS Performance workshops available

During these workshops you will be analyzing your own data!

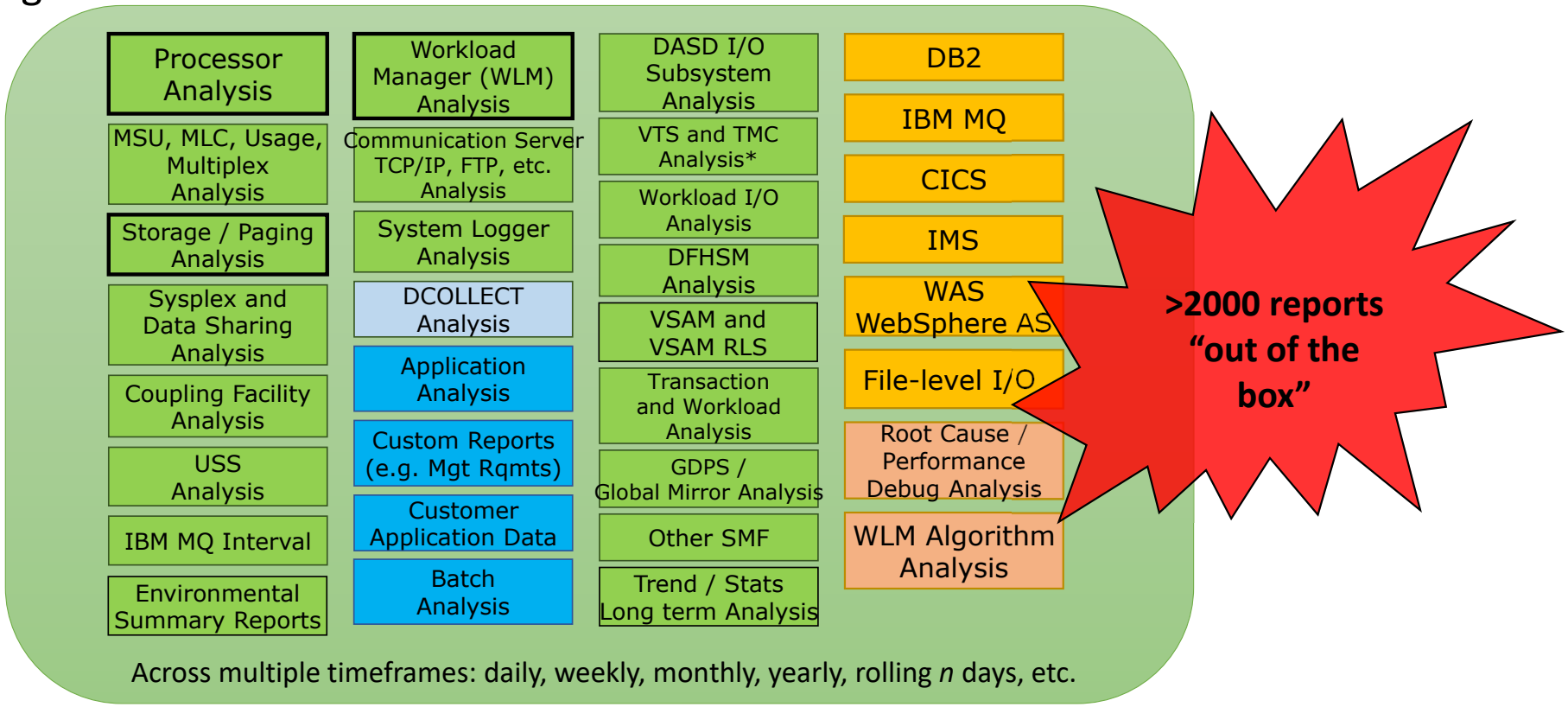
- Essential z/OS Performance Tuning
  - Via web March 20 – 24, 2023
- Parallel Sysplex and z/OS Performance Tuning
  - Via web May 2 – 3, 2023
- WLM Performance and Re-evaluating Goals
  - Via web October 2 – 6, 2023
- Also, once a month we offer a free z/OS educational webinar (see next slide)
  - Visit our website to be notified (www.epstrategies.com)

Like what you see?

- Free z/OS Performance Educational webinars!
  - The titles for our Fall 2022-2023 webinars are as follows:
    - ✓ *Key Reports to Evaluate z16 Processor Caches*
    - ✓ *Understanding System Recovery Boost's Impact on Performance and Performance Reporting*
    - ✓ *WLM Management of DDF Work: What can you do and what has changed?*
    - ✓ *Intensity! Understanding the Concepts and Usage of Intensity Measurements*
    - ✓ *High, Medium, Low: Understanding how HiperDispatch influences performance in z/OS*
    - *Putting a lid on XCF*
    - *How and why Pivotor is different than other performance management reporters*
    - *Key Reports to Evaluate Usage of Parallel Access Volumes*
    - *Key Reports to Evaluate Coupling Facility CPU Utilization*
    - *Understanding how memory management has evolved in z/OS*
  - Let me know if you want to be on our mailing list for these webinars
- If you want a free cursory review of your environment, let us know!
  - We're always happy to process a day's worth of data and show you the results
  - See also: http://pivotor.com/cursoryReview.html

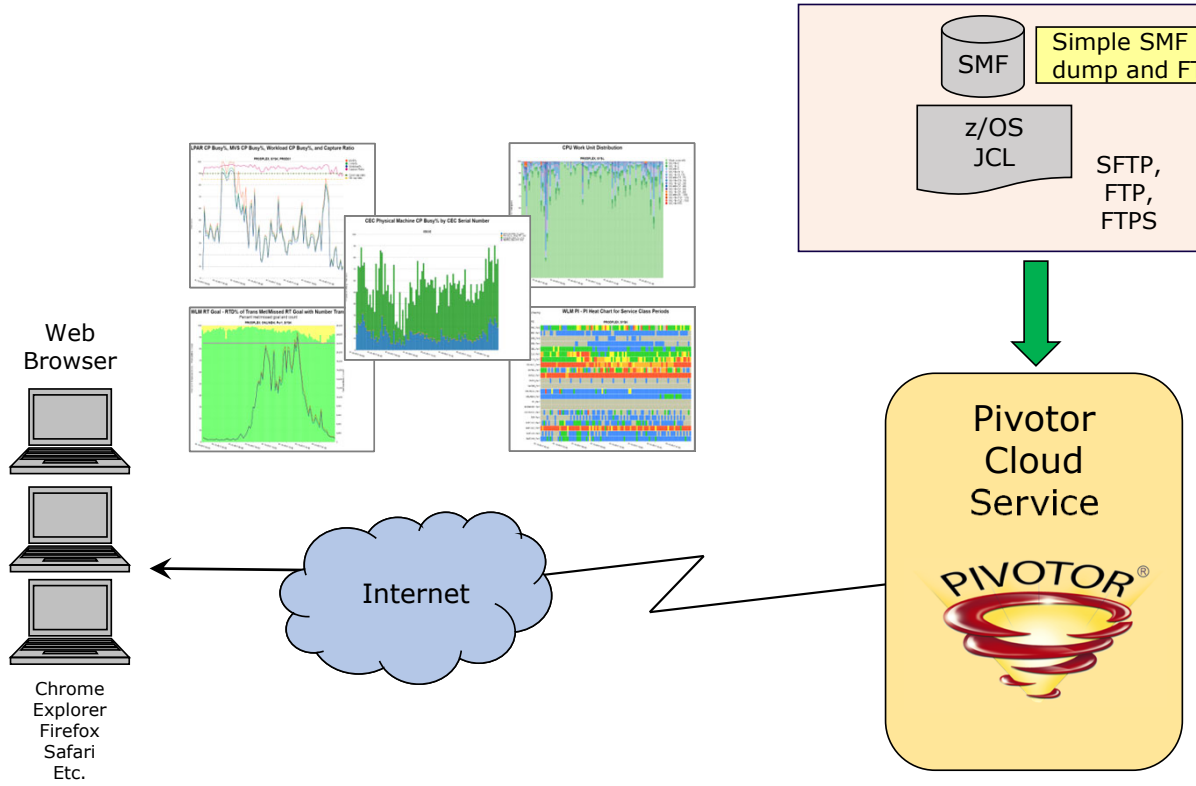
Pivotor – Intelligent Performance Reporting

- Pivotor is our data reporting tool & service designed specifically for z/OS performance reporting



Pivotor Software as a Solution (SaaS)

- Pivotor is offered as both a SaaS or local install
- When SaaS:
  - Formal yearly cursory review / discussion
  - Ability to ask us performance questions, or for us to look at a particular problem or concern. (support@epstrategies.com)
  - We can occasionally look in on your data and performance
  - We can participate in performance debug with IBM, or other vendors



z/OS Performance reporting that fits every need and budget

	Cloud			On-Site
Major Reporting Areas	**FREE**	**Essentials**	**Prime**	**Enterprise**
Basic LPAR, service/report classes	✓	✓	✓	✓
Batch		✓	✓	✓
I/O subsystem & channels			✓	✓
Sysplex, XCF, System Logger			✓	✓
Sub-minute performance (SMF 98/99)			✓	✓
DCOLLECT			✓	✓
TCP/IP (SMF 119)			✓	✓
Hardware Instrumentation (SMF 113)		✓	✓	✓
Dataset I/O Details (SMF 14/15, 42)			Optional	✓
CICS, WAS			Optional	✓
DB2, IMS*			Optional	✓
Custom data sources			✓	✓
Application attribution			✓	✓
Other supported SMF records			✓	✓
Report Retention				
Daily report retention	7 days	2 years*	2 years*	Up to you
Weekly/Monthly/Yearly report retention		Unlimited*	Unlimited*	Up to you
Performance Assistance and Education				
EPS available to answer performance questions with your data	Limited	✓	✓	Limited
Annual review calls			✓	
Playlist-guided analysis	✓	✓	✓	✓
In-depth Report Help	✓	✓	✓	✓
Exceptions	✓	✓	✓	✓
Dashboards			✓	✓
Other				
Least effort: just send us data!	✓	✓	✓	
Complete control & database access				✓
Cost				
Starting price (per year)	$0	$10,000	$25,000	$50,000
Pricing metric	1 system only	Report plexes + systems + RMF interval	Report plexes + systems + RMF interval	CECs + z/OS LPARs

- Pivotor pricing is clear and affordable

Like what you see?

- The z/OS Performance Graphs you see here come from Pivotor™

- If you don't see them in your performance reporting tool, or you just want a free cursory performance review of your environment, let us know!
  - We're always happy to process a day's worth of data and show you the results
  - See also: http://pivotor.com/cursoryReview.html

- We also have a free Pivotor offering available as well
  - 1 System, SMF 70-72 only, 7 Day retention
  - That still encompasses over 100 reports!

Presentation Overview

- This presentation contains some useful WLM analysis exercises
- After this presentation, the attendee is encouraged to conduct each one of these exercises
- If you have any question, feel free to email support@epstrategies.com
  - Or email Peter Enrico directly at Peter.Enrico@EPStrategies.com
- Also understand that this presentation only contains a small number of WLM analysis exercises
  - Considering attending Peter Enrico's *WLM Performance and Re-evaluation of Goals* workshop

Exercise:
Become familiar with your WLM service definition

Exercise:
Become familiar with your WLM service definition

- Review your WLM Service Definition to understand all defined constructs and settings:
  - *Service Policies* – named sets of overrides to defined goals in service policy
  - *Workloads* – aggregation of service classes for reporting purposes
  - *Service Classes* – subdivided into periods, groups of work with similar performance goals, business importance, and resource requirements for reporting and management purposes
  - *Report Classes* – group of work for 'more granular' reporting purposes
  - *Resource Groups* – define processor capacity boundaries across a Sysplex
  - *Classification Rules* – determine how to assign incoming work to a service class and/or a report class
  - *Application Environments* – groups of application functions that execute in server address spaces and can be requested by a client
  - *Scheduling Environments* – lists of named resources along with their required state
  - *Global Settings* – miscellaneous settings for WLM controls

Exercise:
Become familiar with your WLM service definition

- Understanding your WLM service definition is the first step of any WLM analysis
  - Very first step is to convert your WLM service definition to HTML format (see next few slides)
- While becoming familiar with your WLM service definition, there are many mini-analysis exercises you can perform
- A few of the many service definition review exercises include:
  - Make sure all work is classified to a report class
  - Make sure each default report class is unique
  - Consider making each default service class unique
  - Understand when and why a service class is used by multiple subsystems
  - Research dead classification rules
  - Remove unnecessary constructs such as unused service classes and report classes
  - Make sure report classes are homogeneous
  - Use description fields and notepad to document your WLM setup
  - Make sure goals are not being used to prioritize work
  - Etc.

Save your WLM Service Definition in XML Format

- You can edit your WLM service definition in either ISPF or z/OSMF

- When saving the WLM service definition it is recommended to save it in XML format
  - Problem with saving in ISPF tables is that these table can become incompatible with new APARs or z/OS releases. This then makes then ineligible to be updated if the APARs or z/OS releases are rolled back, or if an older release needs to edit or access.

- Select
  - File
  - -> Save as

  Use Save as to save the currently displayed service definition in a PDS as ISPF tables or in a PS as XML

```
File  Utilities  Notes  Options  Help
-------------------------------------------------------------------------------
Functionality LEVEL026 Definition Menu WLM Appl LEVEL026
Command ===> ____________________________________________________________

Definition data set . . : none

Definition name . . . . . ________ (Required)
Description . . . . . . . ________________________________

Select one of the following options.
___ 1. Policies                          12. Tenant Resource Groups
    2. Workloads                         13. Tenant Report Classes
    3. Resource Groups
    4. Service Classes
    5. Classification Groups
    6. Classification Rules
    7. Report Classes
    8. Service Coefficients/Options
    9. Application Environments
   10. Scheduling Environments
   11. Guest Platform Management Provider
```

After you save WLM Service Definition to XML file…

- The XML file will look crazy!

```
Classification>Ú<SubsystemType>IWEB</SubsystemType>Ú<Description>N/A</Descriptio
n>Ú<CreationDate>1900/01/01 00:00:00</CreationDate>Ú<ModificationDate>2000/02/17
 18:04:47</ModificationDate>Ú<ModificationUser>U873</ModificationUser>Ú<DefaultS
erviceClassName>NEWWKL</DefaultServiceClassName>Ú<DefaultReportClassName>NEWIWEB
</DefaultReportClassName>Ú</Classification>Ú<Classification>Ú<SubsystemType>JES<
/SubsystemType>Ú<Description>JES2 Rules</Description>Ú<CreationDate>1900/01/01 0
0:00:00</CreationDate>Ú<ModificationDate>2011/05/16 07:12:56</ModificationDate>Ú
<ModificationUser>I014350</ModificationUser>Ú<DefaultServiceClassName>BATNORM</D
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eClassName>Ú<ReportClassName>BATPROD</ReportClassName>Ú<StorageCritical>No</Stor
ageCritical>Ú<RegionGoal>No</RegionGoal>Ú<ClassificationRule>Ú<QualifierType>Per
form</QualifierType>Ú<QualifierValue>1</QualifierValue>Ú<ServiceClassName>BATNOR
M</ServiceClassName>Ú<ReportClassName>BATPROD</ReportClassName>Ú<StorageCritical
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icationRule>Ú<QualifierType>Perform</QualifierType>Ú<QualifierValue>9</Qualifier
Value>Ú<ServiceClassName>BATEXT</ServiceClassName>Ú<ReportClassName>BATPROD</Rep
ortClassName>Ú<StorageCritical>No</StorageCritical>Ú<RegionGoal>No</RegionGoal>Ú
</ClassificationRule>Ú<ClassificationRule>Ú<QualifierType>TransactionName</Quali
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eClassName>Ú<ReportClassName>DB2UTIL</ReportClassName>Ú<StorageCritical>No</Stor
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ortClassName>Ú<StorageCritical>No</StorageCritical>Ú<RegionGoal>No</RegionGoal>Ú
</ClassificationRule>Ú<ClassificationRule>Ú<QualifierType>TransactionName</Quali
```
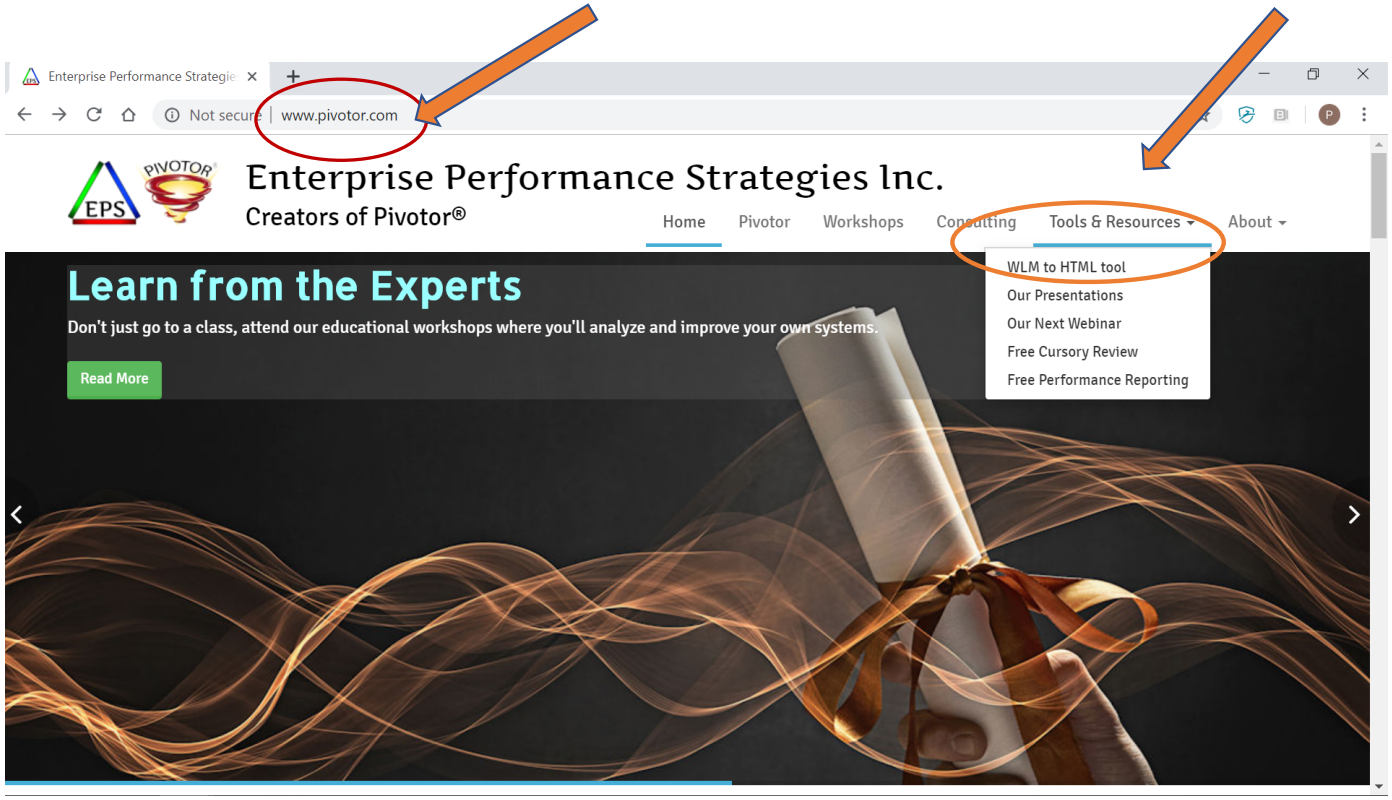

Convert WLM XML file to HTML for Analysis

- Once saved as XML, a tool is available to nicely format the XML file into a easy to read format to assist during your WLM analysis

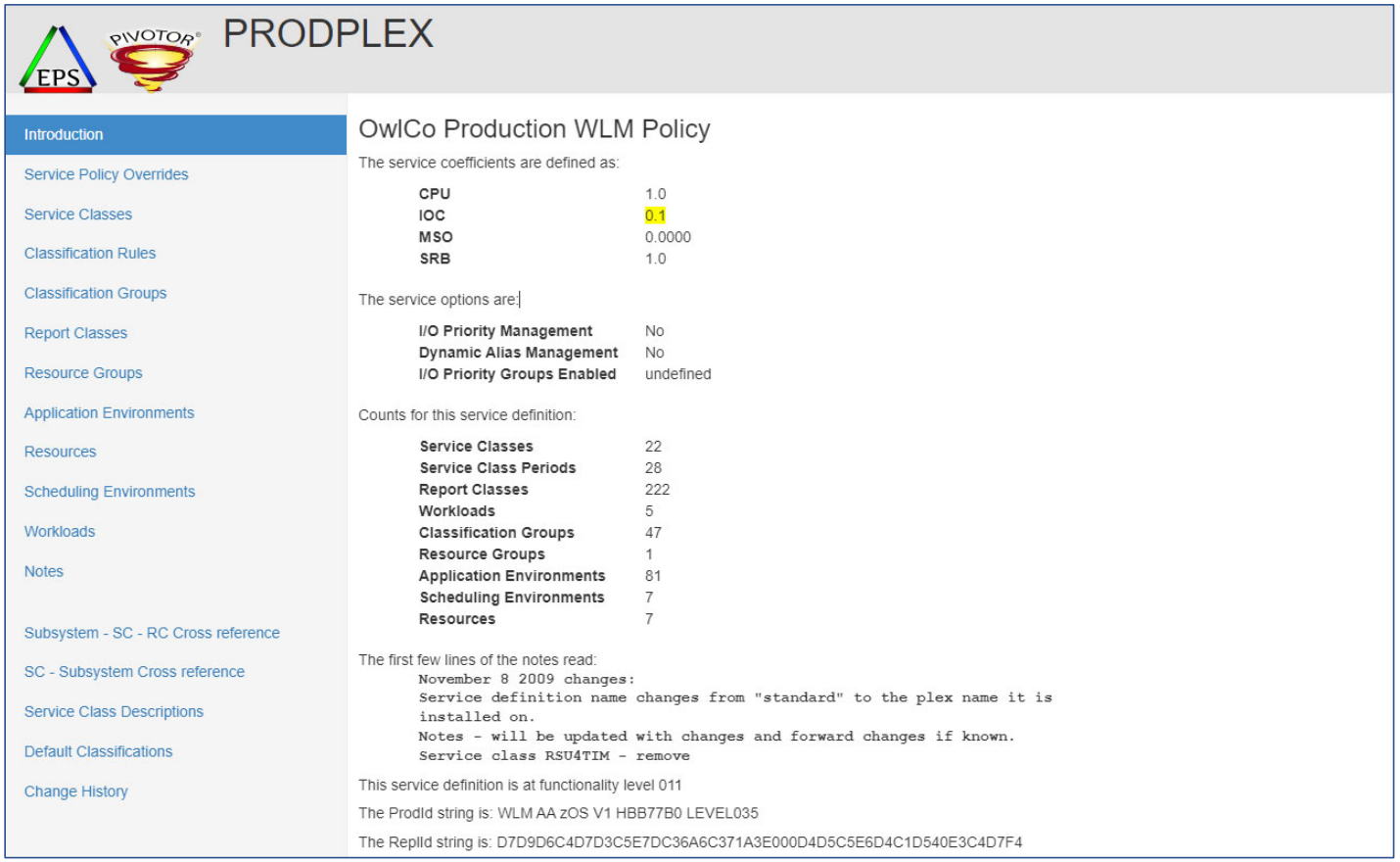
- Visit www.pivotor.com or www.epstrategies.com
- Select 'Tools & Resources' option
- Select WLM TO HTML
- Provide your XML file and email address
  - HTML formatted WLM service definition emailed to you in seconds!



Example of HTML Formatted Service Definition

- Not only is the XML file nicely formatted

  But there is some analysis built into the file to help you with your service definition cleanup.
  - Suggested wrong settings
  - Suggested cleanup
  - Indicators of heterogeneous service and report classes
  - More…



PRODPLEX

Introduction
Service Policy Overrides
Service Classes
Classification Rules
Classification Groups
Report Classes
Resource Groups
Application Environments
Resources
Scheduling Environments
Workloads
Notes
Subsystem - SC - RC Cross reference
SC - Subsystem Cross reference
Service Class Descriptions
Default Classifications
Change History

OwlCo Production WLM Policy

The service coefficients are defined as:

CPU	1.0
IOC	0.1
MSO	0.0000
SRB	1.0

The service options are:

I/O Priority Management	No
Dynamic Alias Management	No
I/O Priority Groups Enabled	undefined

Counts for this service definition:

Service Classes	22
Service Class Periods	28
Report Classes	222
Workloads	5
Classification Groups	47
Resource Groups	1
Application Environments	81
Scheduling Environments	7
Resources	7

The first few lines of the notes read:

```
November 8 2009 changes:
Service definition name changes from "standard" to the plex name it is
installed on.
Notes - will be updated with changes and forward changes if known.
Service class RSU4TIM - remove
```

This service definition is at functionality level 011

The ProdId string is: WLM AA zOS V1 HBB77B0 LEVEL035

The RepId string is: D7D9D6C4D7D3C5E7DC36A6C371A3E000D4D5C5E6D4C1D540E3C4D7F4

Exercise:
Understand resource usage by WLM Importance Level

Then adjust to spread the importance levels out with just a small number of periods assigned importance levels 1 and 2.

Understand resource usage by WLM Importance Level

- During this exercise, understand the resource usage by importance levels
  - Typically, CPU usage is the most important resource to understand
  - Understanding resource usage by importance levels helps to understand the possible tradeoffs that WLM can make between importance levels

- As a reminder:
  - All work assigned a velocity or response time goal is also assigned a relative importance level
    - 1 - highest
    - 2 - high
    - 3 - medium
    - 4 - low
    - 5 – lowest

    - SYSTEM & SYSSTC are more important than importance 1
    - Discretionary goals are less important than importance 5

  - When there is not sufficient capacity to meet goals, WLM uses importance to prioritize work
    - Helps WLM to prioritize goal work relative to other goal work
    - WLM attempts to meet higher importance goals before trying to meet lower importance goals

Exercise: Understand CPU Usage by Importance Level

- Verify the workloads are spread out among all importance levels with just a few at the high importance levels
  - Adjust accordingly

- Some key objectives of this evaluation include the following:
  - Determine which importance levels are being used
  - Helpful to WLM if all 5 importance levels are used

  - Determine the amount of system resources being used by each of the importance levels
    - Example: CPU and Storage

  - Determine if there are opportunities for WLM to steal from lower importance service class periods to give to higher importance service class periods
  - Remember WLM can only steal from another period using the same resource

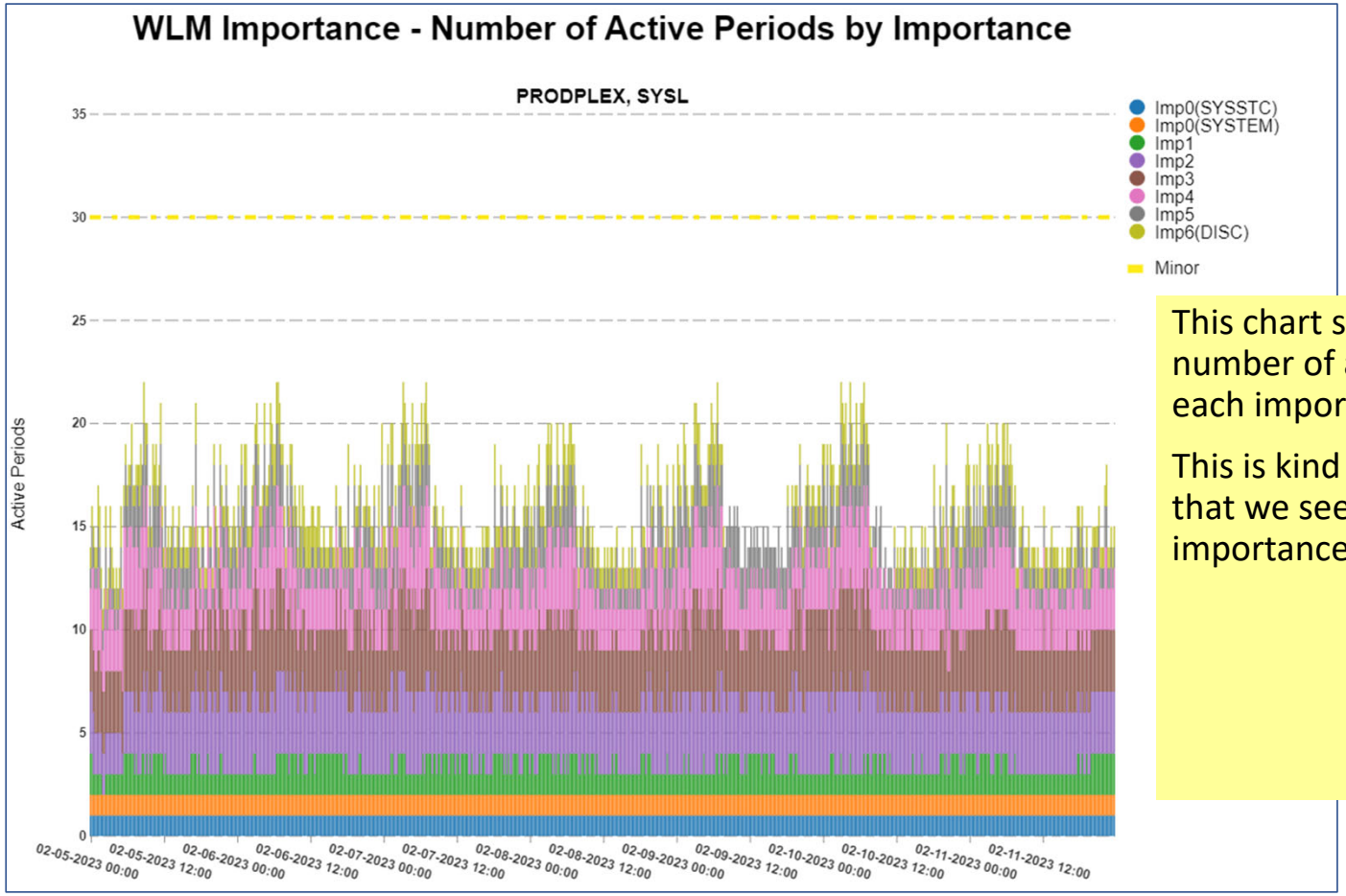
- Some key objectives of this evaluation include the following:
  - Determine if the resource consumption is dominated by importance levels 1 and 2, and little work running in the lower importance levels
  - This might show few periods to steal from to help high importance work

Understand WLM importance level settings

- Examine WLM service definition for the way the importance levels are used

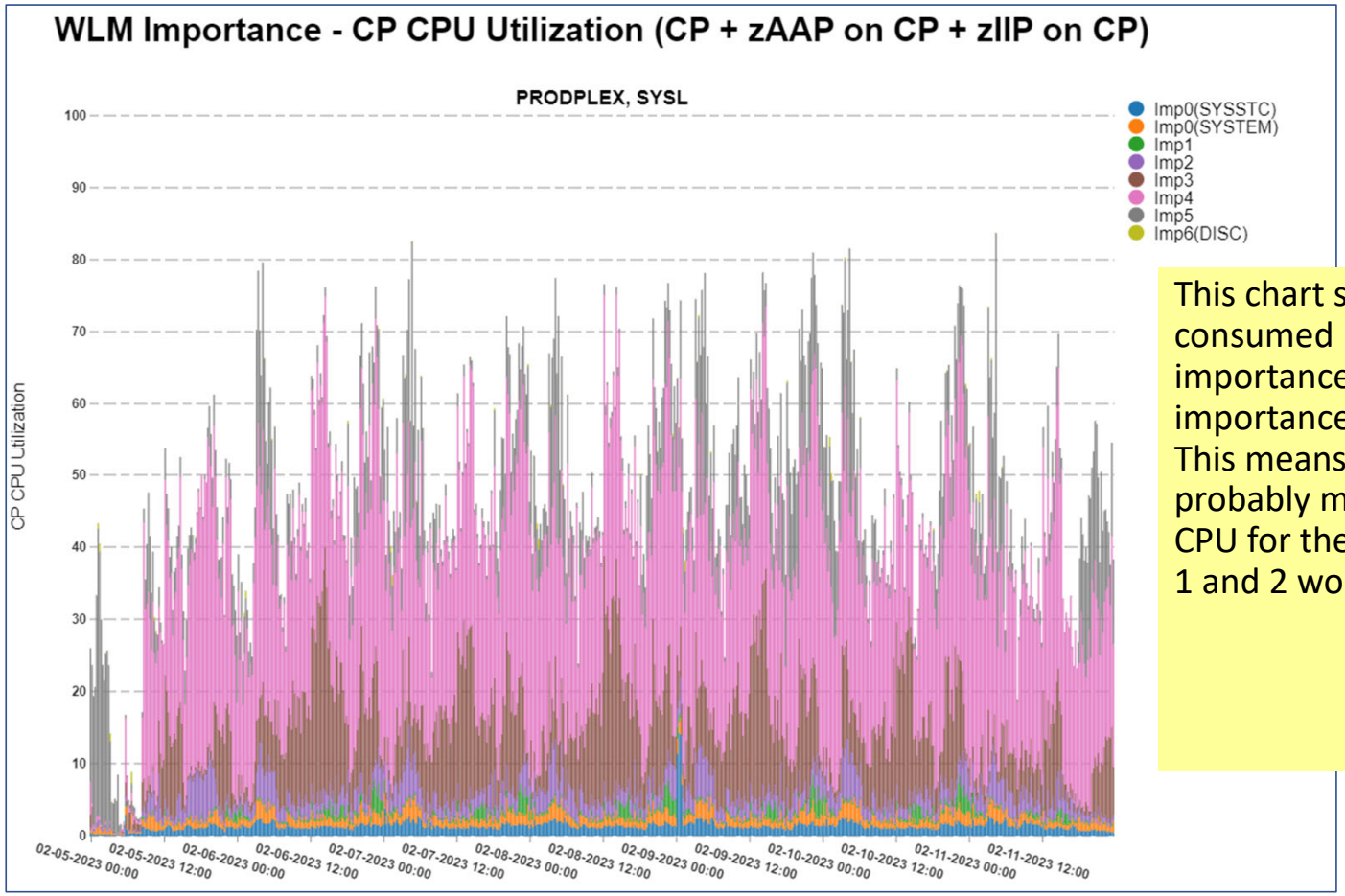
This service definition has a single policy defined.

Workload	SC Name	Period	Duration	Importance	Goal Type	Velocity	Resp Time	Resp %	CPU Crit
STC	SAPHICC	1		1	Velocity	60			Yes
STC	STCHICC	1		1	Velocity	60			Yes
TSO	TSOPRD	1	10000	1	Percentile RT		00:00.500	80	No
ONLINE	NEON	1		2	Percentile RT		00:00.250	90	No
STC	SAPHI	1		2	Velocity	50			No
STC	STCHI	1		2	Velocity	60			No
TSO	TSONORM	1	5000	2	Percentile RT		00:00.500	80	No
BATCH	HOTBATCH	1		3	Velocity	40			No
ONLINE	ONLINEHI	1		3	Percentile RT		00:00.250	85	No
ONLINE	ONLINELO	1		3	Percentile RT		00:01.000	85	No
ONLINE	ONLINESP	1		3	Percentile RT		00:05.000	50	No
STC	SAPMD	1		3	Velocity	50			No
STC	STCMD	1		3	Velocity	40			No
TSO	TSONORM	2	5000	3	Percentile RT		00:03.000	80	No
TSO	TSOPRD	2		3	Velocity	35			No
BATCH	BATCHHI	1	300000	4	Velocity	35			No
BATCH	BATCHLO	1	150000	4	Velocity	35			No
STC	SAPLO	1		4	Velocity	40			No
STC	STCLO	1		4	Velocity	35			No
BATCH	BATCHHI	2		5	Velocity	35			No
BATCH	BATCHLO	2	150000	5	Velocity	35			No
NEWWORK	NEWWORK	1		5	Velocity	35			No
ONLINE	CICSLOW	1		5	Velocity	30			No
ONLINE	DDF	1		5	Velocity	30			No
STC	SAPBW	1		5	Velocity	50			No
BATCH	BATCHLO	3		6	Discretionary				No
STC	KILLIT	1		6	Discretionary				No
TSO	TSONORM	3		6	Discretionary				No

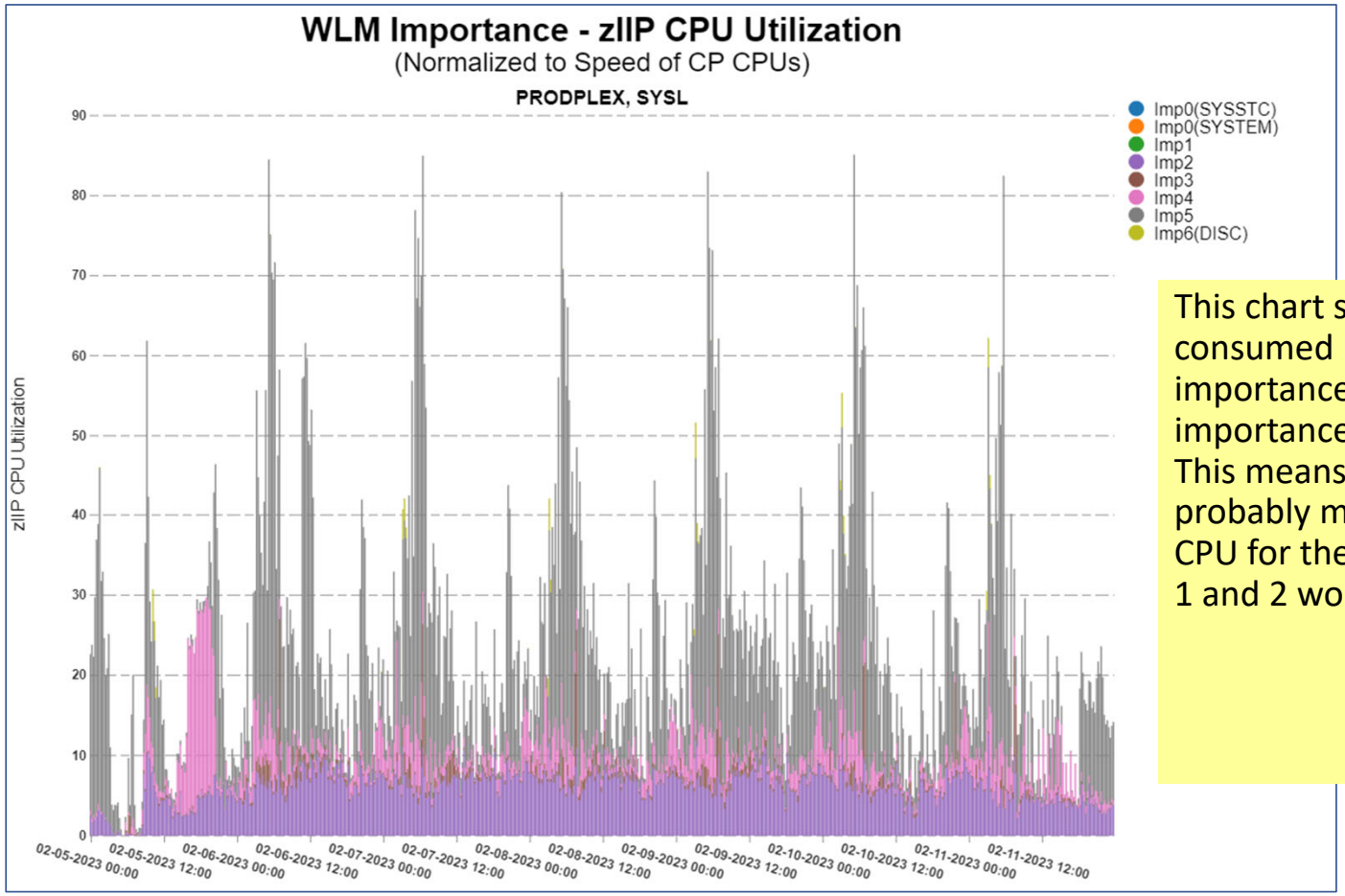


This chart shows the number of active periods at each importance level.

This is kind of interesting int that we see that all importance levels are used.



This chart shows CP CPU consumed by WLM importance level. Not that importance 4 dominates. This means that there is probably more than enough CPU for the importance level 1 and 2 workloads



This chart shows zIIP CPU consumed by WLM importance level. Not that importance 5 dominates. This means that there is probably more than enough CPU for the importance level 1 and 2 workloads

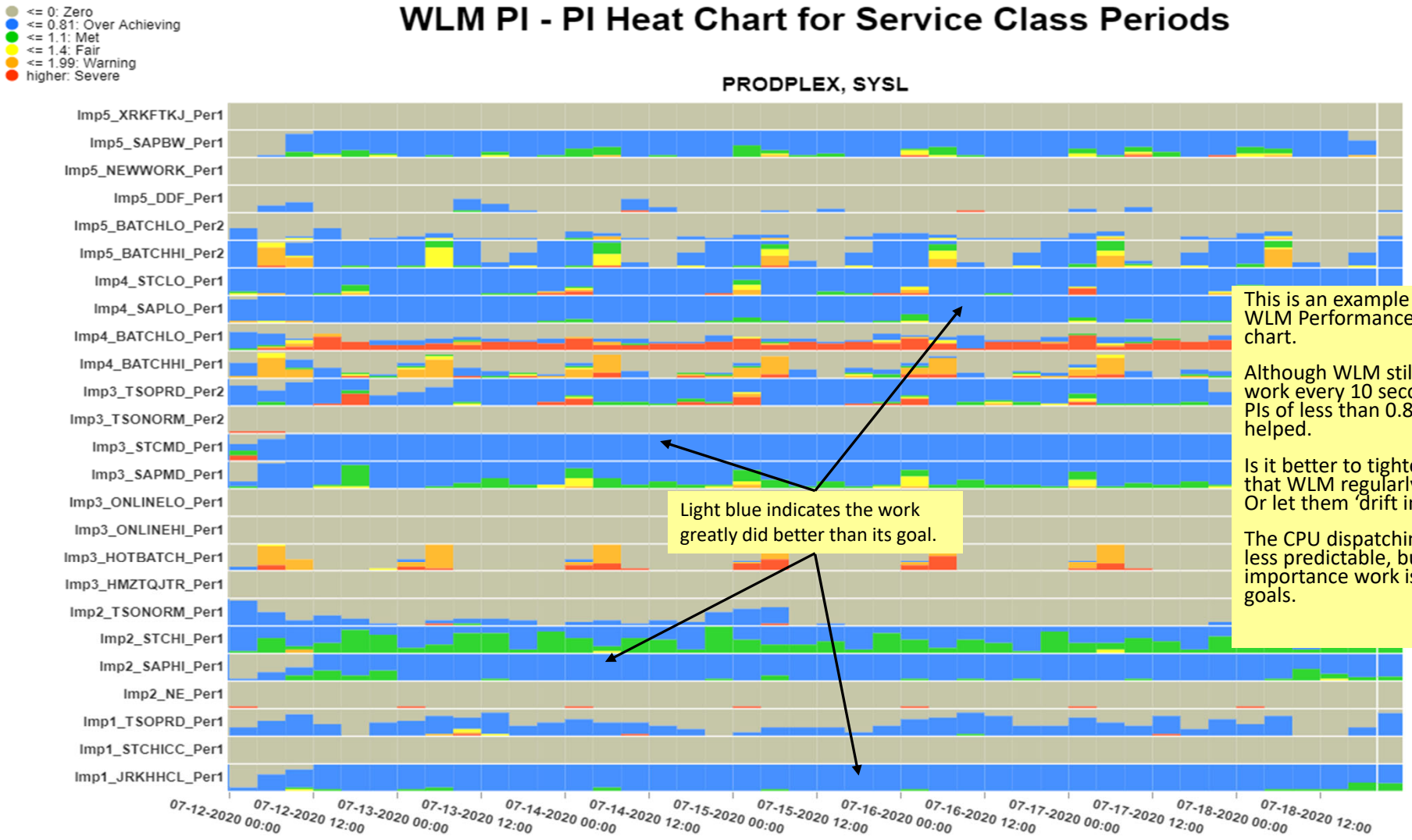
Exercise:
Determine which goals are too easy and which goals are too hard

Once you determine which goals are too easy or too hard, then tighten or loosen the goals accordingly

Determining which goals are too easy or hard

- During this exercise, you want to determine if
  - If any goals are too easy
  - If any goals are too difficult
  - Preferred performance index values are between 0.95 and 1.10
- When goals are too easy, the resources of the work are easily prone to be stolen
- When goals are too difficult, WLM is less likely to ever help the work
- For this exercise, pay more attention to importance 1 and 2 work
  - Still pay attention to importance levels 3, 4, and 5 work, but these goals should be moderate or 'slightly' easier anyway to allow stealing of resource by higher importance work

WLM PI - PI Heat Chart for Service Class Periods



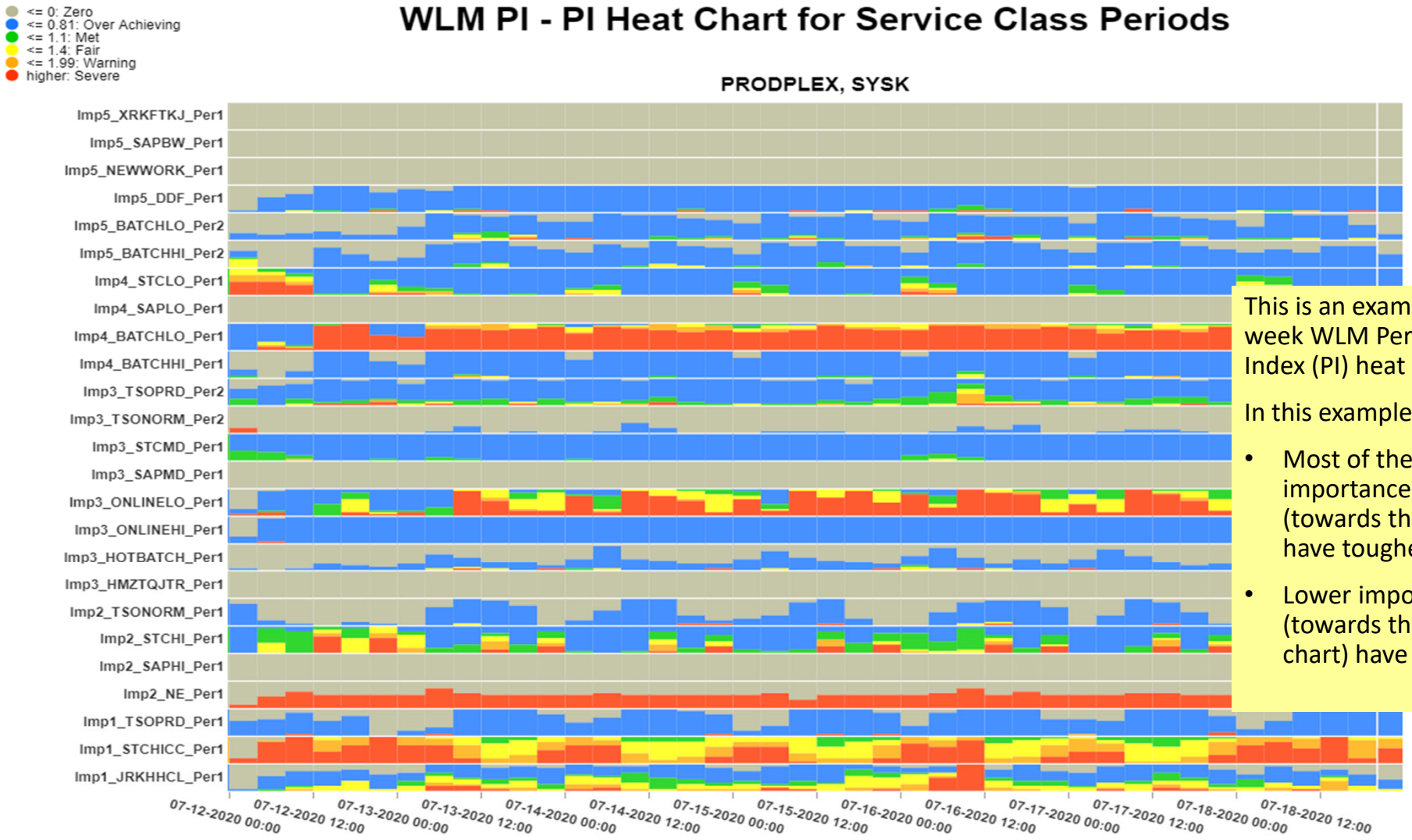
This is an example of a one-week WLM Performance Index (PI) heat chart.

Although WLM still looks at all work every 10 seconds, goals with PIs of less than 0.81 will not be helped.

Is it better to tighten the goals so that WLM regularly helps them? Or let them 'drift in the wind'?

The CPU dispatching priorities are less predictable, but hey… high importance work is meeting its goals.

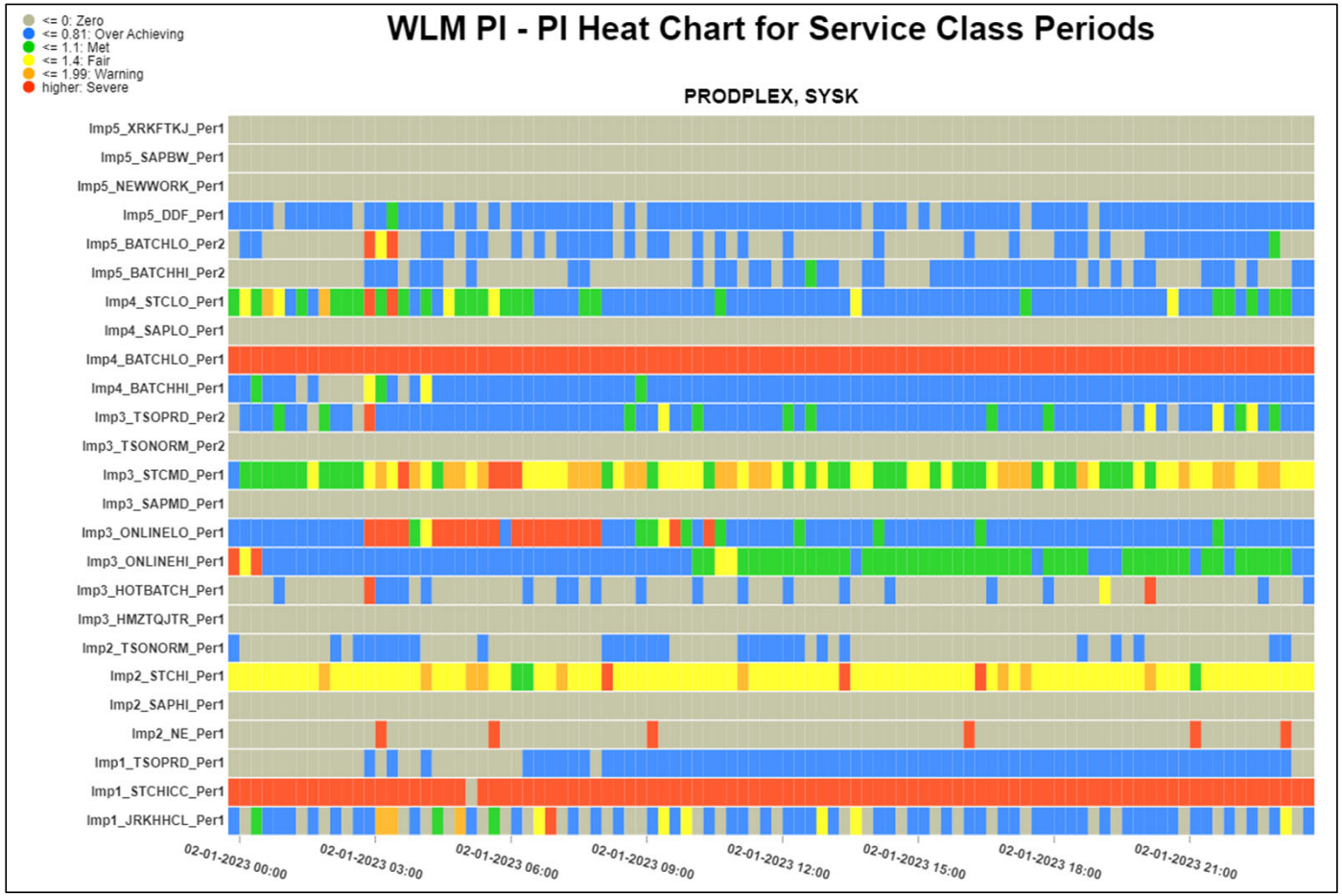
WLM PI - PI Heat Chart for Service Class Periods

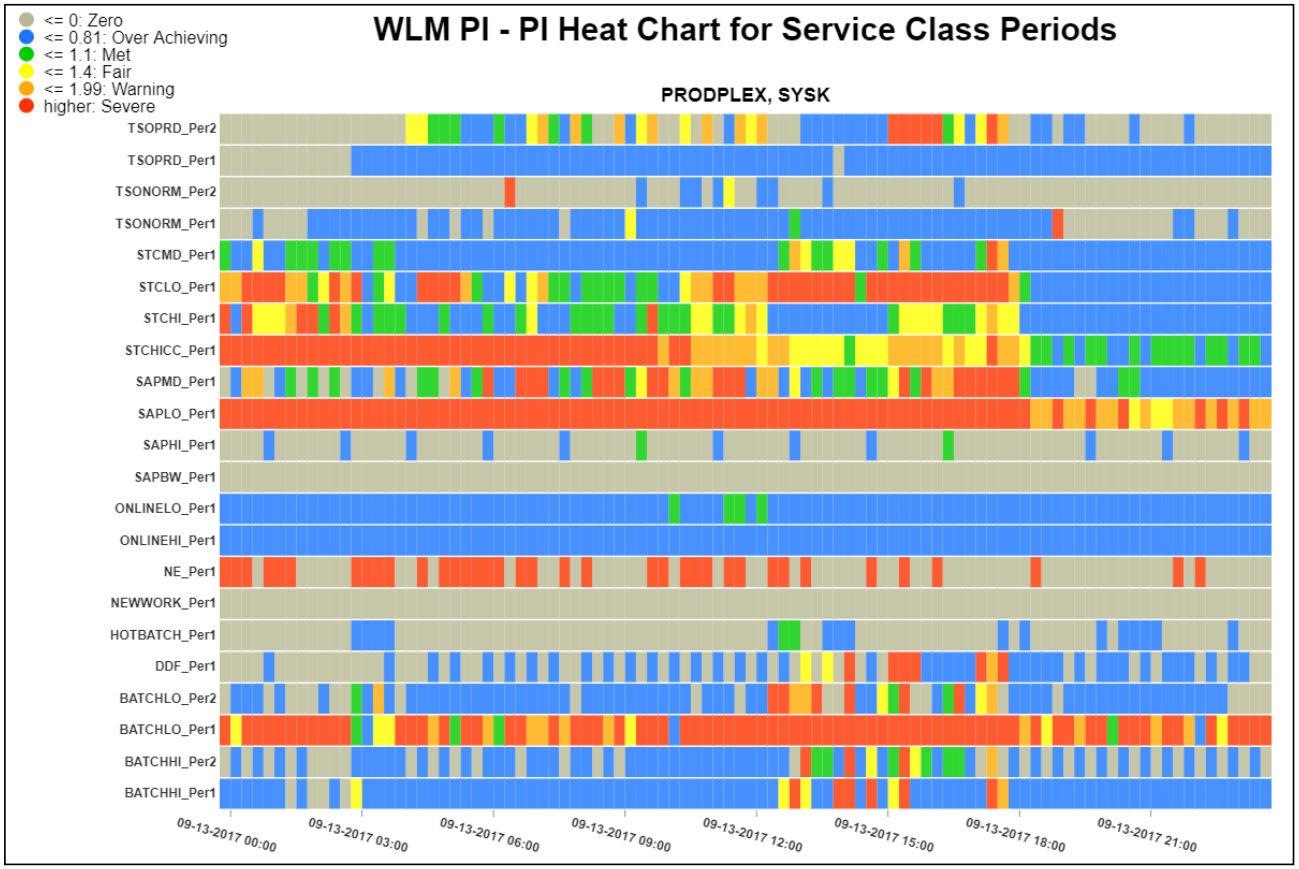


This is an example of a one-week WLM Performance Index (PI) heat chart.

In this example we see:

- Most of the higher importance workloads (towards the bottom) have tougher goals
- Lower importance goals (towards the top of the chart) have easier goals





Exercise:
Disable WLM I/O priority management option

If you are using Parallel Access Volumes (PAVs), then WLM I/O Priority Management is no longer necessary, and could hurt WLM management of the workload

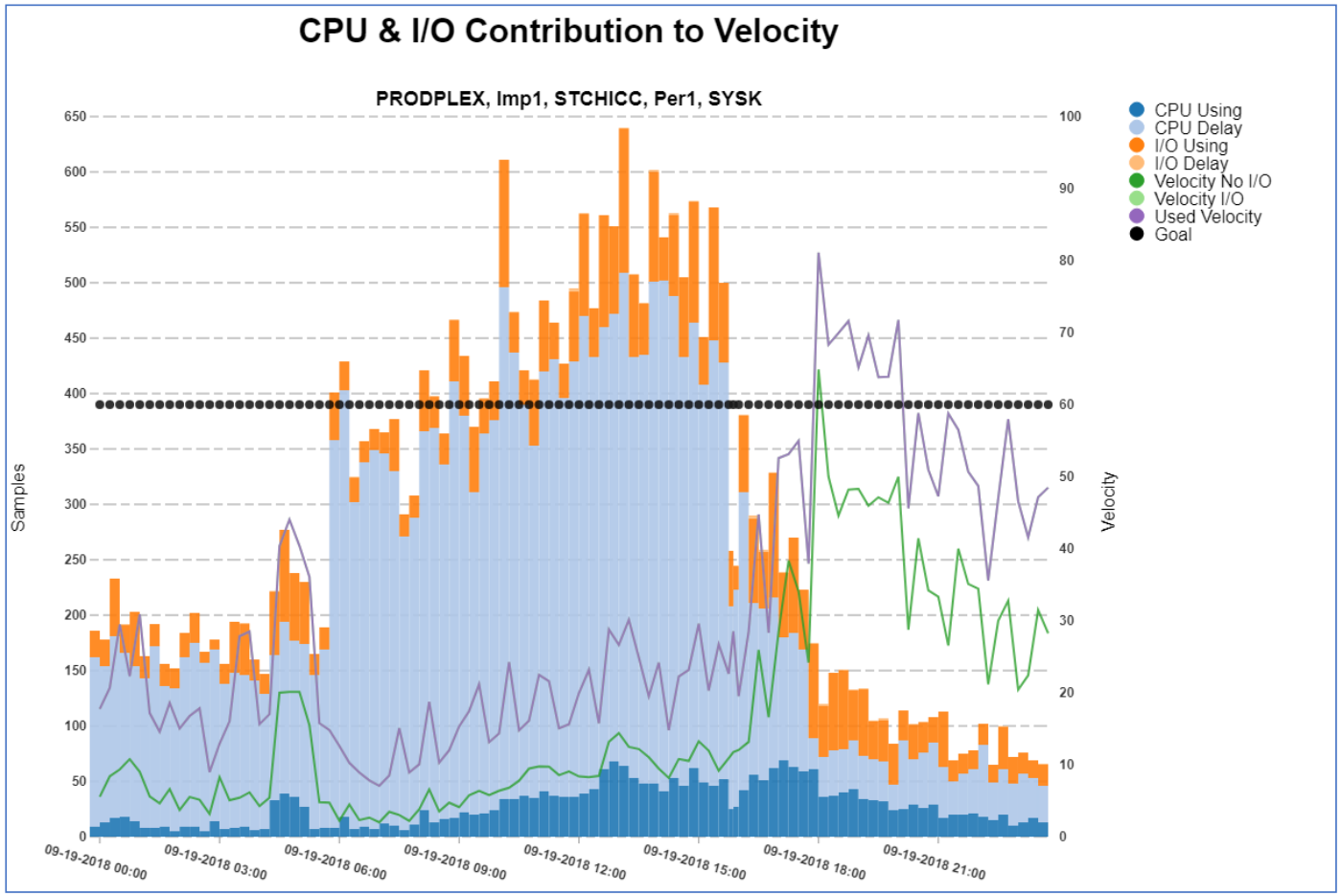
Disable WLM I/O priority management option

- During this exercise, determine which periods need to have their velocity goals tuned after disabling the WLM I/O priority management option
- With the advent of PAVs, I/O priority management no longer necessary
  - There will typically be very few I/O delay samples, but lots of I/O using
  - Results in achieved velocities that skew very high

I/O Priority Management NO

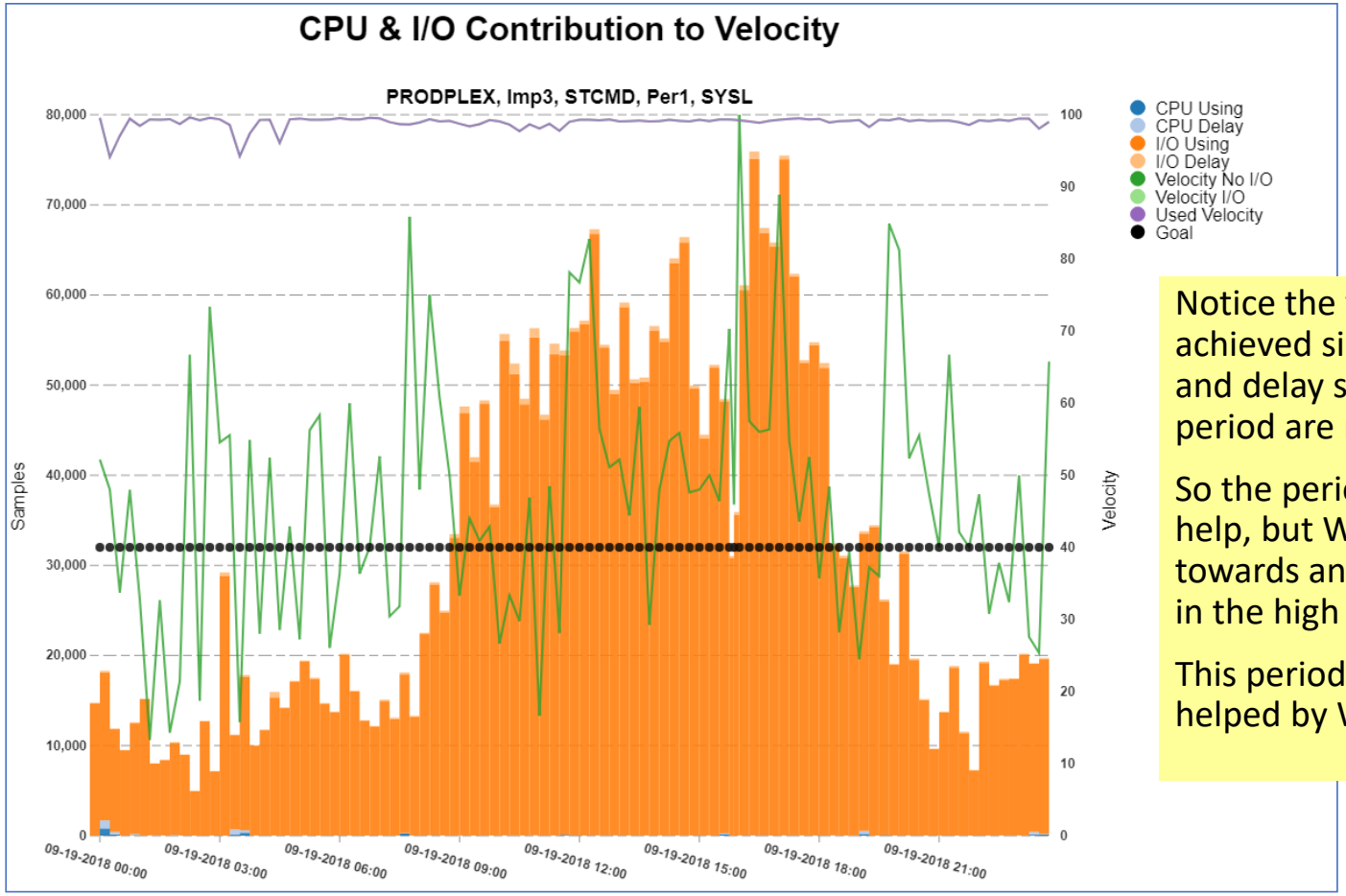
$$\left(\frac{\text{CPU Using}}{\text{CPU Using} + \text{CPU Delay} + \text{Storage Delays}}\right) \text{ versus } \left(\frac{\text{CPU Using} + \text{I/O Using}}{\text{CPU Using} + \text{CPU Delay} + \text{I/O Using} + \text{I/O Delay} + \text{Storage Delays}}\right)$$

I/O Priority Management YES



See YouTube video: https://www.youtube.com/watch?v=1cyiHH8mmZM

- Go to YouTube and search ‘z/OS Peter Enrico I/O’



Notice the very high velocity achieved since this using and delay samples of this period are mostly I/O.

So the period needs CPU help, but WLM manages towards an achieve velocity in the high 90s.

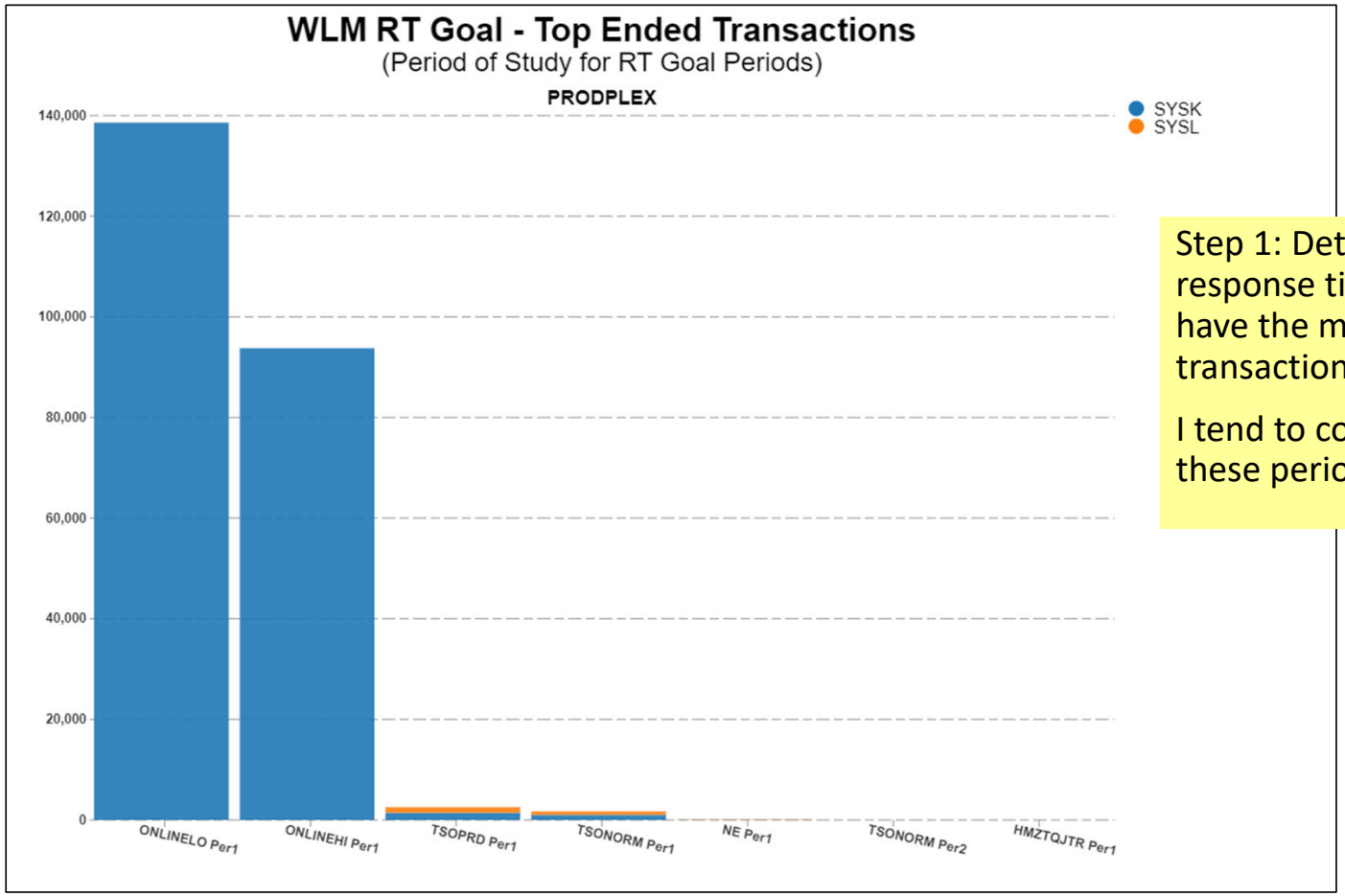
This period will not be helped by WLM

Exercise:
Tune Response Time Goals

Set response time goals (especially for higher importance periods) so that the PI is regularly between 0.95 and 1.10 during periods of time that matter.

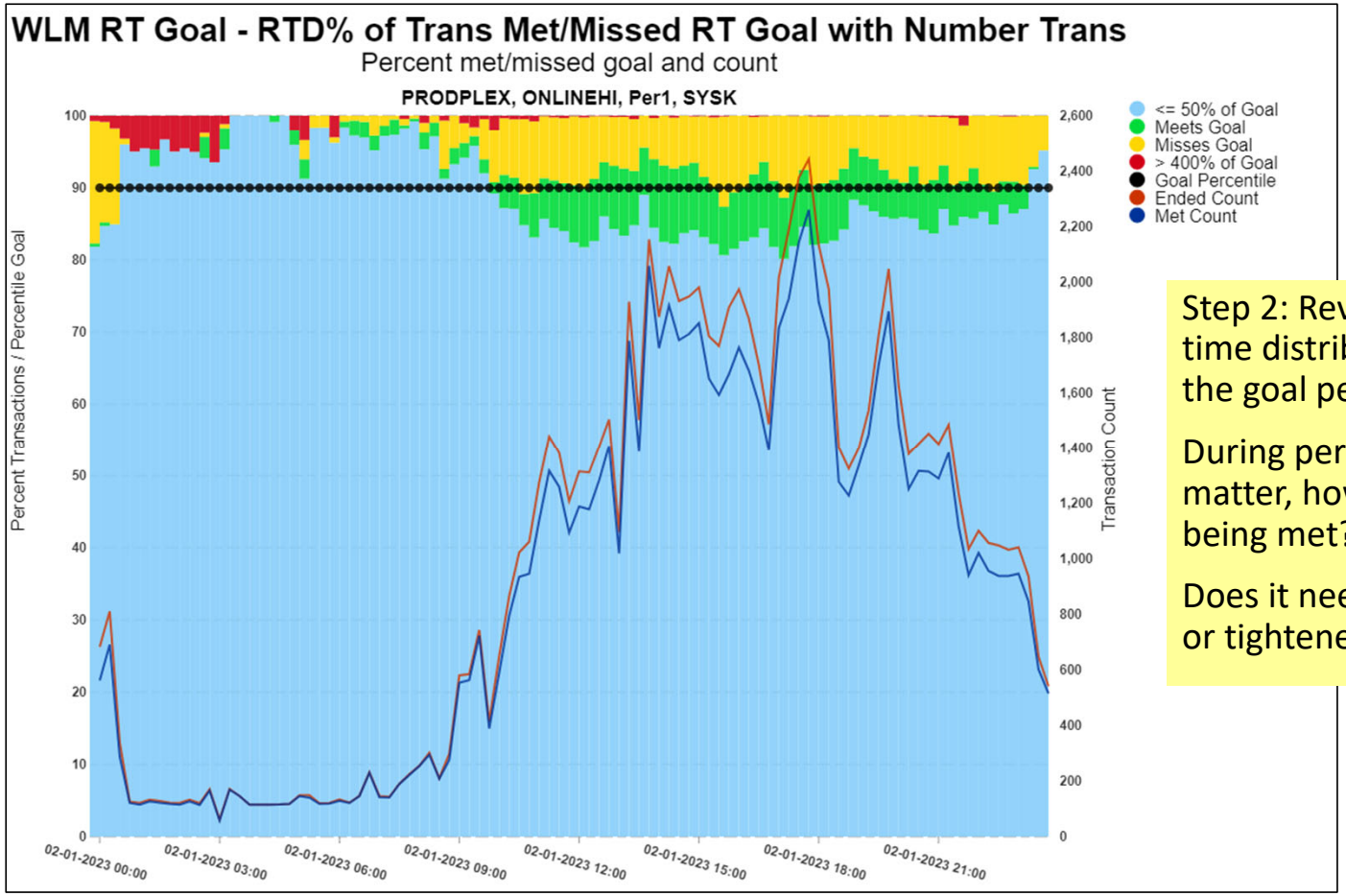
Tune Response Time Goals

- During this exercise, tune your response time goals
  - Typical, tighten higher response time goals to ensure predictable WLM management
    - Do not make goals too tight
    - Try to get the performance index to hover between 1.0 and 1.10 during periods of time that matter
    - Pay most attention to importance 1 and 2 work
- To conduct this exercise:
  - Understand the regular pattern of the response time distribution for the goal period
    - What can be learned from this pattern?
  - Analyze average response times achieved to help set the percentile response time goal
- Some considerations:
  - Concentrate on periods with the most ended transactions
  - Assuming the goal percentile is either 90% or 95%, concentrate on tuning the response time objective and not the percentile



Step 1: Determine which response time goal periods have the most ended transactions

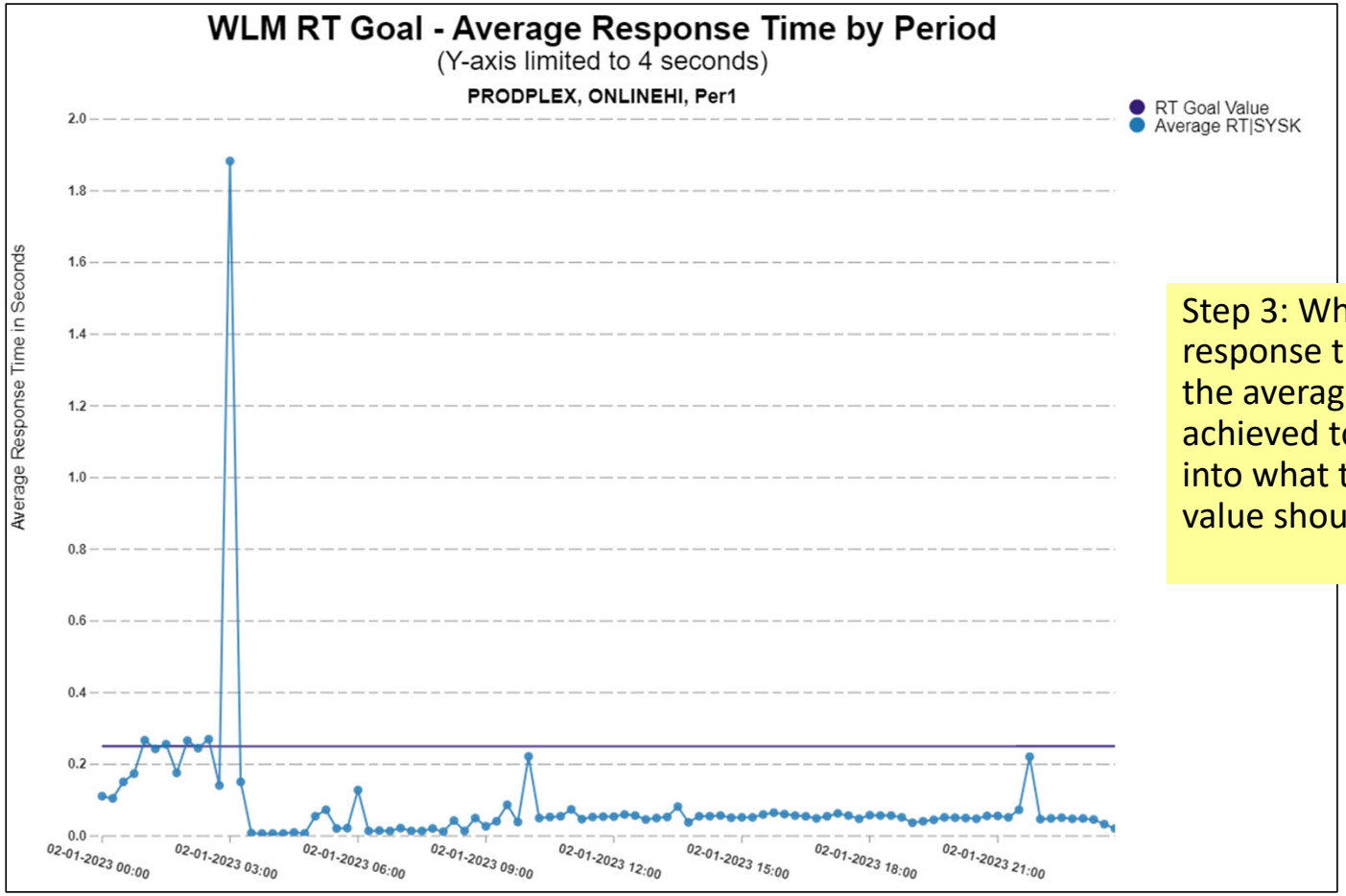
I tend to concentrate on these periods first.



Step 2: Review the response time distribution relative to the goal percentile

During periods of time that matter, how well is the goal being met?

Does it need to be loosened or tightened?



Step 3: When adjusting the response time objective, use the average response time achieved to gain insights into what the new goal value should be.

Exercise:
Tune Velocity Time Goals

Set velocity goals (especially for higher importance periods) so that the PI is regularly between 0.95 and 1.10 during periods of time that matter.

Tune Velocity Time Goals

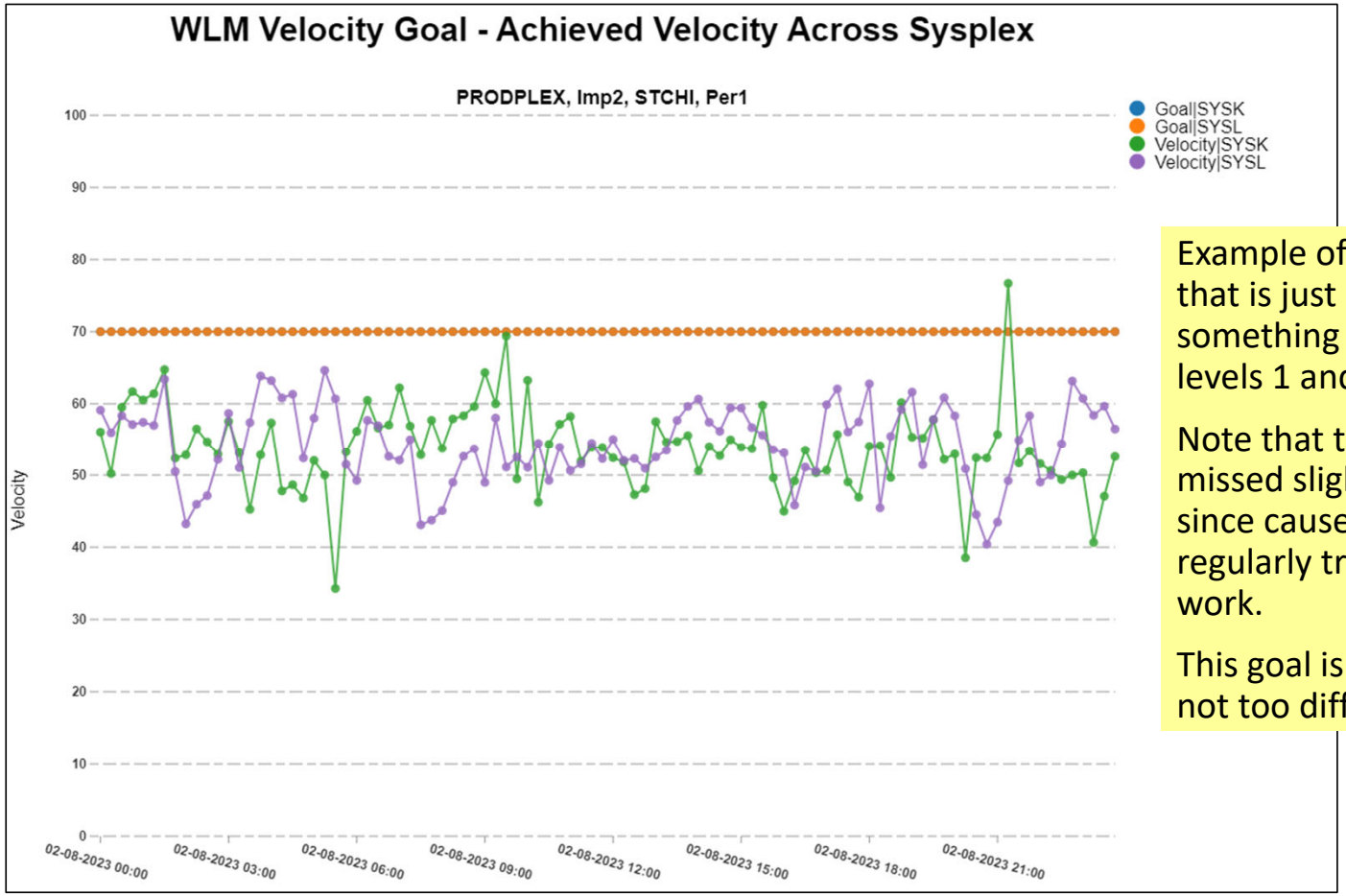
- During this exercise, tune your velocity goals
  - Typical, tighten velocity goals to ensure predictable WLM management
    - Do not make goals too tight
    - Try to get the performance index to hover between 1.0 and 1.10 during periods of time that matter
    - Pay most attention to importance 1 and 2 work

- To conduct this exercise:
  - Understand the regular pattern of achieved velocity
    - What can be learned from this pattern?
  - Also analyze using and delay samples to better understand achieve velocities

- Some considerations:
  - Concentrate on periods with the using and delay samples
  - Velocity goal periods with little work, or few using and delay samples will be erratic

Question when tuning velocity goals

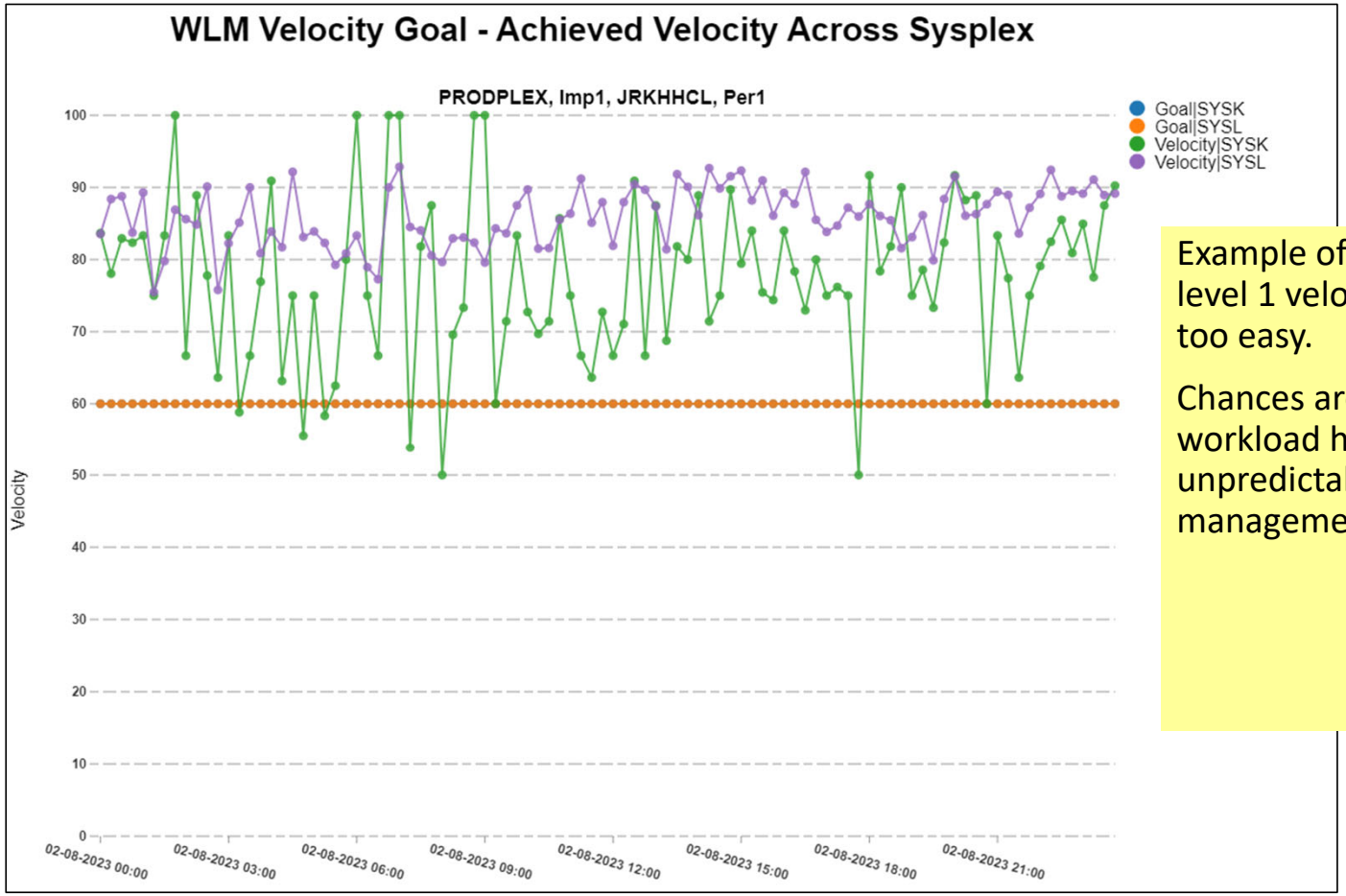
- What are the velocities regularly being achieve?
  - Are the achieved velocities for a period regular or erratic?
  - Are the achieved velocities for a period regularly very high or very low?
  - Does there appear to be a correlation between achieved velocities and the processor utilization for the LPAR and machine?
- Are there any assigned velocity goals greater than 90? If so, can these goals really be explained and justified?
  - Check the I/O using and delay samples contributing to velocity
  - Consider turning off I/O priority management option
- How much work is regularly running in the velocity goal period?
  - Relative to the number of active address spaces or enclaves in the period.
  - Relative to the amount of resource consumption of the work in the period.



Example of a velocity goal that is just about right for something at importance levels 1 and 2.

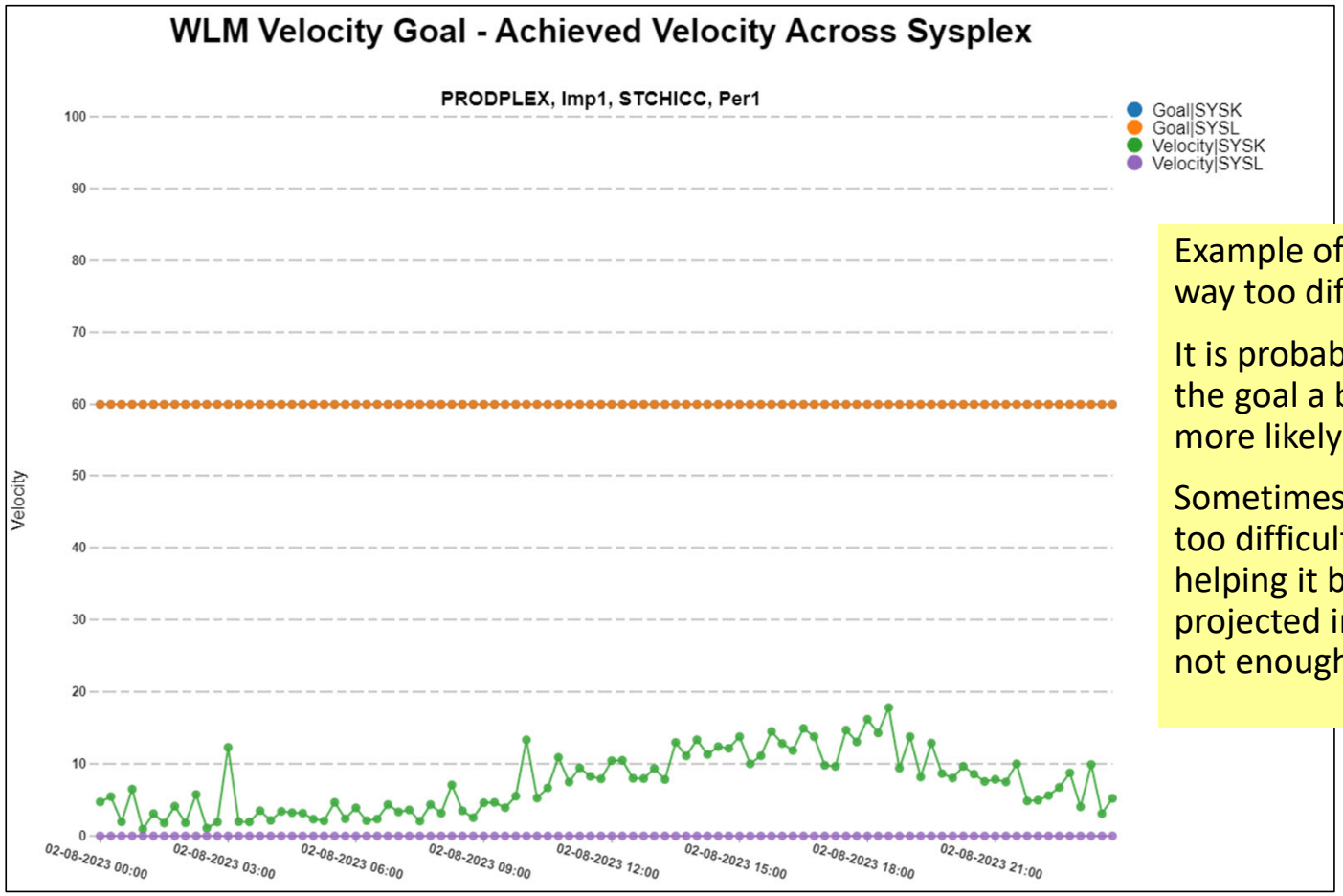
Note that the goal is being missed slightly. This is good since causes WLM to regularly try to help the work.

This goal is not too easy, and not too difficult.



Example of an importance level 1 velocity goal that is too easy.

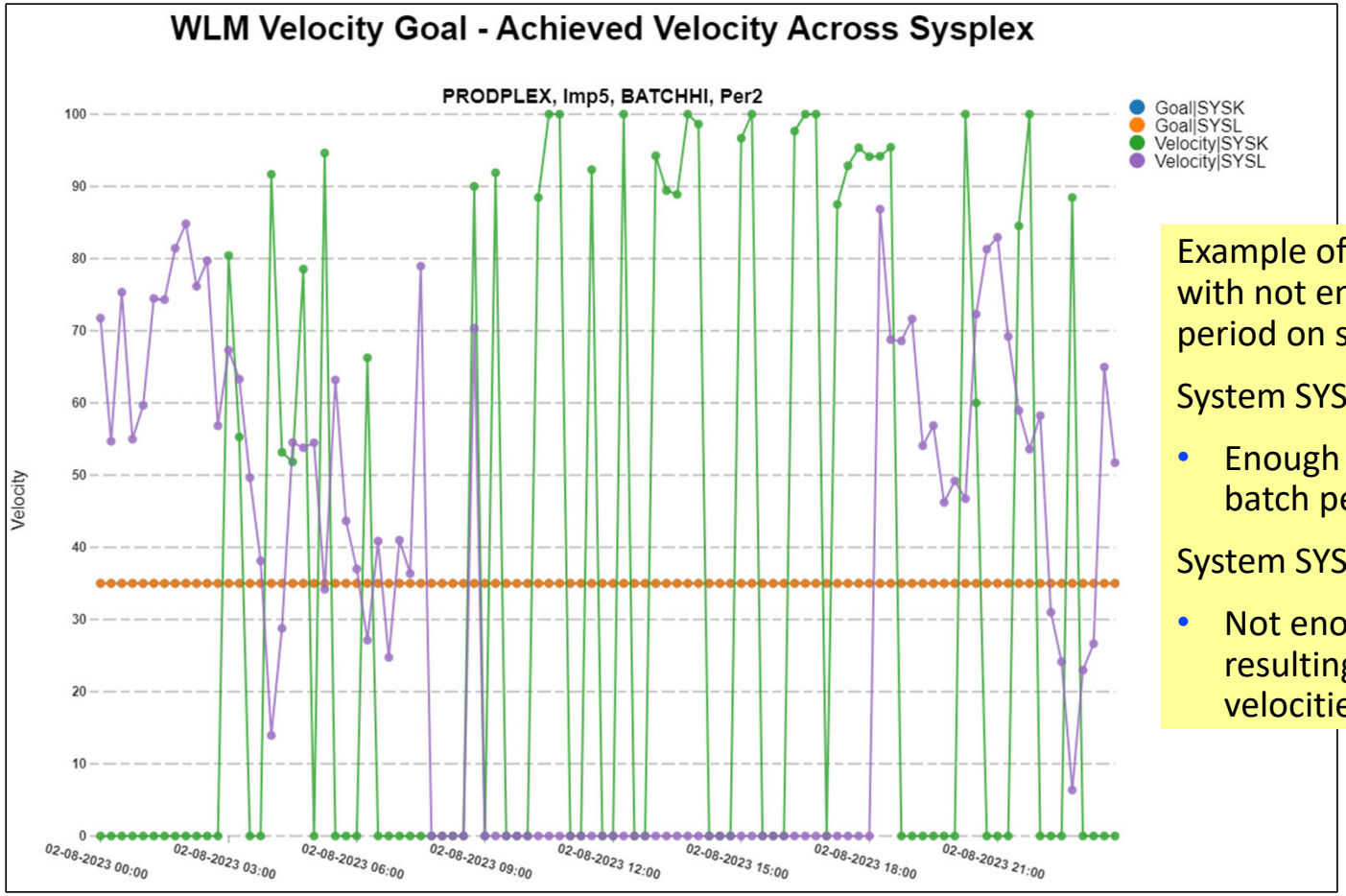
Chances are that this workload has erratic and unpredictable WLM management.



Example of a velocity goal way too difficult.

It is probably better to relax the goal a bit so that WLM is more likely to help the work.

Sometimes when goals are too difficult, WLM rejects helping it because any projected improvement is not enough.



Example of a velocity goal with not enough work in the period on system SYSK.

System SYSL:

- Enough workload during batch periods of time

System SYSK:

- Not enough work resulting is very erratic velocities.

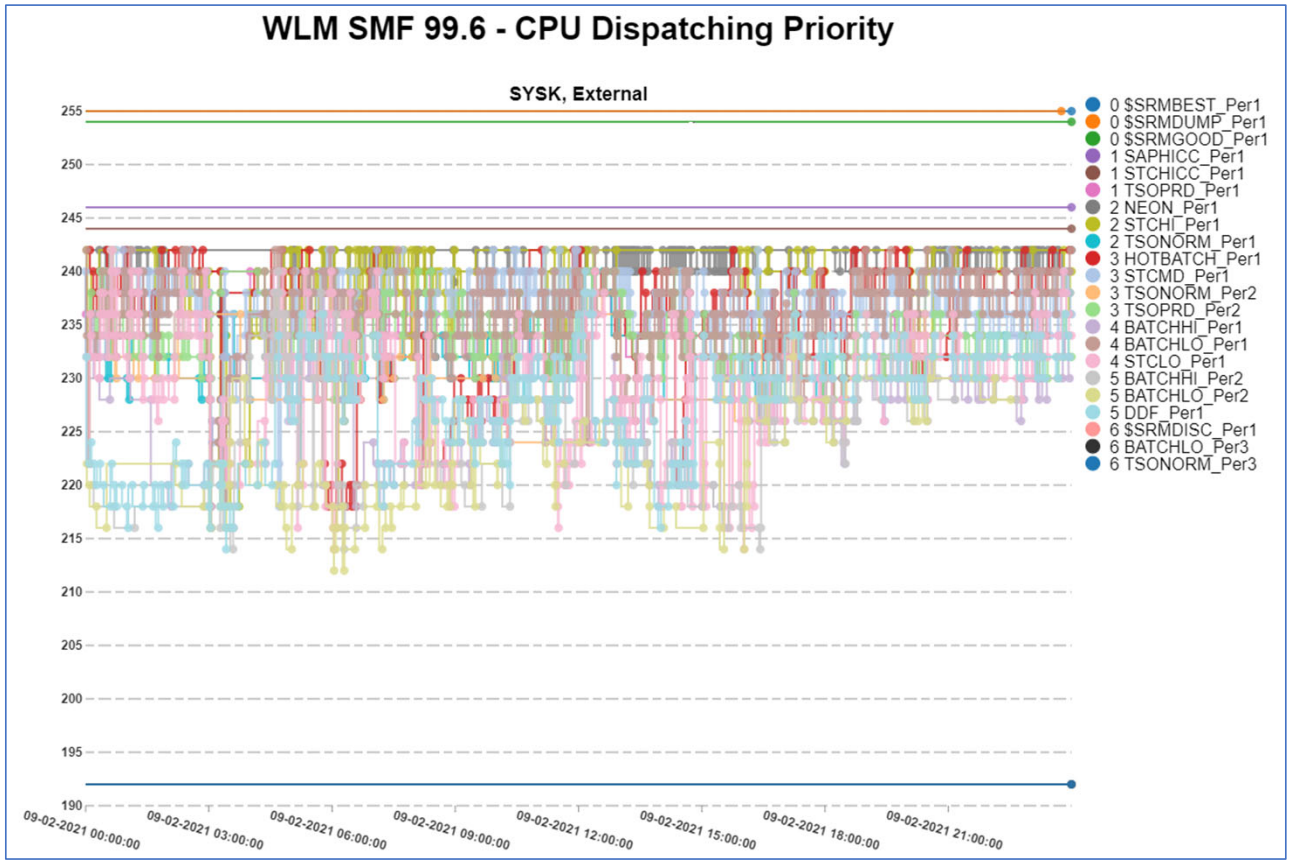
Exercise:
Review CPU Dispatching Priorities

This will give you insights into the management of the work by WLM.

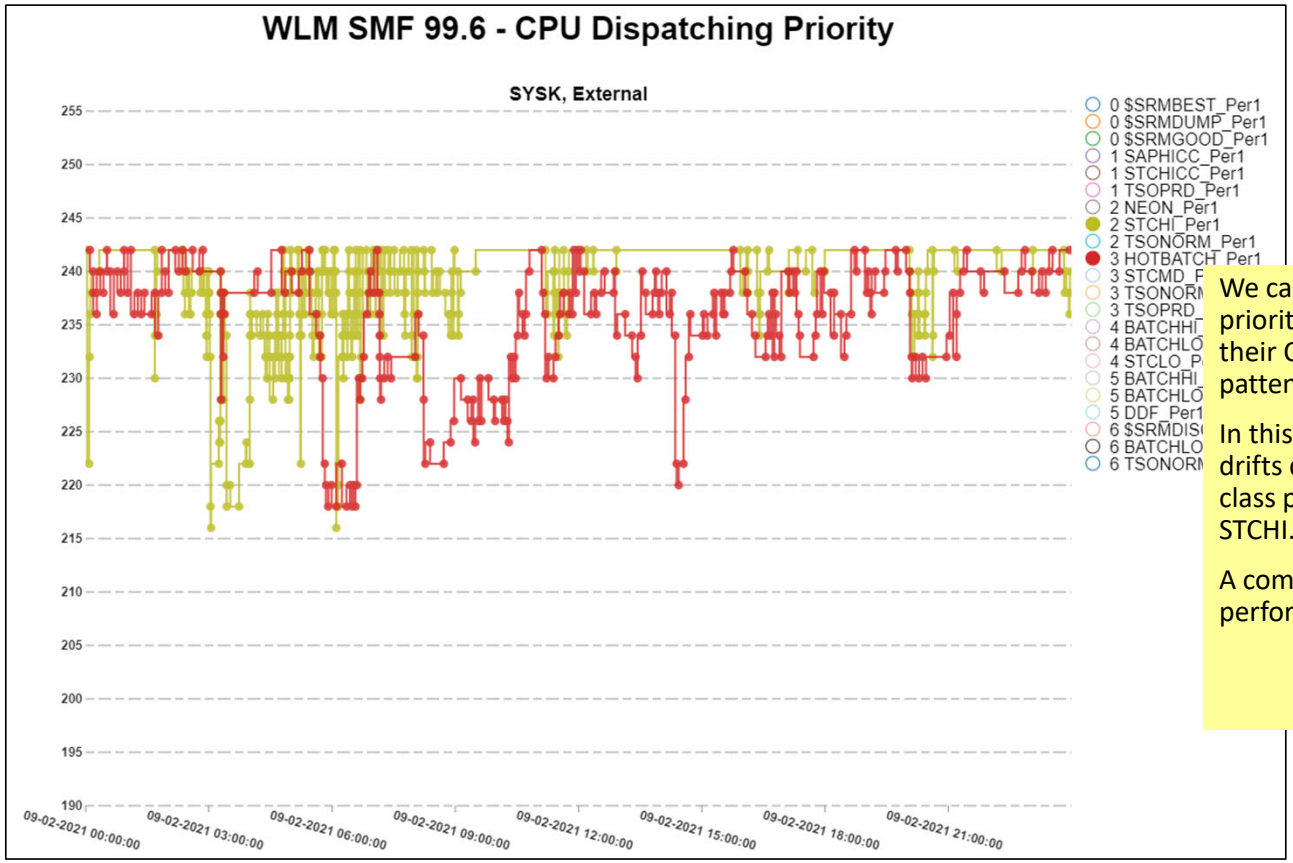
Review CPU Dispatching Priorities

- During this exercise, review the relative CPU dispatching priority order
  - Over time, what is the assigned dispatching priorities of each service class period?
  - How do the priorities change over time?
  - Relative to the goal value and importance level, is the assign priority as desired?
  - Are there sudden drops in CPU dispatching priority followed by quick increases
    - Could indicate a goal that is too easy and the work very sensitive to CPU access
- Adjust goals and importance levels accordingly

SMF 99.6 CPU Dispatching Priority – Every 10 Seconds



SMF 99.6 CPU Dispatching Priority – Every 10 Seconds



We can look at the dispatching priority of various workloads to see their CPU dispatching priority pattens.

In this example, we see extreme drifts download in CPU DP for service class periods for HOTBATCH and STCHI.

A common objective of z/OS performance tuning is predictability.

Q & A

Questions about content of webinar?

Of maybe general performance questions?