How to Stop Stalling

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Contents

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Agenda

- What is a Pipeline?
- Multistream Pipelines
- Keeping Records in Order
- Writing Your Own Stages in REXX
- How Stalls Happen
- How to Prevent Stalls
- CMS Pipelines HELP

What is a Pipeline?

Pipelines

- Definition
  - A Pipeline is a series of programs called stages through which data flows
  - The output of one stage automatically becomes the input to the next
  - It is a method of executing a Data Flow diagram

What is a Pipeline?

Pipelines

What is a Pipeline?..... Pipeline

- **Pipe Command:**

```
Pipe   < INPUT FILE A| drop 4| locate 5.1 /4/
|   sort 34-36 | specs 1.3 1 5.1 nw 22.16 nw
|   > OUTPUT FILE A
```

- **Pipe Command in REXX EXEC:**

```
/* TEST1 EXEC                                    */
'Pipe ( endchar ?)',
  '      < INPUT FILE A',        /*Read           */
  '|     drop 4',                 /* Select        */
  '|     locate 5.1 /4/',
  '|     sort 34-36',            /*Sort,Pick      */
  '|     specs 1.3 1 5.1 NextWord 22.16 nw',
  '|     > OUTPUT FILE A'        /*Write          */
```

What is a Pipeline?.. Pipeline

- **Input File:**

```
Nbr S Last      Ans          Next          Nx  Dpt
    E Act       Code         Action        Ac  Nxt
    V Done                   To Do         ID  Act
----+-------1----+--------2--------+-------3-----+--
001 3 RECEIVED               ANSWER        KL  A32
002 3 RECEIVED               ANSWER        BR  A32
003 3 RECEIVED               ANSWER        BI  A00
004 5 ANSWERED   COLD        INT1          VM  B29
005 3 ANSWERED   DUP         CLOSE         CO  B26
006 3 OPENED                 RECEIVE       BI  A00
007 4 REROUTED               RECEIVE       PE  B18
008 3 OPENED                 RECEIVE       BI  A00
009 4 RECEIVED               ANSWER        BE  B18
010 3 ANSWERED   COLD        SSV           DE  A31
011 4 CLOSED     CNEW        NONE
012 4 CLOSED     CNEW        NONE
013 3 OPENED                 RECEIVE       CP  A64
014 4 RECEIVED               ANSWER        NE  B18
```

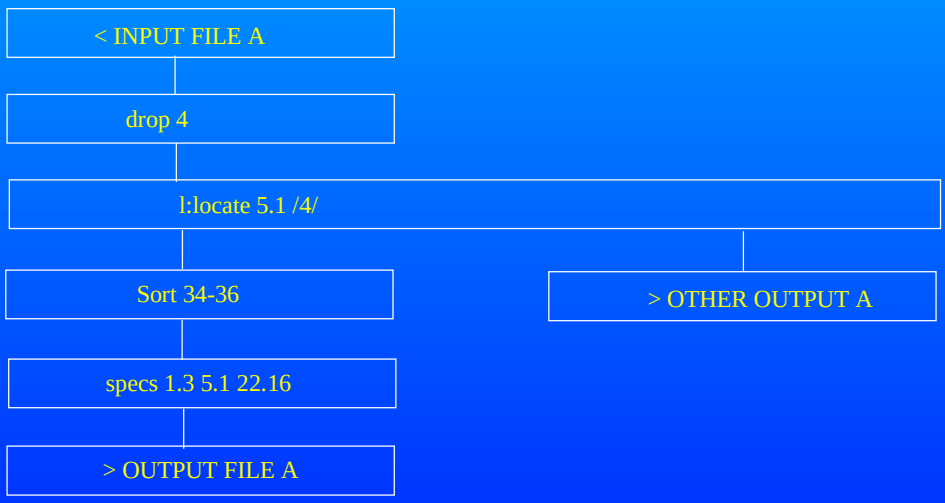
What is a Pipeline?..

- **Output:**

```
011 4 NONE
012 4 NONE
007 4 RECEIVE  PE B18
009 4 ANSWER   BE B18
014 4 ANSWER   NE B18
```

What is a Multistream Pipeline?

- **A Multistream Pipeline Set that contains multistream stages.**



- **This 2D picture needs to be represented in a 1D format**

What is a Multistream Pipeline?.... Pipelines

```
/* TEST1 EXEC                    */
'Pipe ( endchar ?)',
  '    < INPUT FILE A',          /*Read                 */
  '|  drop 4',                   /* Select              */
  '|l:locate 5.1 /4/',
  '|  sort 34-36',               /*Sort,Pick            */
  '|  specs 1.3 1 5.1 NextWord 22.16 nw',
  '|  > OUTPUT FILE A',         /*Write                */
  '?l:',
  '|  > OTHER OUTPUT A'  /*Write                */
Exit
```

- Definitions
  - Pipeline Set
  - Pipeline
  - Stage
  - Stage Separator
  - End Character
  - Device Drive
  - Filter
  - Stream
  - Label

What is a Multistream Pipeline?... Pipelines

- Multistream Stages
  - Selection Stages
  - Fanout - Copy the input record to all output streams
  - Fanin - Combines multiple input streams into one output stream in specified
  - Faninany - Combines multiple input streams into one output stream in arrival order
  - Lookup, Merge, and Collate - Combines streams
  - Overlay - Overlays streams
  - Predselect - For destructive tests
  - Synchronize - Balance two streams
  - Gate - Stop selected streams
  - Hole - One EOF from multiple streams

What is a Multistream Pipeline?... Pipelines

What is Multistream Pipeline?... Pipelines

- **RPTDG EXEC**

```
/* RPTHDG EXEC    4/24/92                */
'Pipe ( endchar ?)',
  '   < INPUT FILE A',      /* Read      */
  '|f:fanout',
  '|  drop 4',             /* Select    */
  '|  locate 5.1 /4/',
  '|  sort 34-36',         /* Sort,Pick */
  '|i:faninany',
  '|  spec 1.3 1 5.1 NextWord 22.16 nw',
  '|  > OUTPUT FILE A ',   /* Write     */
  '?f:',
  '|  take 4',             /* Keep Hdg  */
  '|i:'
```

- **Output data for RPTHDG EXEC - OUTPUT FILE A**

```
Nbr S Next     Nx Dpt
   E Action    Ac Nxt
   V To Do     ID Act
--- + ---+----3----+-
011 4 NONE
012 4 NONE
007 4 RECEIVE  PE B18
009 4 ANSWER   BE B18
014 4 ANSWER   NE B18
```

Keeping Records in Order Pipelines

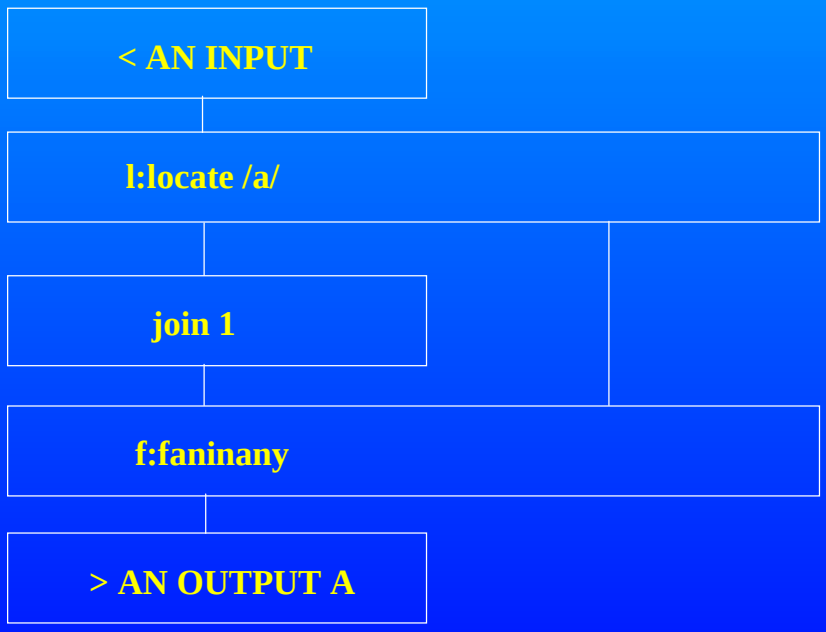
- This documentation allows the relative order of records in a set of multistream pipelines to be kept in order
- Documentation
  - The VM/ESA CMS Pipeline User's Guide documents the concepts needed to write pipelines that keep records in order
  - the first usage note for each stage indicates whether the stage delays the records or not (CMS Pipelines Reference Manual)
- Types of Stages
  - Stages that KEEP records in order
    - Don't delay the record
    - Examples - XLATE, LOCATE, and CMS
  - Stages that DO NOT KEEP records in order
    - Do delay the records
    - Examples - BUFFER and SORT
  - Stages that CAN DO EITHER
    - Depends on options
    - Examples - JOIN 1, SPECS..READ, TAKE LAST
  - Stages where this does not apply
    - Stages that have to be the first stage in a pipeline
    - Example - <.

Keeping Records in Order... Pipelines

- Concept - Any stage will execute until held up by a dispatcher call. For example a stage may be held up:
  - Waiting for a record to be available to it
  - Waiting for a record to be consumed from its OUTPUT subcommand
- Theory - To maintain the relative order of records in a set of multistream pipelines, the pipelines must:
  - Start at one common stage
  - Be split into multiple pipelines using only stages that do not delay the record
  - Contain only stages that do not delay the records
  - Be combined into a single stream using a stage that combines multiple streams as records arrive (for example, FANINANY)

Keeping Records in Order... Pipelines

- Example of How Records Get Out of Order



Keeping Records in Order... Pipelines

```
Pipe ( endchar ?)
   |  < AN INPUT
   |l:locate /a/
   |  join 1
   |f:faninany
   |  > AN OUTPUT A
   ?l:
   |f:

 AN INPUT
   a1
   b2
   a3
   b4
 AN OUTPUT
   b2
   a1a3
   b4
```

- Notice the JOIN 1 stage cause the problem because:"JOIN delays records. The last input record in each set of concatenated records is not delayed." (this is from usage note 1).
- If JOIN is replaced with XLATE the records will be kept in order since "XLATE does not delay the record."

Stages Written in REXX — Pipelines

- Obtaining Arguments
  - Arg ....(normal REXX)
- Pipes within Pipes
  - Callpipe - Subroutine pipelines
  - Addpipe - Parallel pipelines
- Reading Pipeline Records
  - Readto - Consumes the record
  - Peekto - Doesn't consume the record
  - *.input.0: - Consumes the record
- Writing Pipeline Records
  - Output - Write to pipeline
  - *.output.0: - Write to pipeline

Stages Written in REXX — Pipelines

- Stream Management
  - Select - Pick a stream
  - Sever - Get rid of a stream
  - Short - Attach two streams
  - MaxStream - How many streams?
  - StageNum- Where is my stage?
  - StreamState - What is my stream doing?
  - StreamNum - What stream am I using now?
- Other
  - Message - Issue a message
  - Rexx - invokes a REXX program
  - SetRC - sets return RC

Stages Written in REXX Pipelines

- **Msgevery REXX**

```
 /* To demonstrate MSGEVERY REXX filter */
'Pipe',
  '   < INPUT FILE A',
  ' | msgevery 3 This is an Example',
  ' | > OUTPUT FILE A'
Exit
```

MSGEVERY Console Log

```
THIS IS AN EXAMPLE        Record Number: 3
THIS IS AN EXAMPLE        Record Number: 6
THIS IS AN EXAMPLE        Record Number: 9
THIS IS AN EXAMPLE        Record Number: 12
THIS IS AN EXAMPLE        Record Number: 15
THIS IS AN EXAMPLE        Record Number: 18
THIS IS AN EXAMPLE        Record Number: 20
```

Stages Written in REXX Pipelines

- **Msgevery REXX**

```
 /*  To do a SAY for every x lines      */

arg count message
signal on error
'PEEKTO in_data'
do rcd_nbr  = 1 while rc = 0
   'OUTPUT' in_data
   if rcd_nbr // count = 0
    then say message 'Record Number:' rcd_nbr
   'READTO'
   'PEEKTO in_data'
   end /* do while rc = 0 */

error:
   say message 'Record Number:' rcd_nbr
   Exit RC*(RC<>12)
```

How Stalls Happen — Pipelines

- The FANIN way


```
Pipe ( endchar ?)
   |    < AN INPUT
   |  f:fanout
   |  i:fanin
   |    > AN OUTPUT A
   ? f:
   |  i:
```

How Stalls Happen — Pipelines

- Stall Messages

```
DMSDSO2674E     Pipelines stalled
DMSPMG2653I     ...     Issued by stage number 2 of pipeline number 1
DMSPMG2651I     ...     Running stage:      fanout
DMSDSP2675I Stage is in state wait out
DMSPMG26531     ...     Issued by stage number 1 of pipeline number 1
DMSPMG2651I     ...     Running stage:  < profile exec
DMSDSP2675I Stage is in state wait out
DMSPMG2653I     ...     Issued by stage number 2 of pipeline number 1
DMSPMG2651I     ...     Running stage:  fanout
DMSDSP2675I Stage is in state wait loc
DMSPMG265eI     ...     Issued by stage number 3 of pipeline number 1
DMSPMG2651I     ...     Running stage:      fanin
DMSDSP2675I Stage is in state wait loc
DMSPMG2653I     ...     Issued by stage number 4 of pipeline number 1
DMSPMG2651I     ...     Running stage:      > AN OUTPUT A
    2 ** 'Pipe  (endchar  ?)|      < profile exec
||f:fanout  |      i:fanin     |      > AN OUTPUT A
?f:          |      i:'
        +++ RC(-4095) +++
```

How Stalls Happen — Pipelines

- The SPECS way


```
Pipe ( endchar ?)
   |    < AN INPUT
   |  f:fanout
   |  s:specs 1-* 1 select 1 1-*  nw
   |    > AN OUTPUT A
   ? f:
   |  s:
```

How Stalls Happen — Pipelines

- Stall Messages

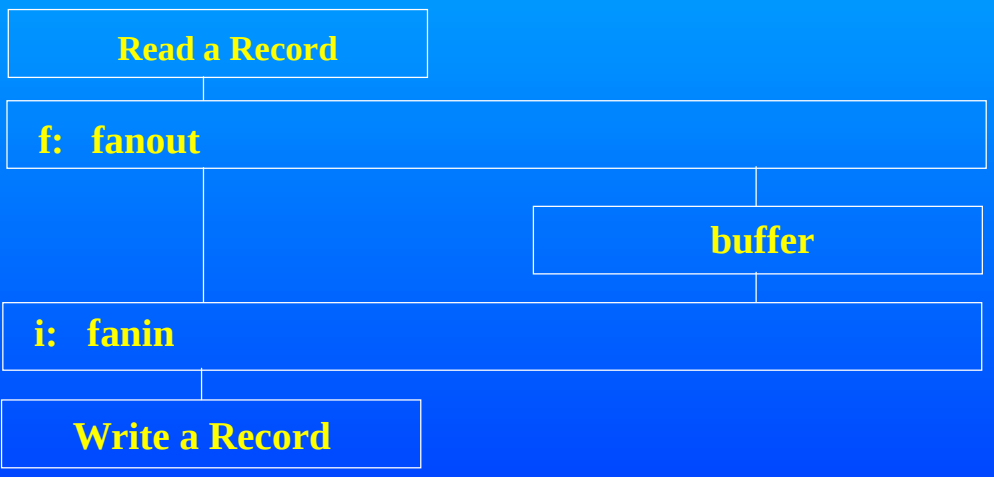
```
DMSDSO2674E      Pipelines stalled
DMSPMG2653I      ...     Issued by stage number 4 of ...
DMSPMG2651I      ...     Running stage:> AN OUTPUT A
DMSDSP2675I Stage is in state wait out
DMSPMG26531      ...     Issued by stage number 1 of ...
DMSPMG2651I      ...     Running stage:  < AN INPUT
DMSDSP2675I Stage is in state wait out
DMSPMG2653I      ...     Issued by stage number 2 ...
DMSPMG2651I      ...     Running stage:  fanout
DMSDSP2675I Stage is in state wait loc
DMSPMG265eI      ...     Issued by stage number 3 ...
DMSPMG2651I      ...     Running stage:specs 1-* 1 select 1 1-* nw
DMSDSP2675I Stage is in state wait loc
DMSPMG2653I      ...     Issued by stage number 4 of ...
DMSPMG2651I      ...     Running stage:> AN OUTPUT A
        2 ** 'Pipe  (endchar  ?)
|      < AN INPUT                          |f:fanout
|s:specs 1-* 1 select 1 1-* nw  |      > AN OUTPUT A
?f:                                       |s:'
            +++ RC(-4095) +++
```

How Stalls Happen — Pipelines

- Delay records to prevent stalls
  - ► BUFFER (with no arguments)
    - – Buffers all records until EOF received
  - ► COPY
    - – Delays one record
  - ► ELASTIC
    - – Delays as many records as required to prevent a stall

How to Prevent Stalls — Pipelines

- The FANIN solution

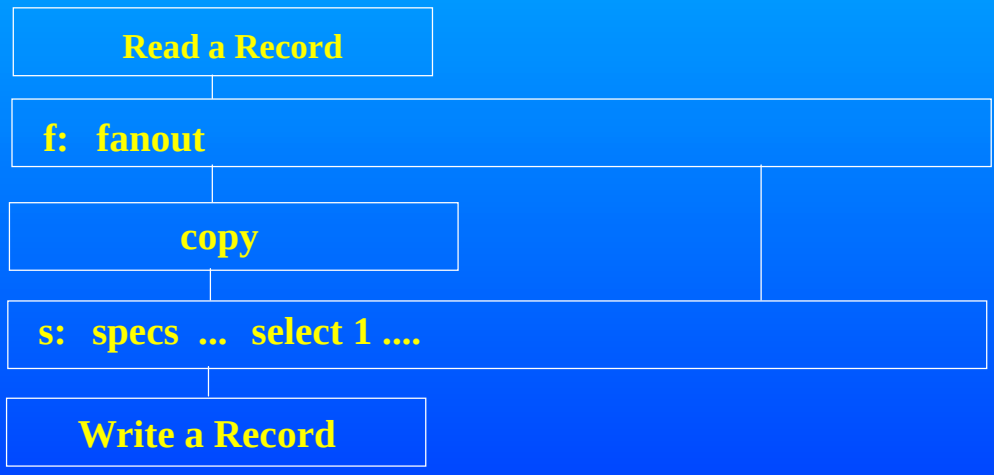



```
Pipe ( endchar ?)
   |    < AN INPUT
   |  f:fanout
   |  i:fanin
   |    > AN OUTPUT A
   ? f:
   |    buffer
   |  i:
```

- Or use ELASTIC

How to Prevent Stalls — Pipelines

- The SPECS solution




```
Pipe ( endchar ?)
   |  < AN INPUT
   |f:fanout
   |  copy
   |s:specs 1-* 1 select 1 1-* nw
   |  > AN OUTPUT A
   ? f:
   |  s:
```

- Or use ELASTIC

REXX Interface — Pipelines

- VAR
  - ► Gets/Sets a variable
- STEM
  - ► Gets/Sets a stemmed array
- REXXVARS
  - ► Gets all variables
- VARLOAD
  - ► Sets all variables

REXX Interface — Pipelines

- PRODUCER option
  - Obtains or sets REXX variables from the stage preceding it in the pipeline
  - Consider: pipe ONE | TWO | console
    - TWO can obtain or set variables in ONE
  - The following must exist:
    - Stage ONE must be blocked in output
    - stage TWO must issue the command from a CALLPIPE

For More Information — Pipelines

- CMS Pipelines User's Guide - SC24-5777
- CMS Pipelines Reference - SC24-5778
- CMS Pipelines Author's Edition - SL26-0018
- Quick Reference - SX24-5290
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