RDF stream

- An RDF stream is an infinite sequence of timestamped events (triples or graphs)

$$\ldots$$

$$<event_i, t_i>$$

$$<event_{i+1}, t_{i+1}>$$

$$<event_{i+2}, t_{i+2}>$$

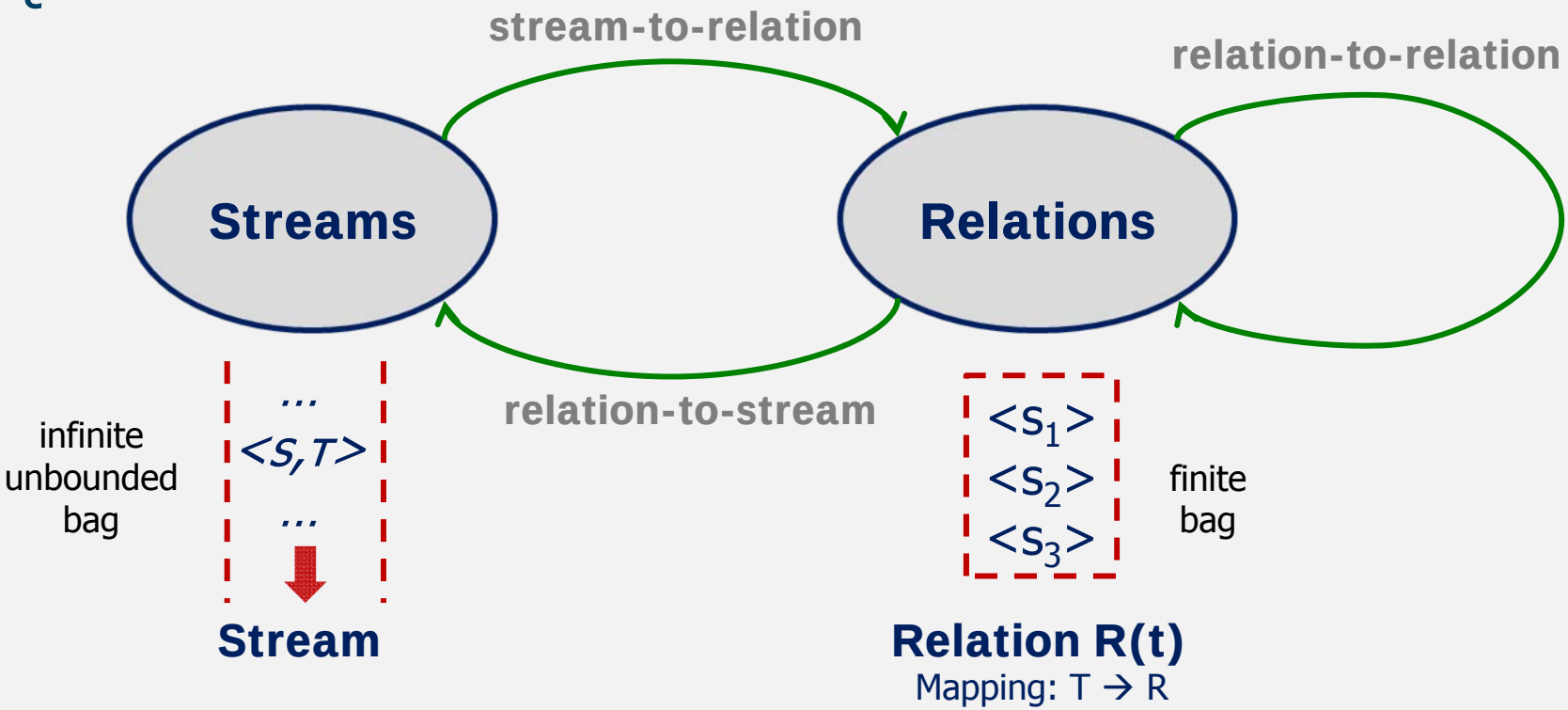
$$\ldots$$

- The (application) timestamps must be non-decreasing

$$t_i <= t_{i+1}$$

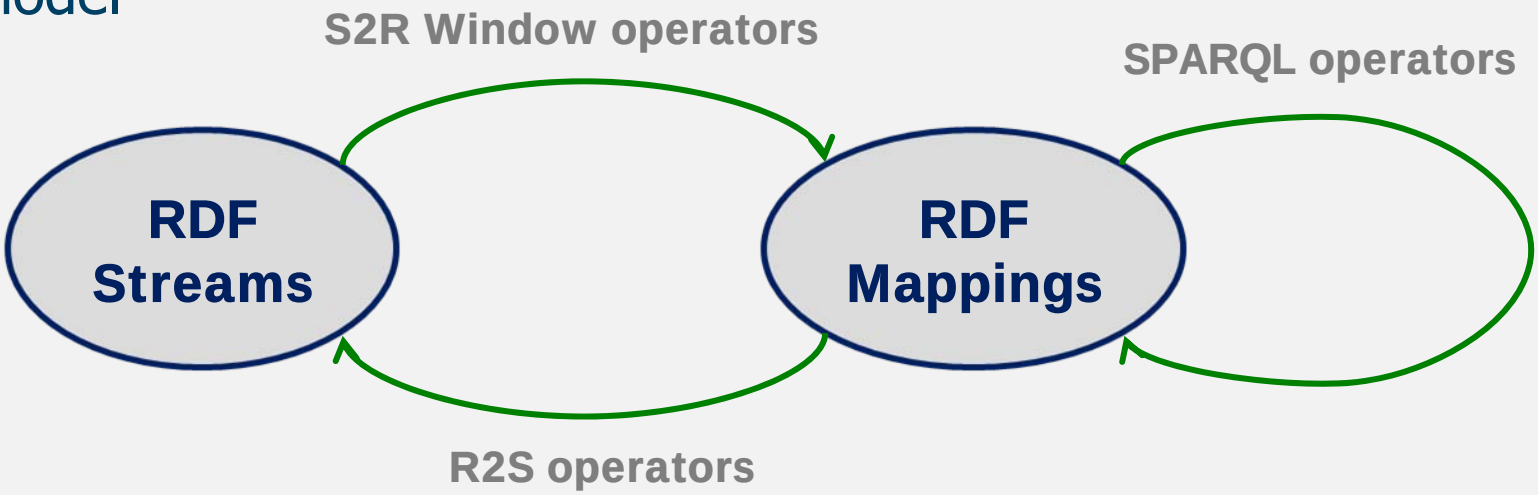
Querying data streams

- CQL model



Querying RDF data streams

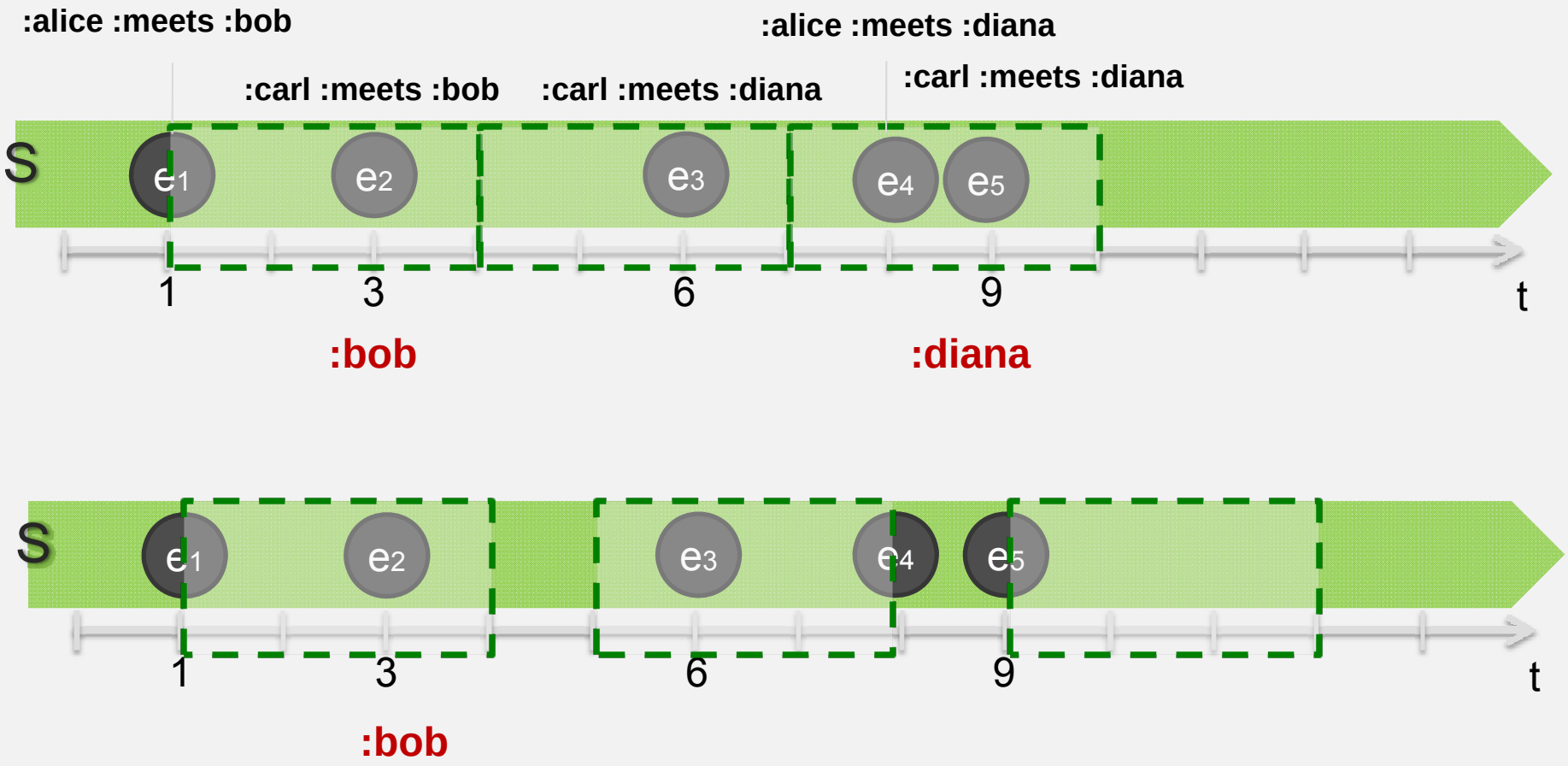
- CQL model



***Abstract* query processing model**

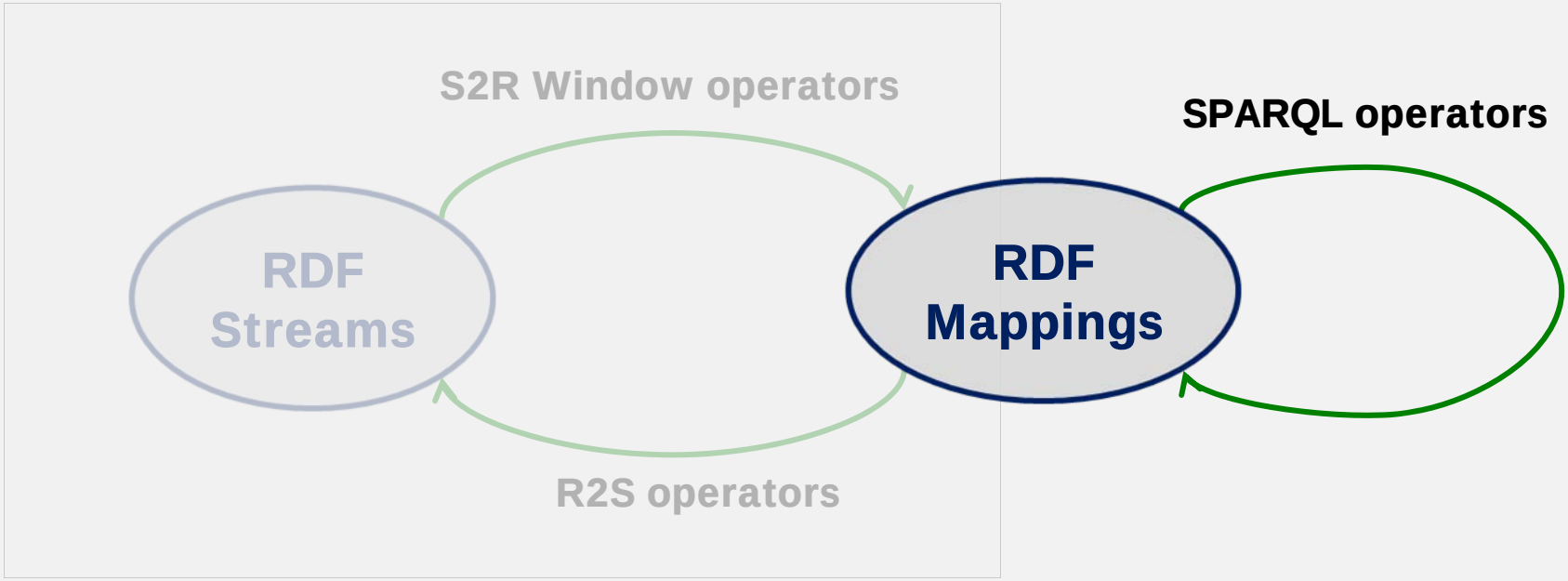
Time-based Windows

- Who are both alice and carl meeting?

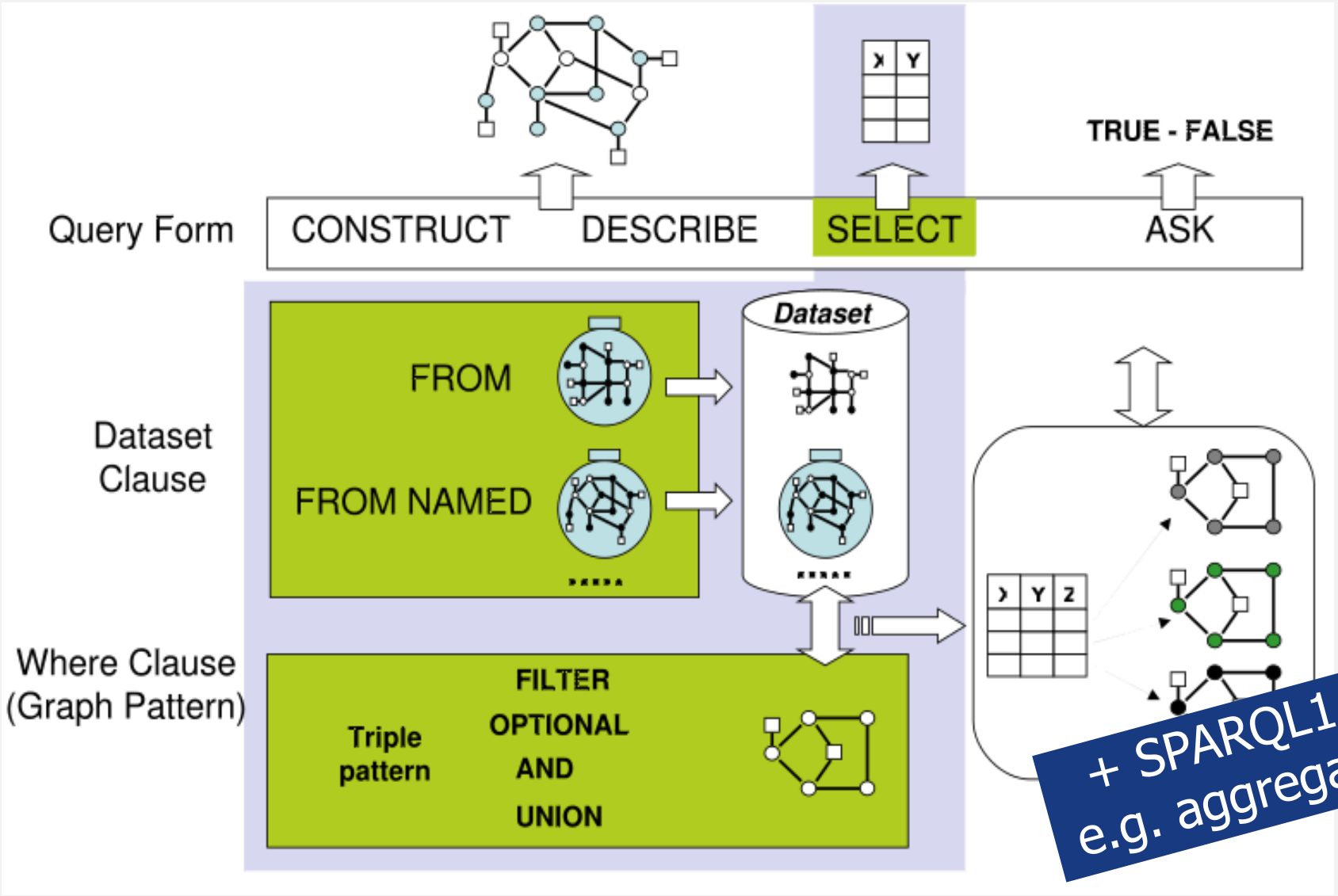


R2R operators

- SPARQL operators
  - Graph pattern matching
  - JOIN
  - OPTIONAL JOIN
  - SELECTION
  - UNION

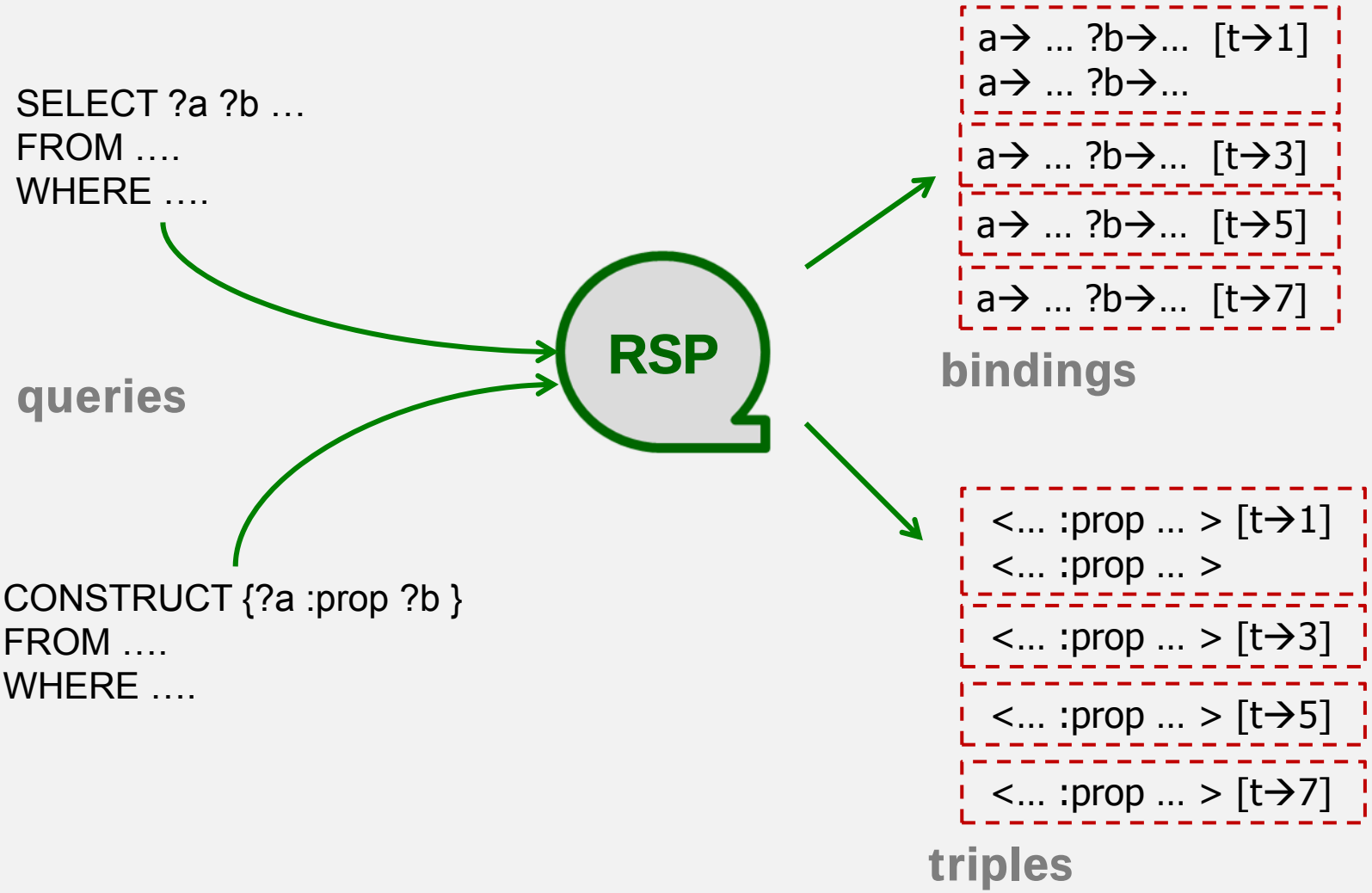


SPARQL: a quick recap



Output: relation

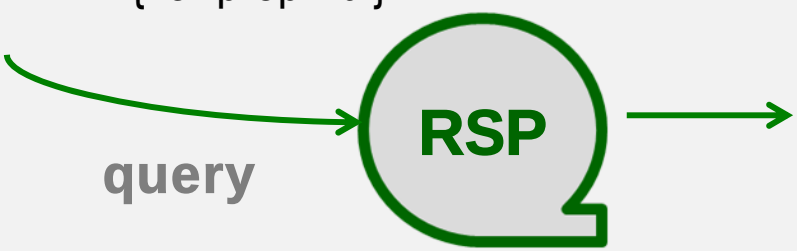
- Case 1: the output is a set of timestamped mappings



Output: stream

- Case 2: the output is a stream
- R2S operators

CONSTRUCT RSTREAM {?a :prop ?b }
FROM ….
WHERE ….



stream

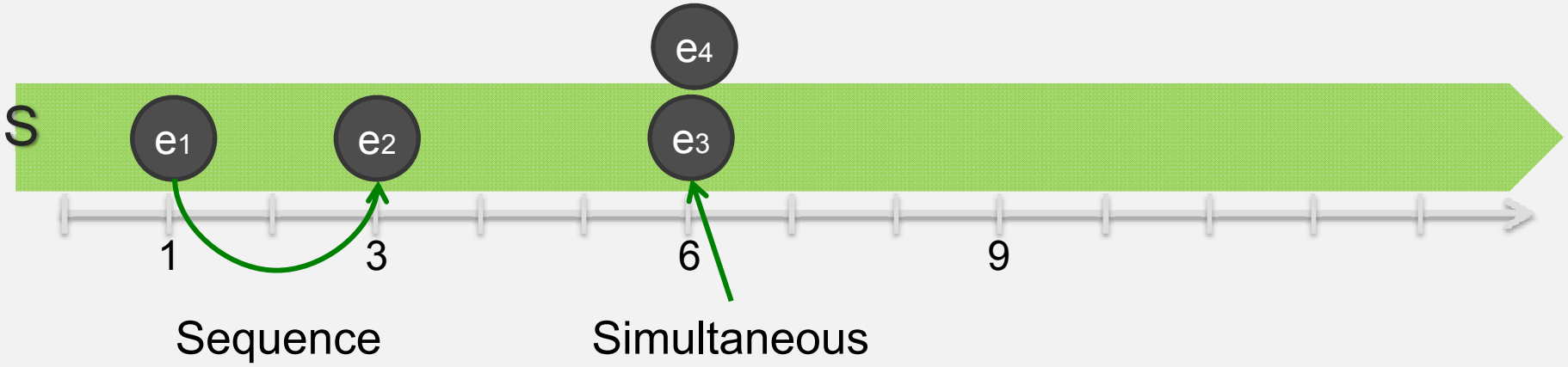
…
<… :prop … > [t→1]
<… :prop … > [t→1]
<… :prop … > [t→3]
<… :prop … > [t→5]
< …:prop … > [t→7]
…

Can be the input to another continuous query

- R2S operators:
  - ISTREAM: stream out data in the last step that wasn't on the previous step
  - DSTREAM: stream out data in the previous step that isn't in the last step
  - RSTREAM: stream out all data in the last step

Other operators

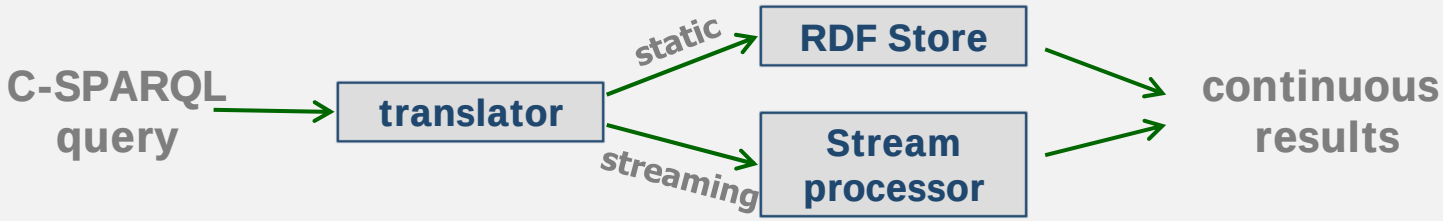
- Sequence operators and CEP world



- SEQ: joins $e_{ti,tf}$ and $e'_{ti',tf'}$ if e' occurs after e
- EQUALS: joins $e_{ti,tf}$ and $e'_{ti',tf'}$ if they occur simultaneously
- OPTIONALSEQ, OPTIONALEQUALS: Optional join variants

Existing RSP systems

- C-SPARQL: RDF Store + Stream processor
  - Combined architecture

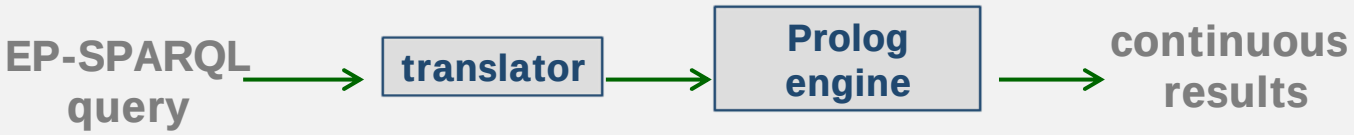


- CQELS: Implemented from scratch. Focus on performance
  - Native + adaptive joins for static-data and streaming data

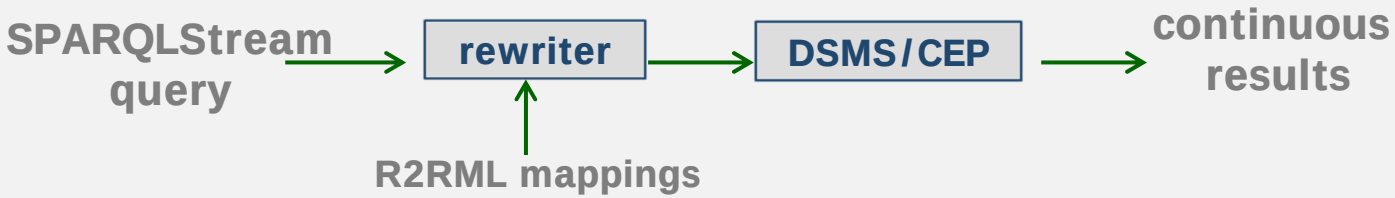
Disclaimer: **oversimplified descriptions**

Existing RSP systems

- EP-SPARQL: Complex-event detection
  - SEQ, EQUALS operators



- SPARQLStream: Ontology-based stream query answering
  - Virtual RDF views, using R2RML mappings
  - SPARQL stream queries over the original data streams.



- Instans: RETE-based evaluation

Disclaimer: **oversimplified descriptions**

Classification of existing systems

	Model	Continuous execution	Union, Join, Optional, Filter	Aggregates	Time window	Triple window	R2S operator	Sequence, Co-ocurrence	Time function
TA-SPARQL	TA-RDF	✗	✔	Limited	✗	✗	✗	✗	✗
tSPARQL	tRDF	✗	✔	✗	✗	✗	✗	✗	✗
Streaming SPARQL	RDF Stream	✔	✔	✗	✔	✔	✗	✗	✗
C-SPARQL	RDF Stream	✔	✔	✔	✔	✔	✗	✗	✔
CQELS	RDF Stream	✔	✔	✔	✔	✔	✗	✗	✗
SPARQLStream	(Virtual) RDF Stream	✔	✔	✔	✔	✗	✔	✗	✗
EP-SPARQL	RDF Stream	✔	✔	✔	✗	✗	✗	✔	✗
Instans	RDF	✔	✔	✔	✗	✗	✗	✗	✗