METHODS TO OPTIMALLY TRADE BANDWIDTH AGAINST BUFFER SIZE FOR A VBR STREAM

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Overview

- Motivation
- Problem description
- Algorithms
  - Buffer-increasing trade-off algorithm
  - Rate-increasing trade-off algorithm
- Comparison
- Conclusions

Motivation

- Various connected devices typically for ambient intelligent environment
- Smart usage of resources required
- Variable-bit-rate streams profit from buffering
- algorithms for a VBR transmission schedule:
  - Set fixed bandwidth, calculate min. buffer size
  - Set fixed buffer size, calculate min. bandwidth

► We want to find an optimal trade-off!

Problem Description

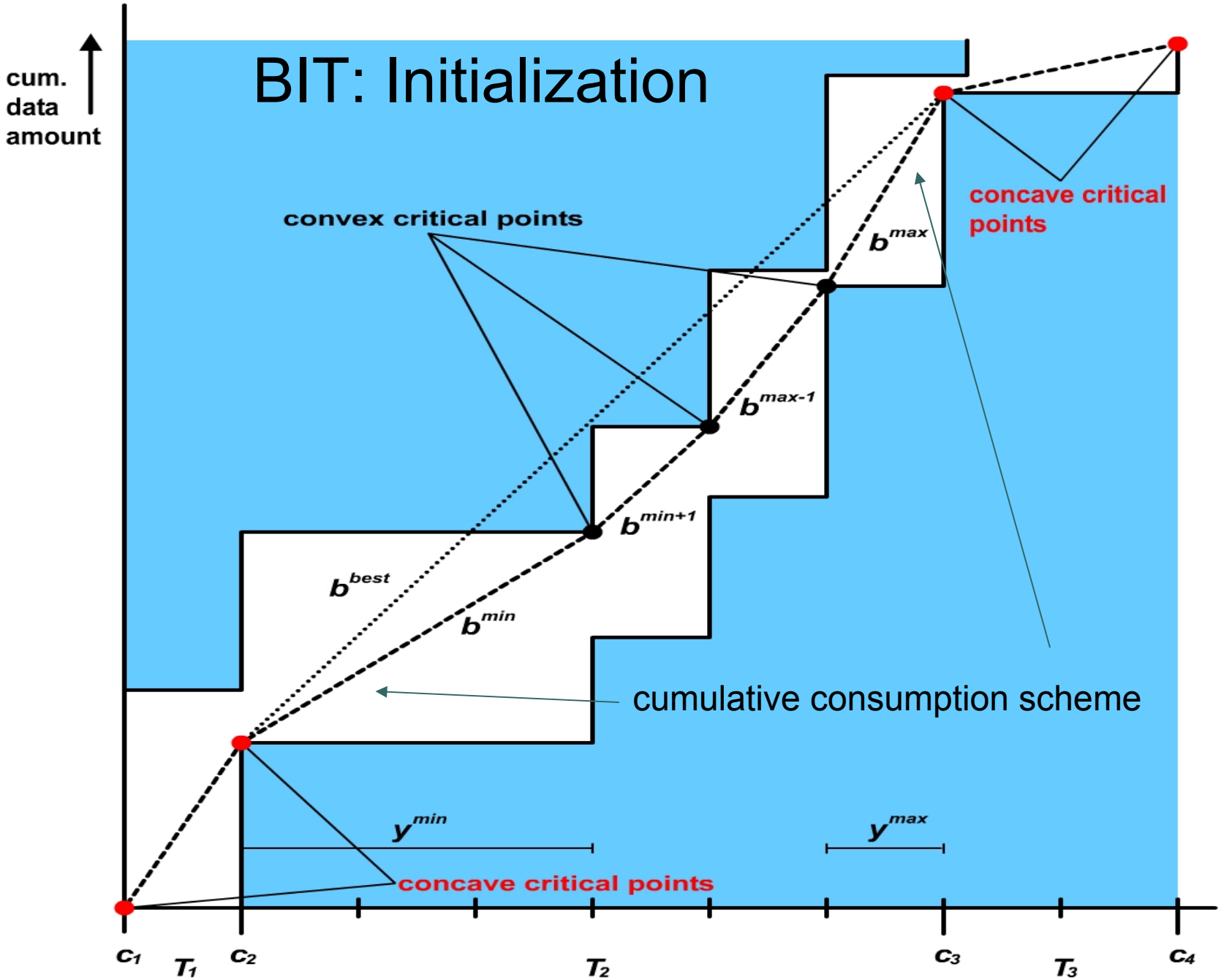
Products of cost coefficient and related resource together should be minimal, while basic constraints are not violated

Algorithms

- Buffer-increasing trade-off algorithm (BIT)
- Rate-increasing trade-off algorithm (RIT)

Buffer-Increasing Trade-Off Algorithm

- VBR with piecewise CBR
- Rate changes at **critical points**
- Determine min. buffer using known algorithms
- Increase buffer and monitor effect on bandwidth


BIT: Initialization
cum. data amount
convex critical points
concave critical points
b^{max}
b^{max-1}
b^{min+1}
b^{best}
b^{min}
cumulative consumption scheme
y^{min}
y^{max}
concave critical points
c_1
T_1
c_2
T_2
c_3
T_3
c_4

BIT: Possible Events

- Highest transmission rate might shift to another interval
- Convex critical point can stop being a critical point
- Concave critical point may no longer be a critical point (two intervals merge into one)

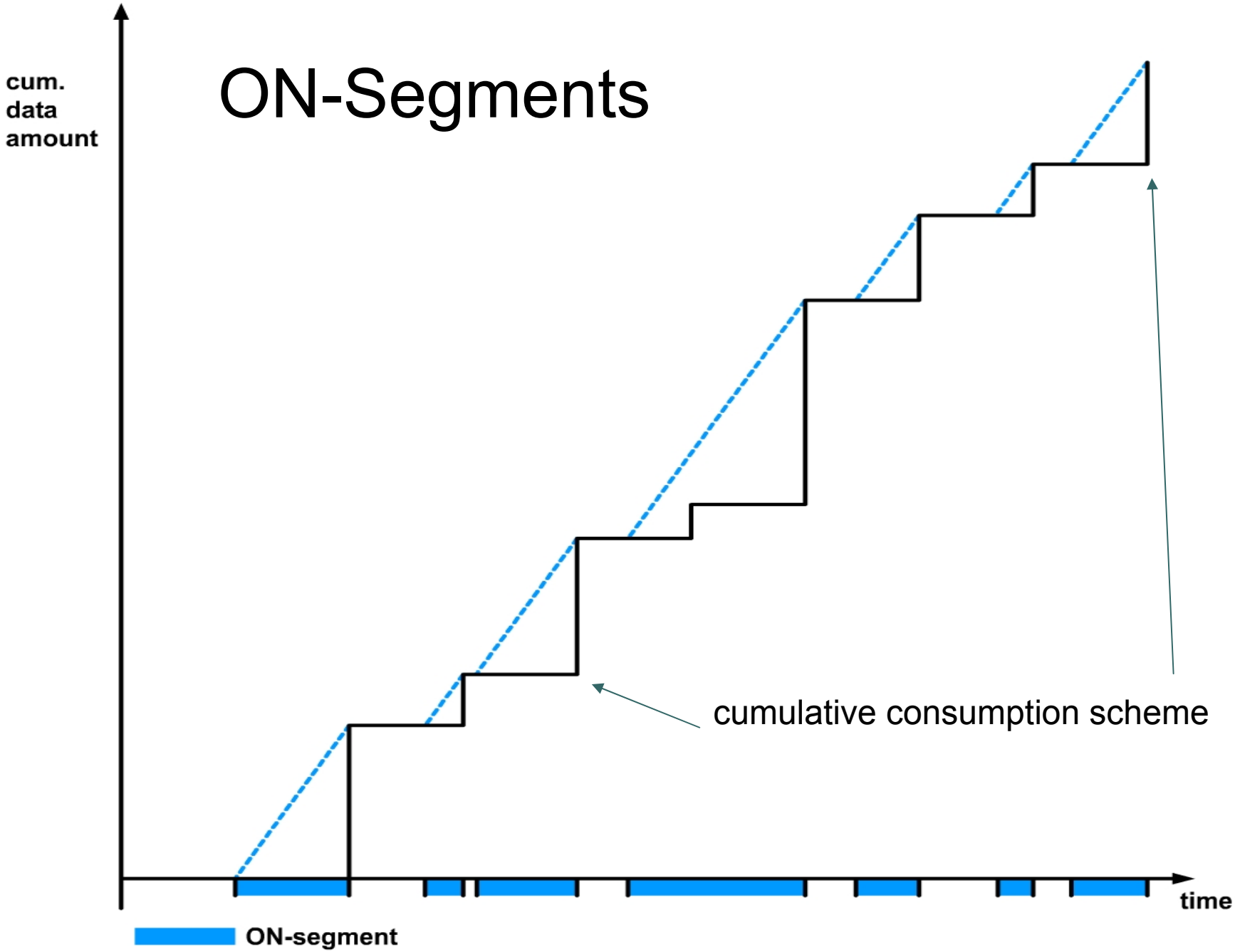
BIT: Determine Trade-Off

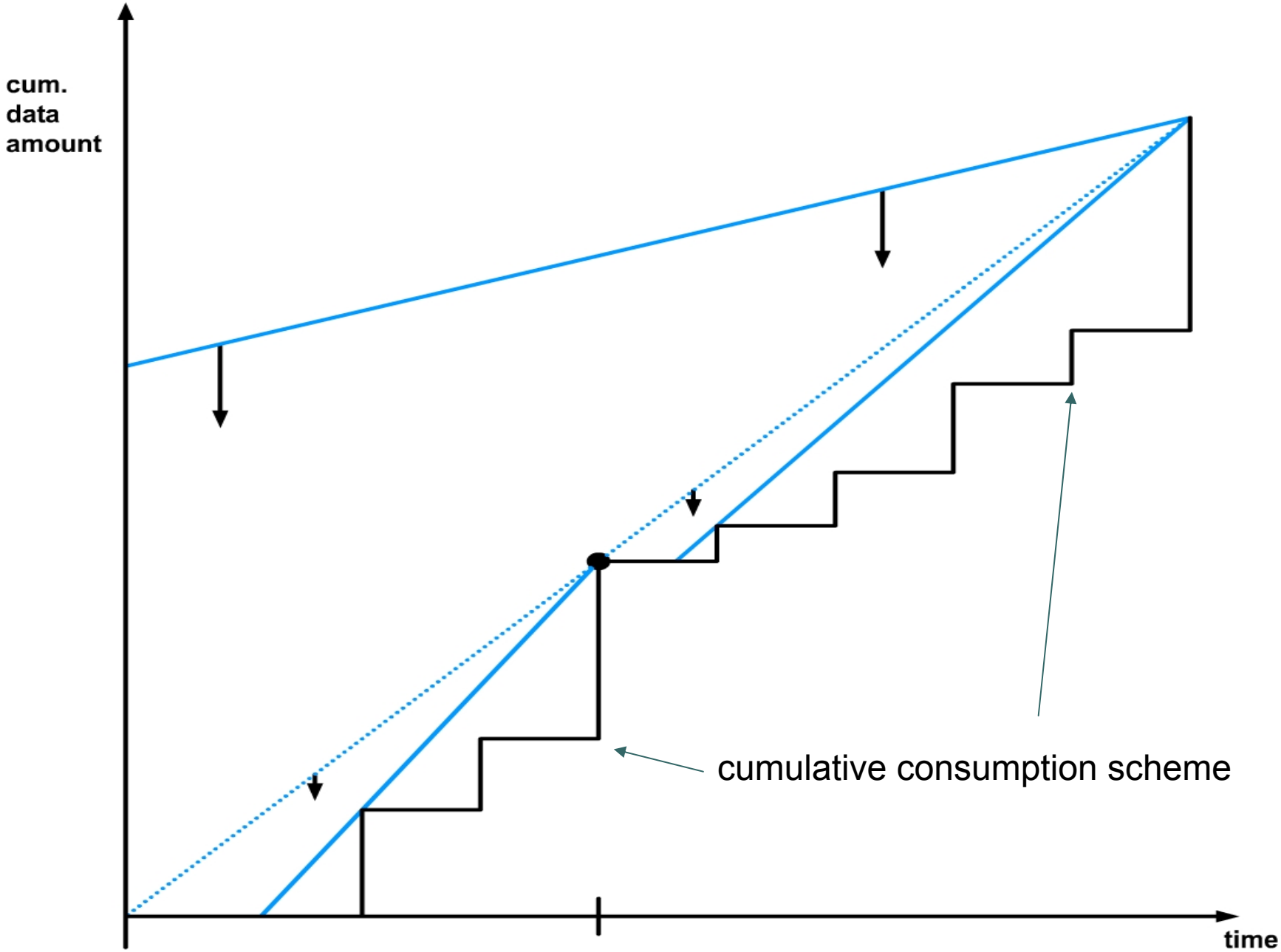
- Increase buffer size as long as costs decrease
- If one of the described events takes place, adjust and recalculate parameters
- For complete trade-off curve continue till maximum buffer size

Rate-Increasing Trade-Off Algorithm

- Based on ON-OFF-transmission schedule
- Transmission of data not evenly over time but at a fraction of time using all of reserved bandwidth
- Smoothing by calculating point at which transmission at maximum bandwidth finishes at outer-edge

ON-Segments

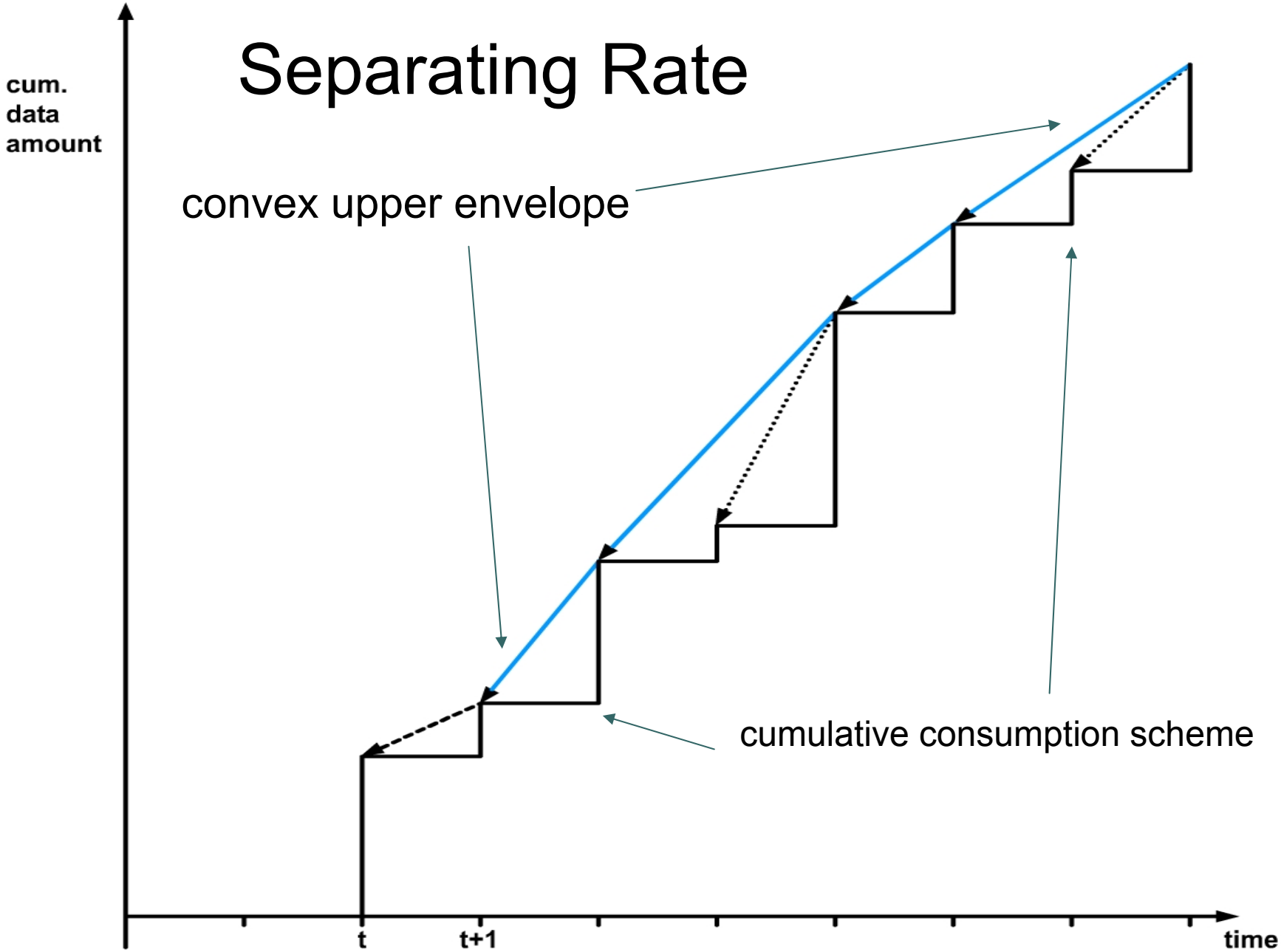

cum.
data
amount
cumulative consumption scheme
time
ON-segment


cum.
data
amount
cumulative consumption scheme
time

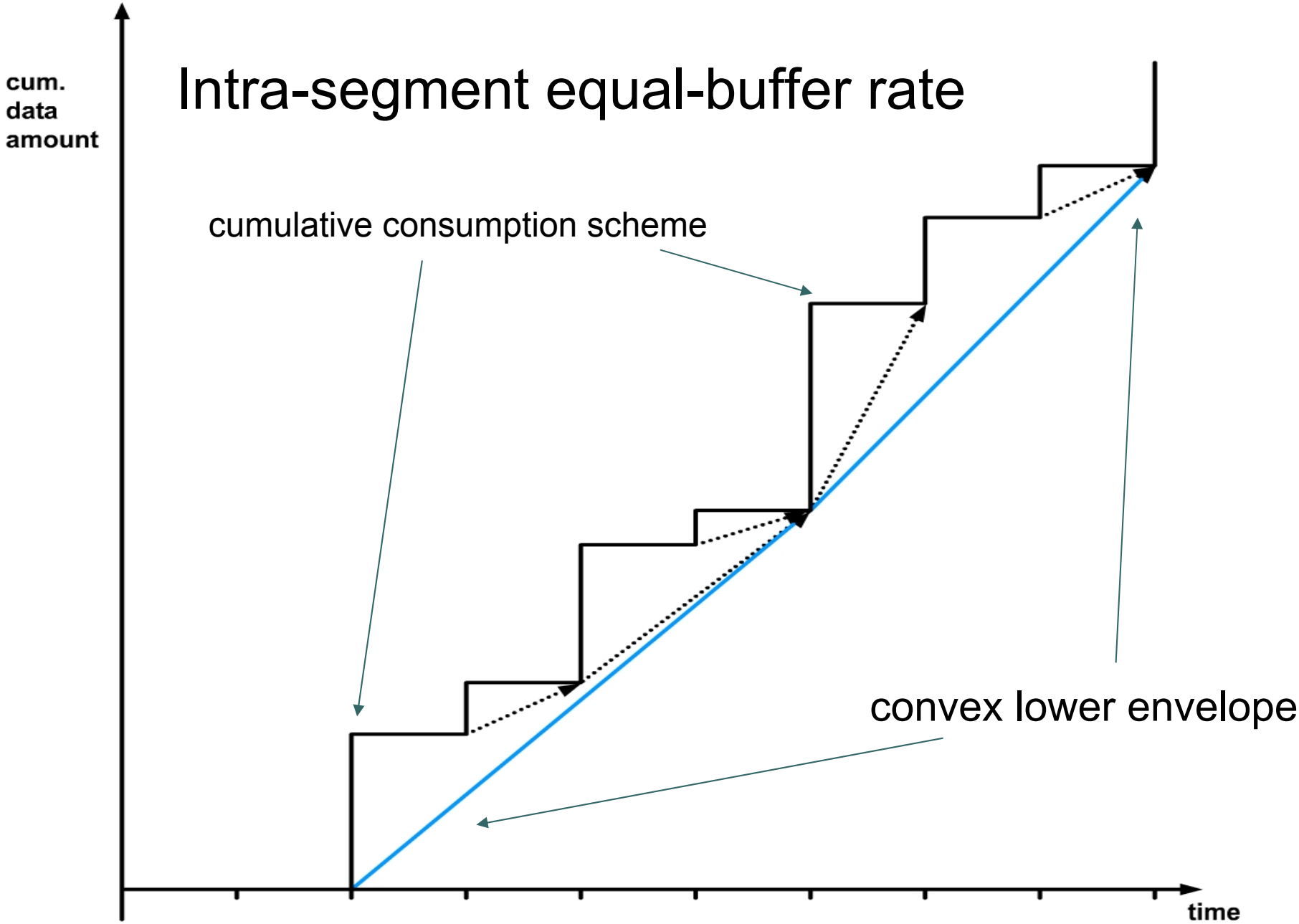
RIT: Possible Events

- Segment can split into two new segments
  - ► **separating rate**
- Largest buffer point of a segment may move to another point
  - ► **intra-segment equal-buffer rate**
- Segment with highest buffer requirement can change
  - ► **inter-segment equal-buffer rate**

Separating Rate



Intra-segment equal-buffer rate



RIT: Inter-Segment Equal-Buffer Rate

- Can be determined from separating rates and intra-segment equal-buffer rates
- Calculate trade-off for each segment and plot them in a plane
- Consider intersections at maximum buffer requirement for each rate

RIT: Determine Trade-Off

- Calculate separating rates and intra-segment equal-buffer rates and sort them in increasing order
- Start with rate of zero and process other rates increasingly
- Check for intersection with maximum and adjust values

Comparison: Structure

Algorithms are very similar

- One of the variables taken as given (minimum)
- Given variable increased, effect on other monitored
- Events can change the effect of a variable on the other

Comparison: Complexity

- BIT: Overall time complexity: **O(KT)**
- RIT: Overall time complexity: **O(T log T)**

Complexity differs by incomparable factors

► Comparison by tests necessary

Comparison: Tests

Average test results:

	receiving (s)			sending (s)			memory req. (KB)	
T	K	BIT	RIT	K	BIT	RIT	BIT	RIT
132591	2224	0.513	0.699	1735	0.395	0.715	4061	9946

- BIT is dependent on number of intervals (K)
- RIT constant on sending and receiving
- RIT uses twice the amount of memory of RIT

Conclusions

- Algorithms have similar structure
- Time complexity and memory usage differ (test results)

- Overall the BIT algorithm has the better performance because it runs faster despite using only half the amount of memory

References

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Questions ?

Thank you for your attention