# ScaleJoin: a Deterministic, Disjoint-Parallel and Skew-Resilient Stream Join

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# Agenda

- What is a stream join?
- Which are the challenges of a parallel stream join?
- Why ScaleJoin?
- How well does ScaleJoin addresses stream joins' challenges?
- Conclusions

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# Motivation

Applications in sensor networks, cyber-physical systems:

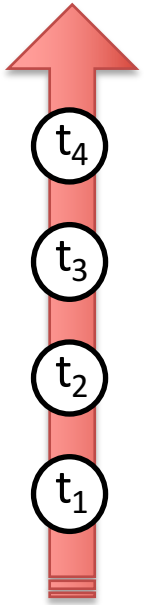
- large and fluctuating volumes of data generated continuously

demand for:

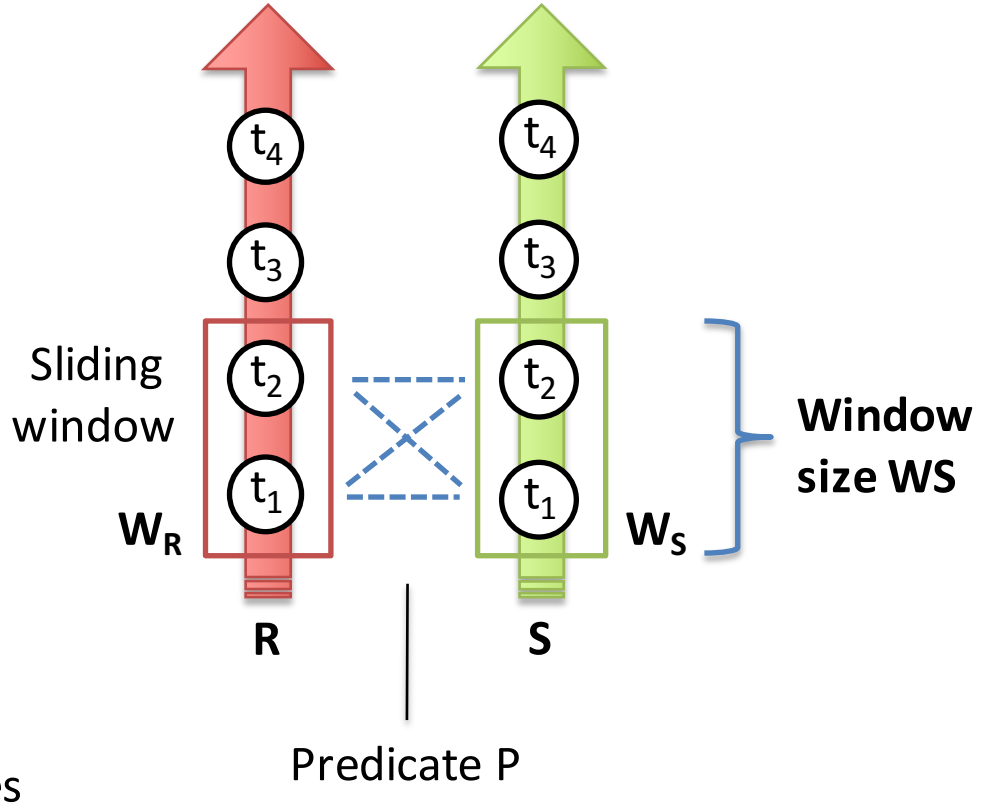
- Continuous processing of data streams
- In a real-time fashion

**Store-then-process is not feasible!!!**

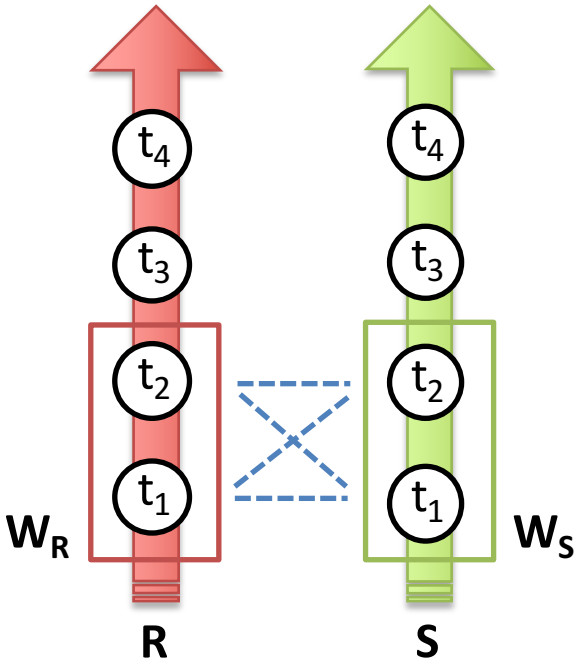
# What is a stream join?




Data stream:
unbounded sequence of tuples



# Why parallel stream joins?




- WS = 600 seconds

- R receives 500 tuples/second
- S receives 500 tuples/second

- $W_R$ will contain 300,000 tuples
- $W_S$ will contain 300,000 tuples

- Each new tuple from R gets compared with all the tuples in $W_S$
- Each new tuple from S gets compared with all the tuples in $W_R$

… **300,000,000** comparisons/second!

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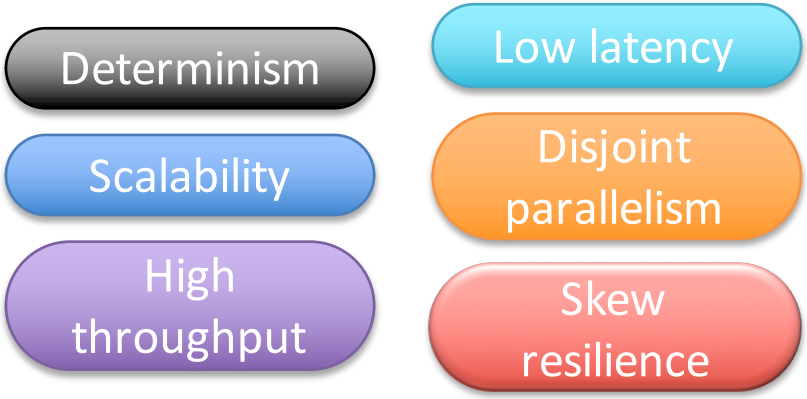
# Which are the challenges of a parallel stream join?



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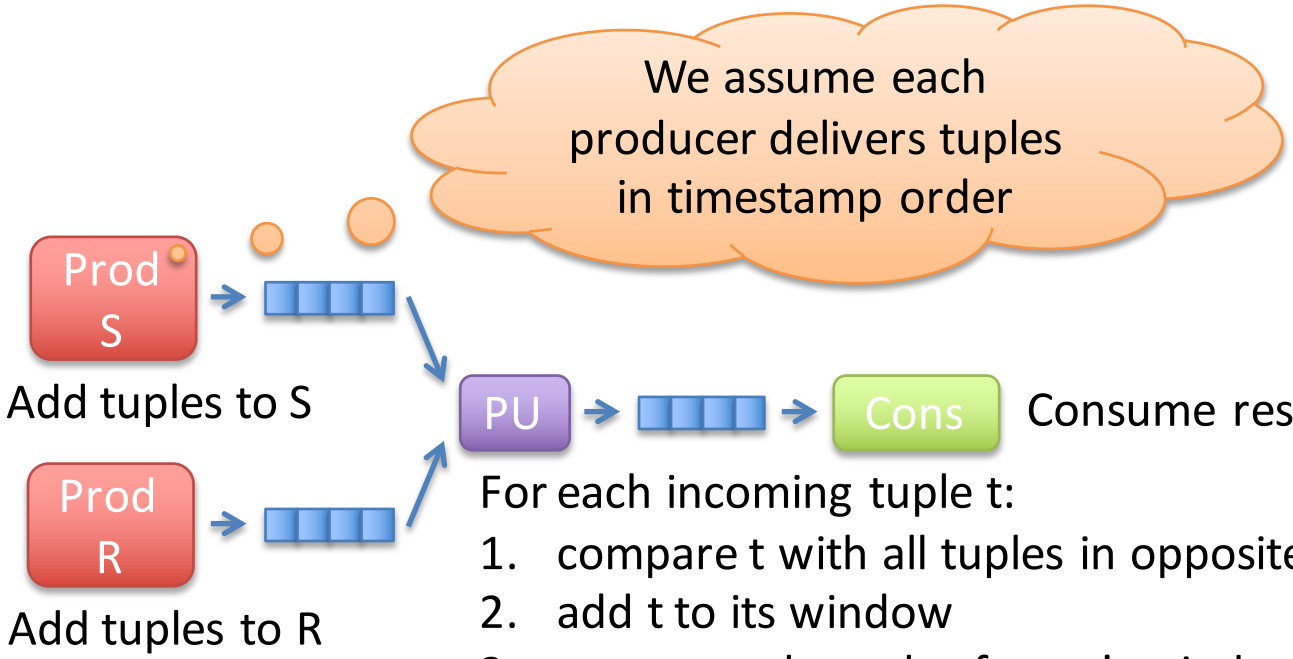
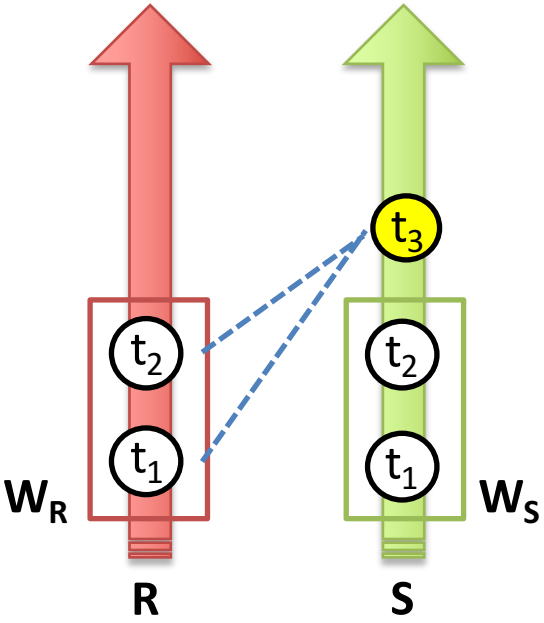
# The 3-step procedure (sequential stream join)

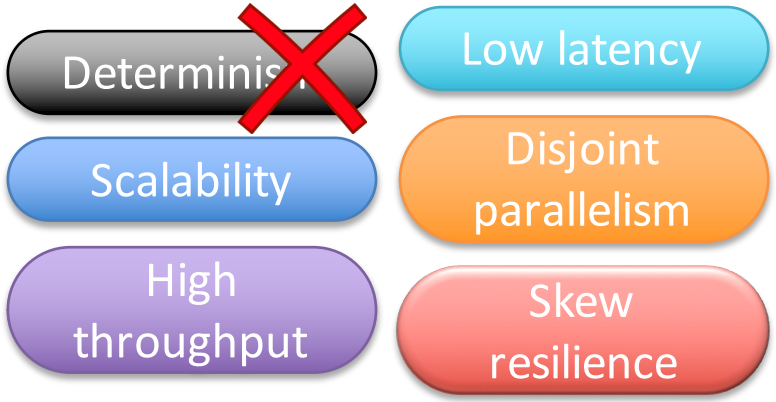


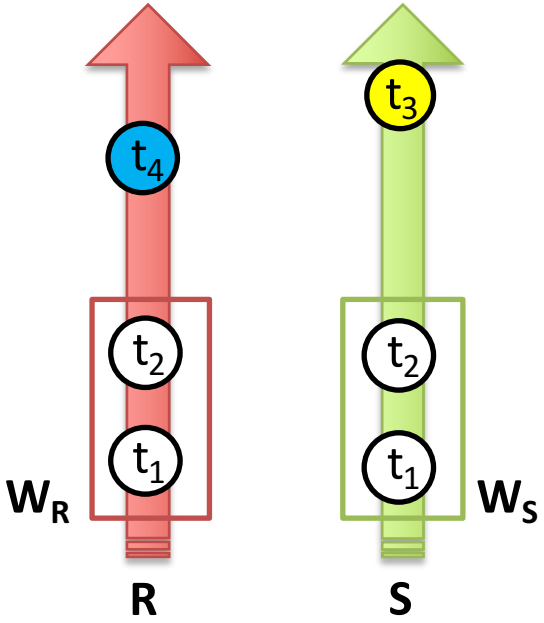

For each incoming tuple t:

1. compare t with all tuples in opposite window given predicate P
2. add t to its window
3. remove stale tuples from t's window

# The 3-step procedure, is it enough?

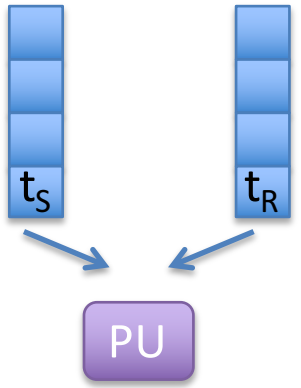


# Enforcing determinism in sequential stream joins

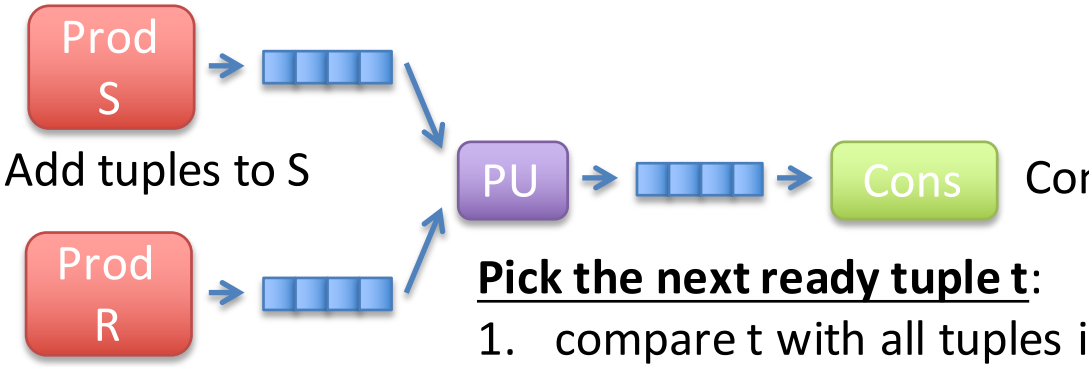
- Next tuple to process = earliest($t_S$,$t_R$)




- The earliest($t_S$,$t_R$) tuple is referred to as the next *ready* tuple

- Process *ready* tuples in timestamp order → Determinism

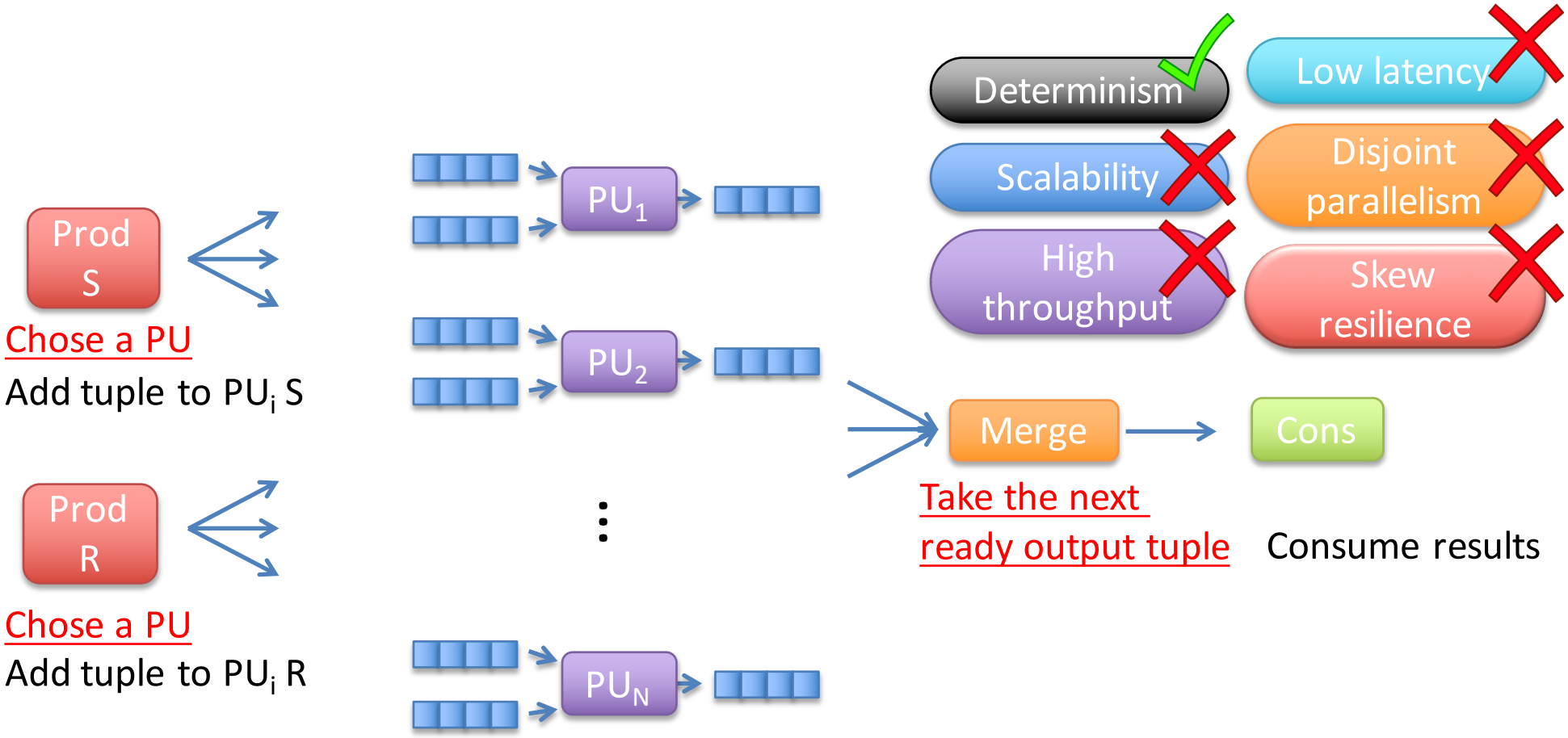
# Deterministic 3-step procedure




**Pick the next ready tuple t**:

1. compare t with all tuples in opposite window given predicate P
2. add t to its window
3. remove stale tuples from t's window

# Shared-nothing parallel stream join (state-of-the-art)

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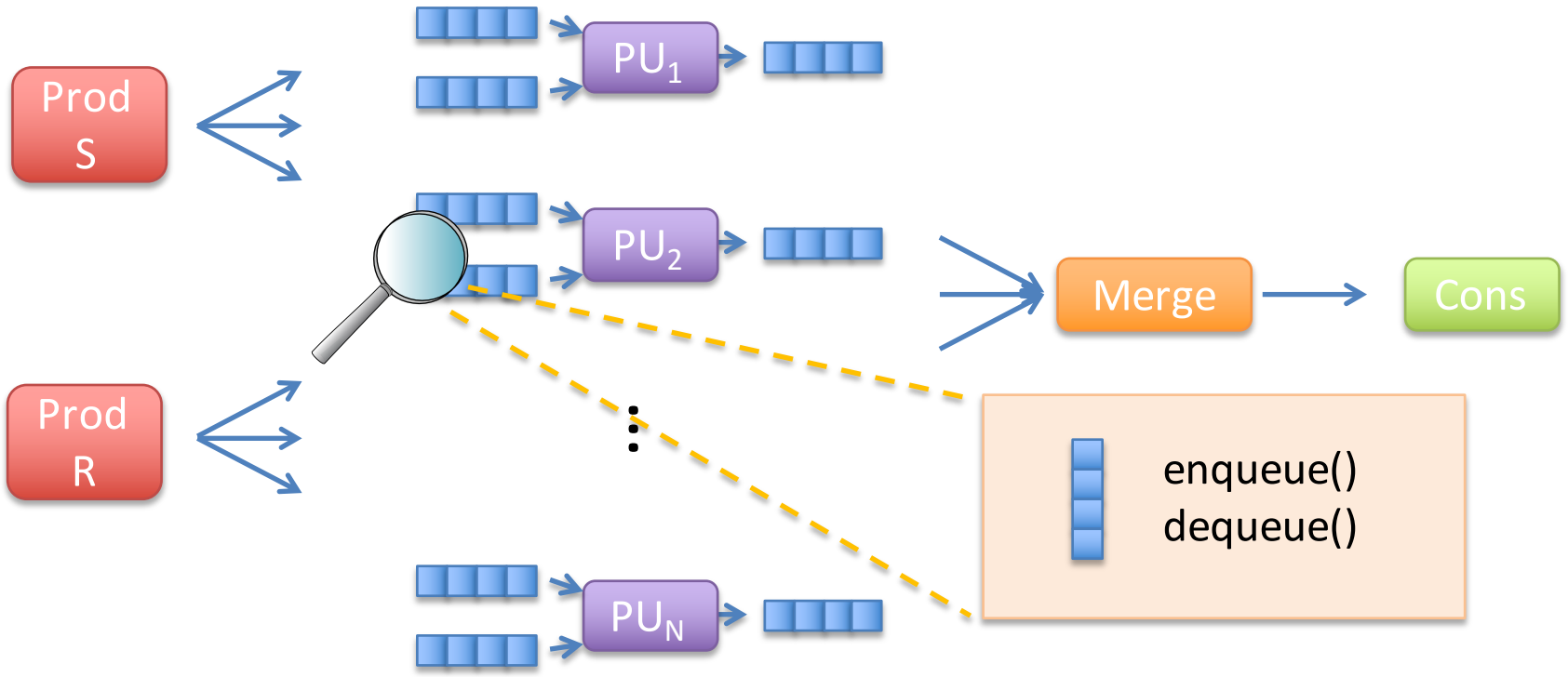
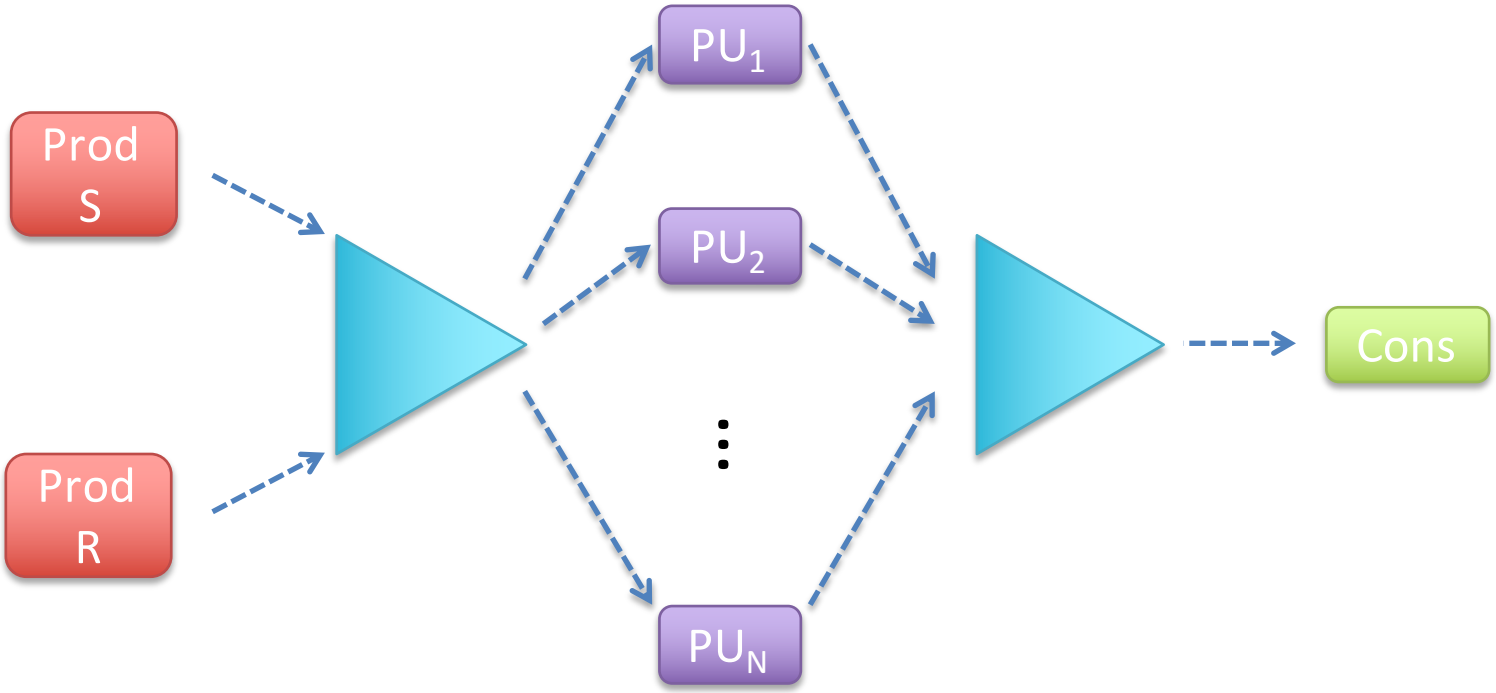
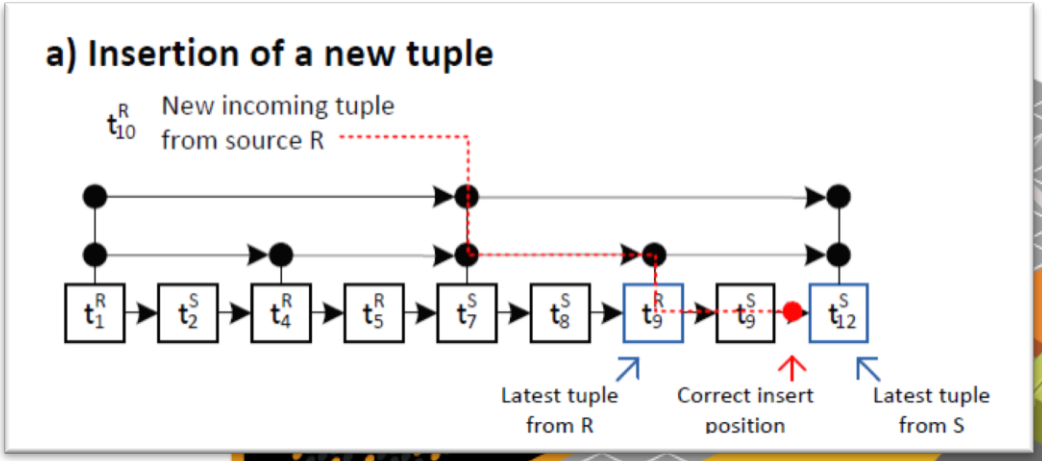


# From coarse-grained to fine-grained synchronization



# ScaleGate

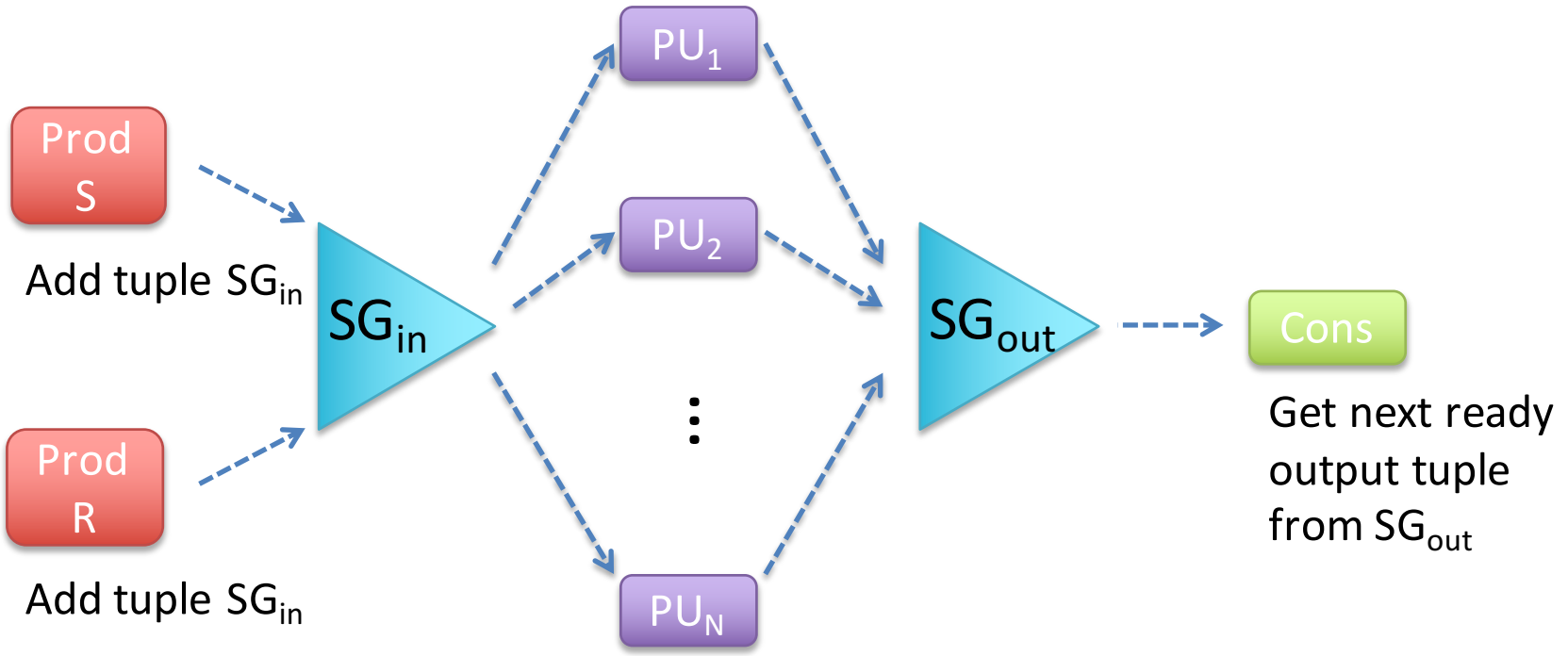



https://github.com/dcs-chalmers/ScaleGate_Java

`addTuple(tuple,sourceID)`
allows a tuple from `sourceID` to be merged by ScaleGate in the resulting timestamp-sorted stream of ready tuples.

`getNextReadyTuple(readerID)`
provides to `readerID` the next earliest ready tuple that has not been yet consumed by the former.

# ScaleJoin



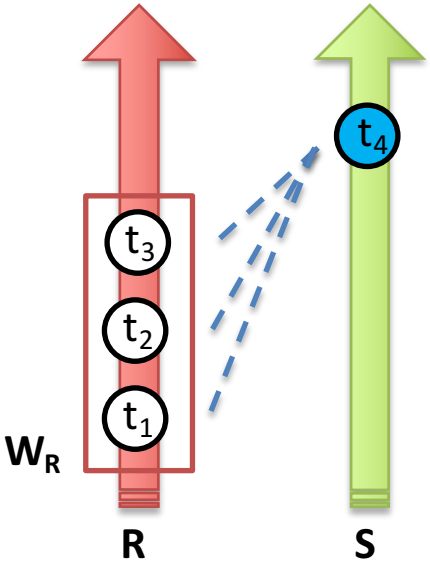

**Steps for PU**

Get next ready input tuple from $SG_{in}$

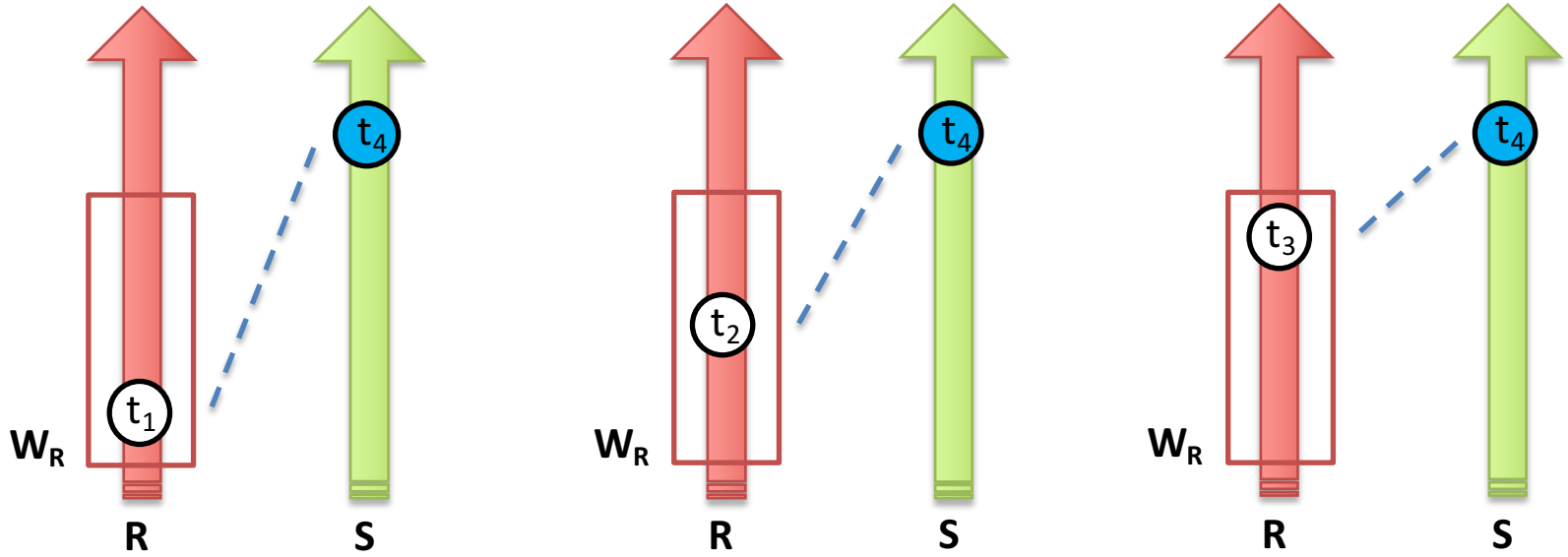
1. compare t with all tuples in opposite window given P
2. add t to its window **in a round-robin fashion**
3. remove stale tuples from t's window

# ScaleJoin (example)

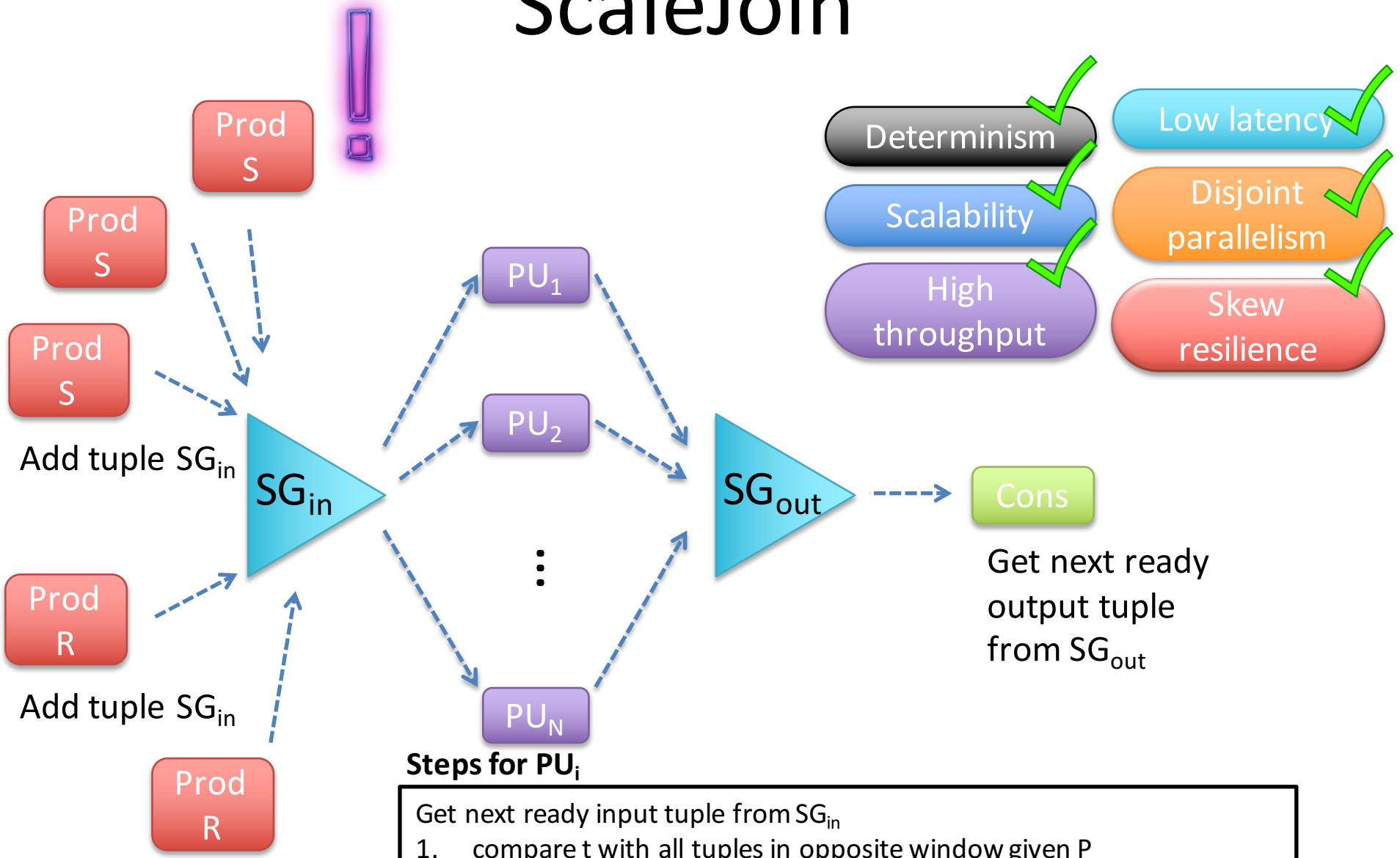
**Sequential stream join:**




**ScaleJoin with 3 PUs:**



# ScaleJoin




**Steps for $PU_i$**

Get next ready input tuple from $SG_{in}$

1. compare t with all tuples in opposite window given P
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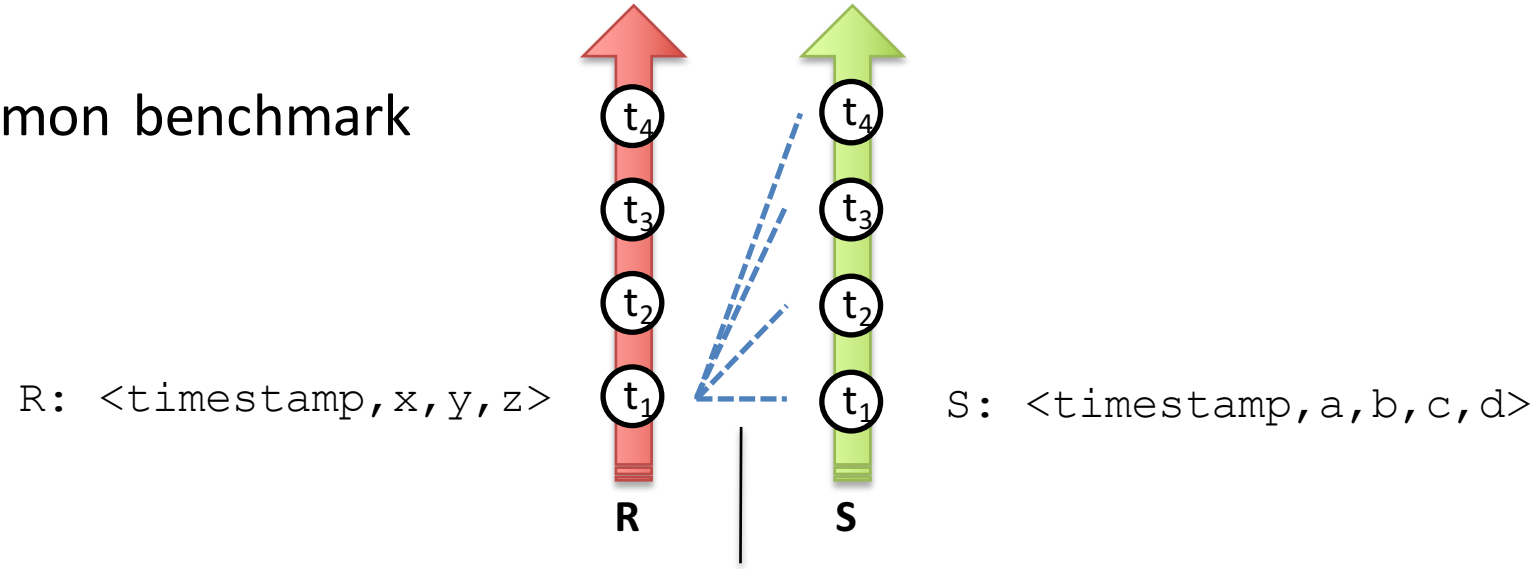
# Evaluation setup

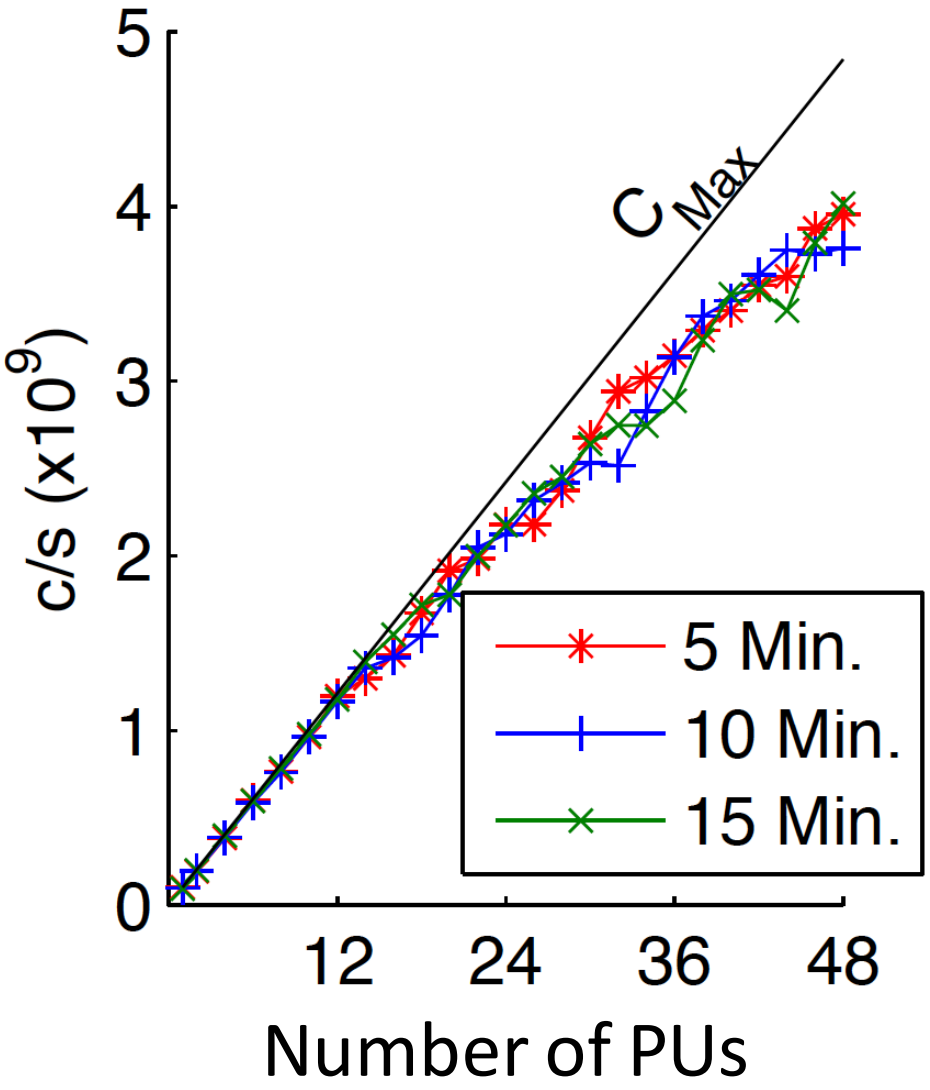
- Common benchmark



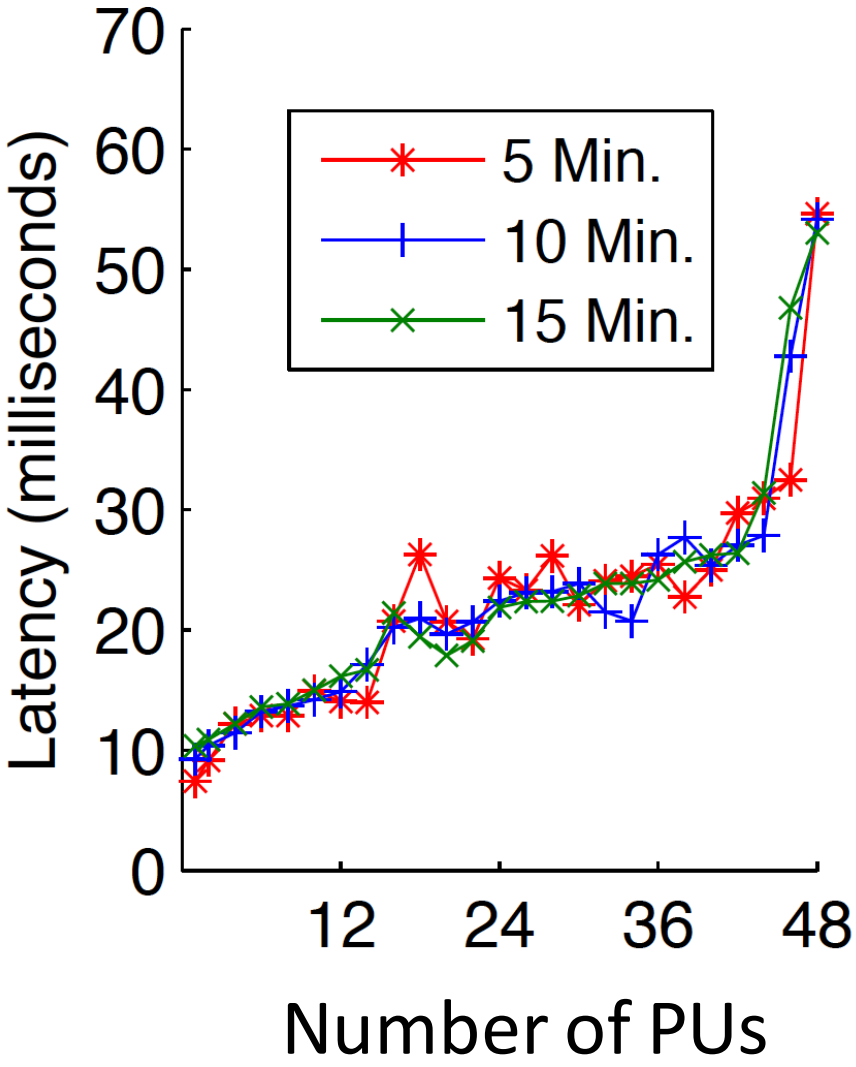

- Implemented in Java

- Evaluation platform
  - NUMA architecture: 2.6 GHz AMD Opteron 6230 (48 cores over 4 sockets), 64 GB of memory
  - Architecture with Hyper Threading: 2.0 GHz Intel Xeon E5-2650 (16 cores over 2 sockets), 64 GB of memory

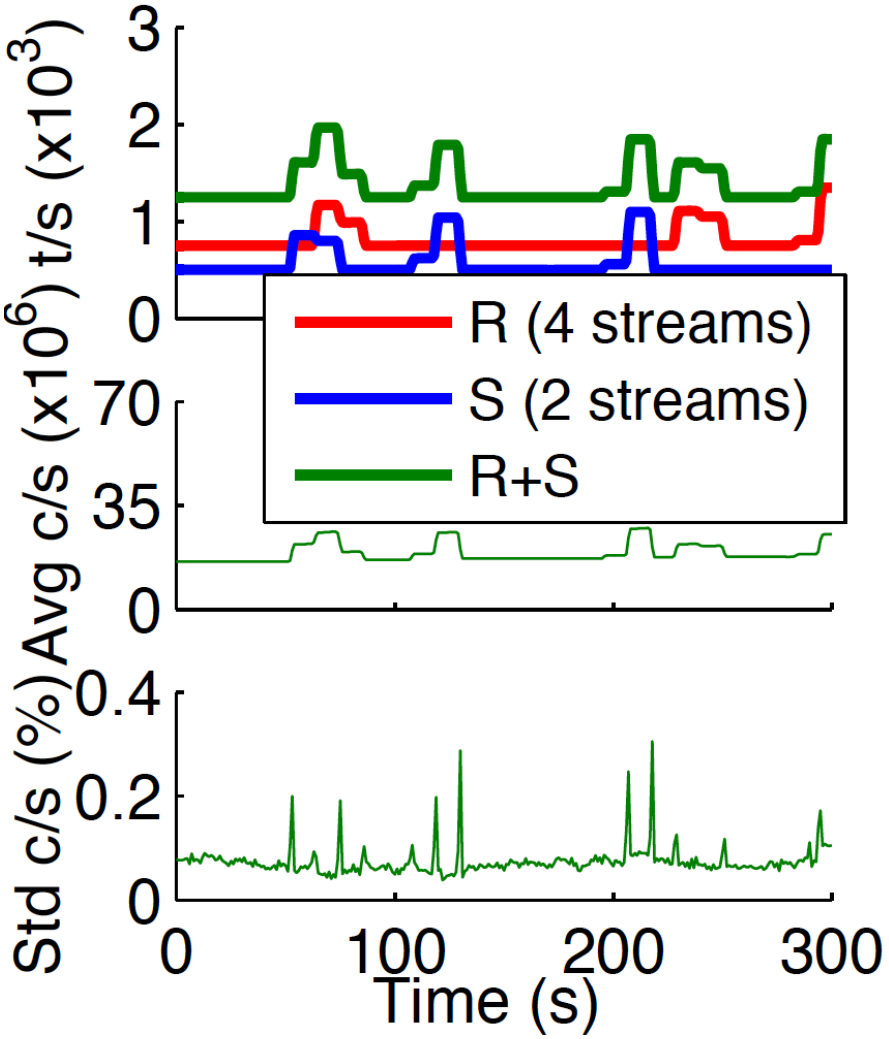
# ScaleJoin Scalability – comparisons/second



# ScaleJoin latency – milliseconds



# ScaleJoin skew-resilience
# Constant distinct rates with peaks



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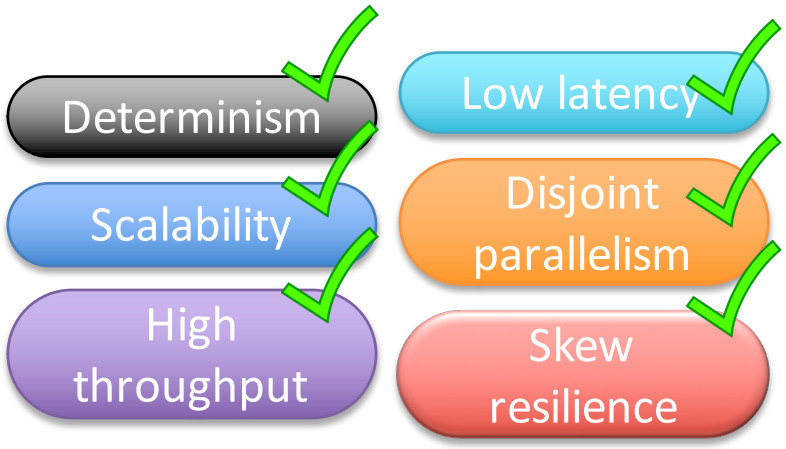
# Conclusions

- ScaleJoin: a Deterministic, Disjoint-Parallel and Skew-Resilient Stream Join
- Challenges of parallel stream joins




- Fine-grained synchronization (ScaleGate)
- 4 billion comparisons/second, with latency lower than 60 milliseconds

# ScaleJoin: a Deterministic, Disjoint-Parallel and Skew-Resilient Stream Join

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## Thank you! Questions?