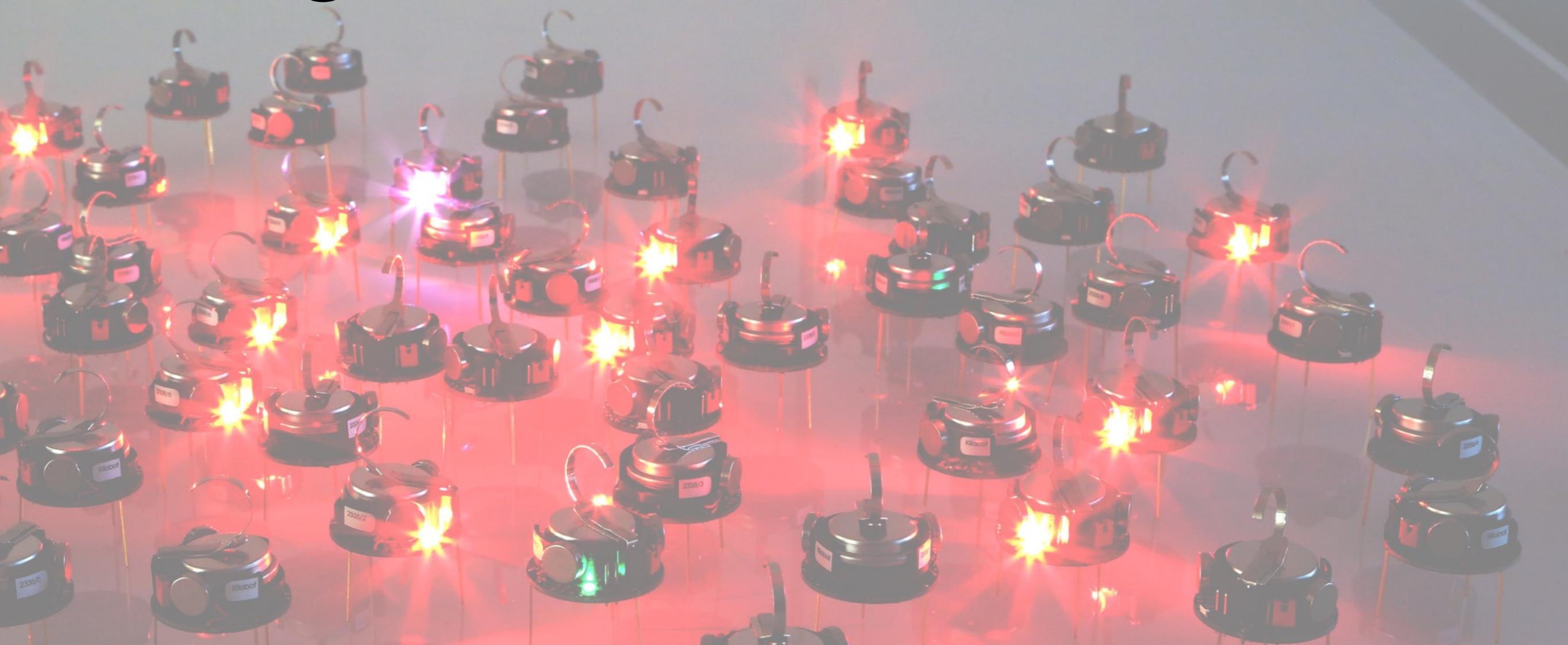


Teams & Roboter gemeinsam mehr erreichen



UNIVERSITÄT ZU LÜBECK
INSTITUTE OF COMPUTER ENGINEERING

Prof. Dr.-Ing. Heiko Hamann
Institut für Technische Informatik
Universität zu Lübeck

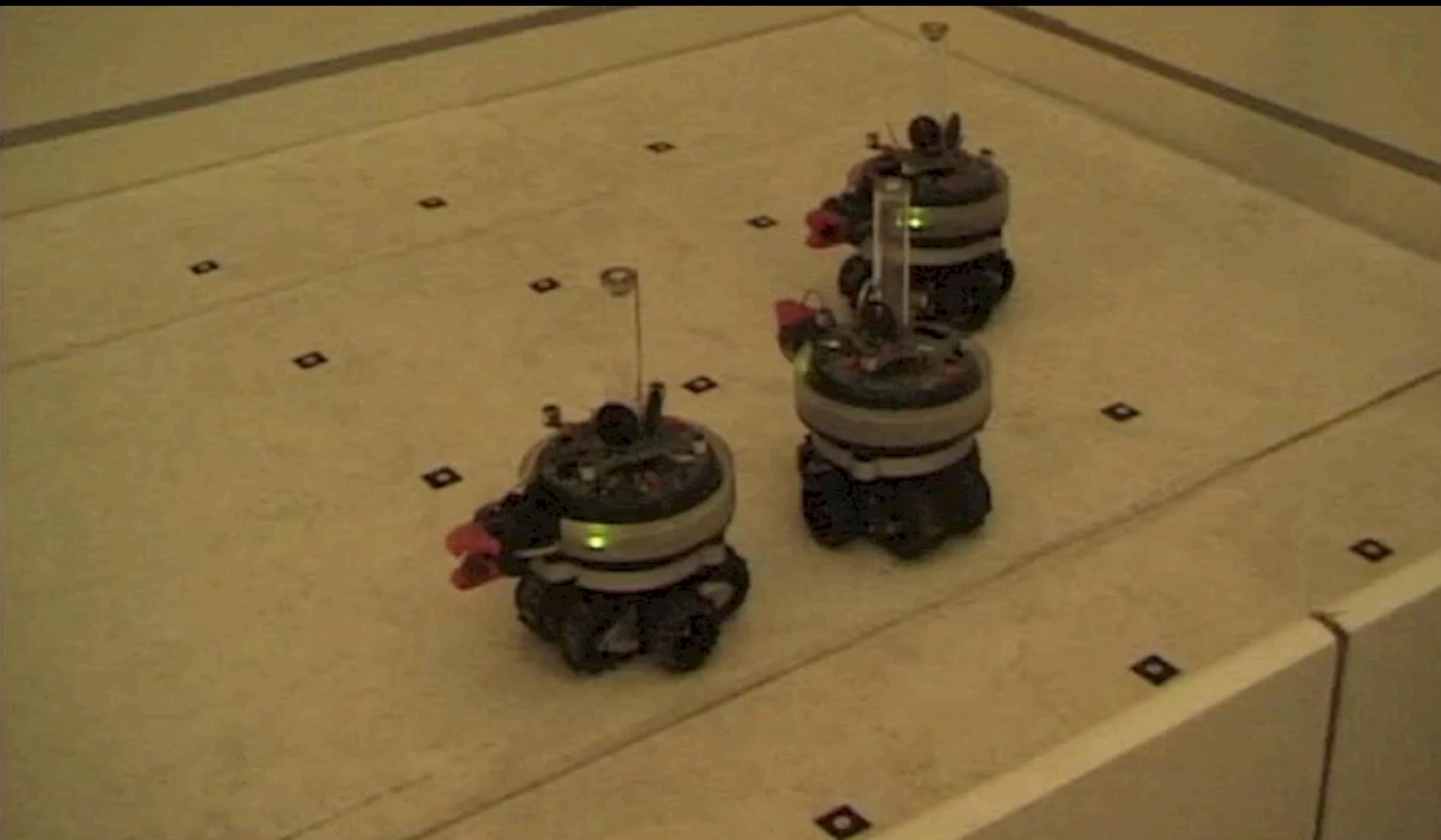
A black and white photograph showing the backs of two young children as they walk away from the viewer. A girl on the left, wearing a floral dress, holds the hand of a boy on the right, who is wearing a light-colored tank top and dark shorts. They are walking on a dirt path through a grassy field with trees in the background.

gemeinsam ist man
weniger allein...

...get the
job done

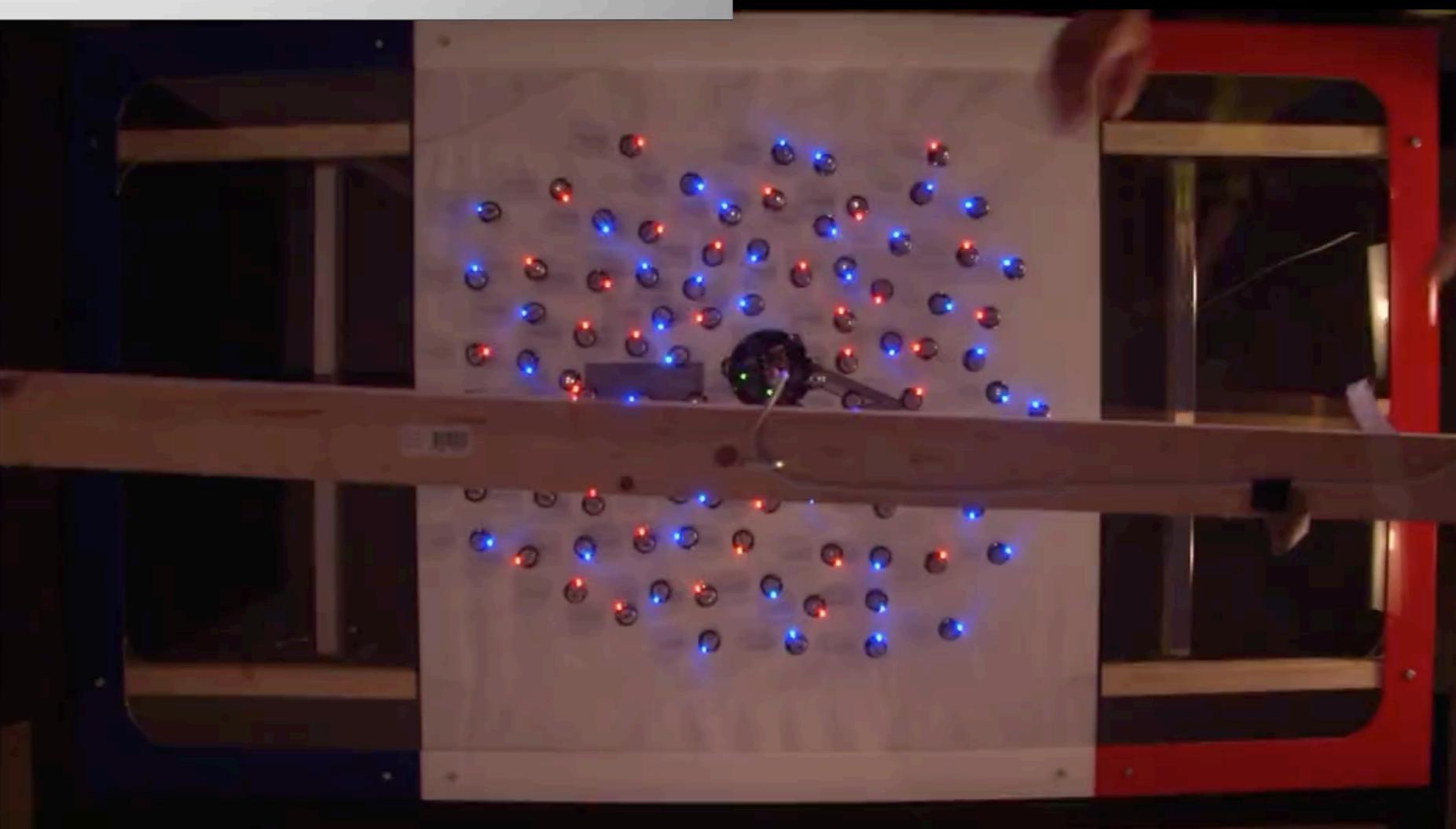
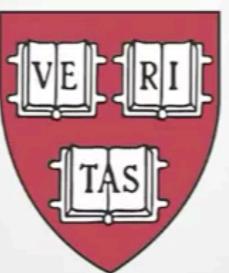






Marco Dorigo et al., ULB

HARVARD UNIVERSITY



SE



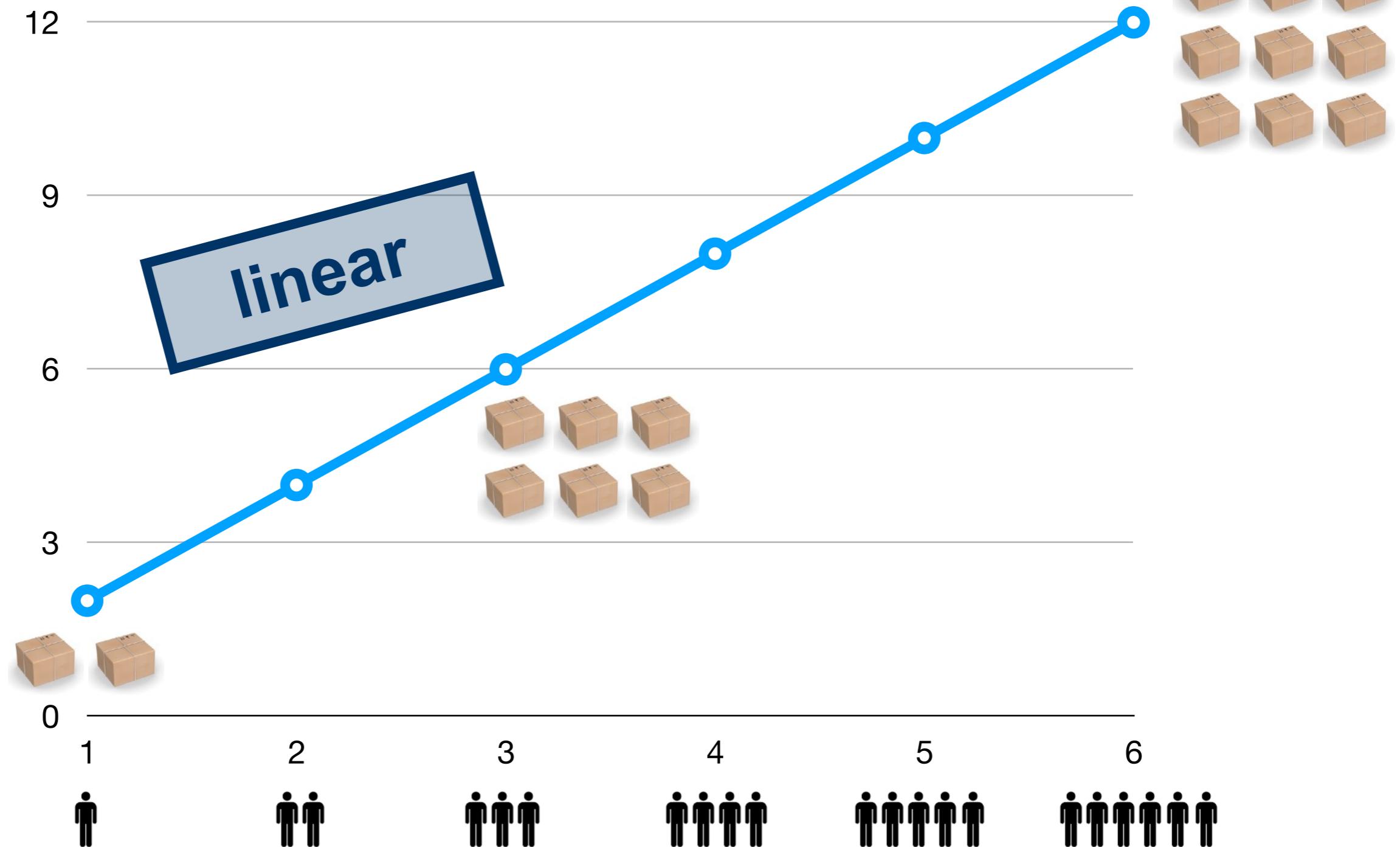
PARALLEL PROCESSING



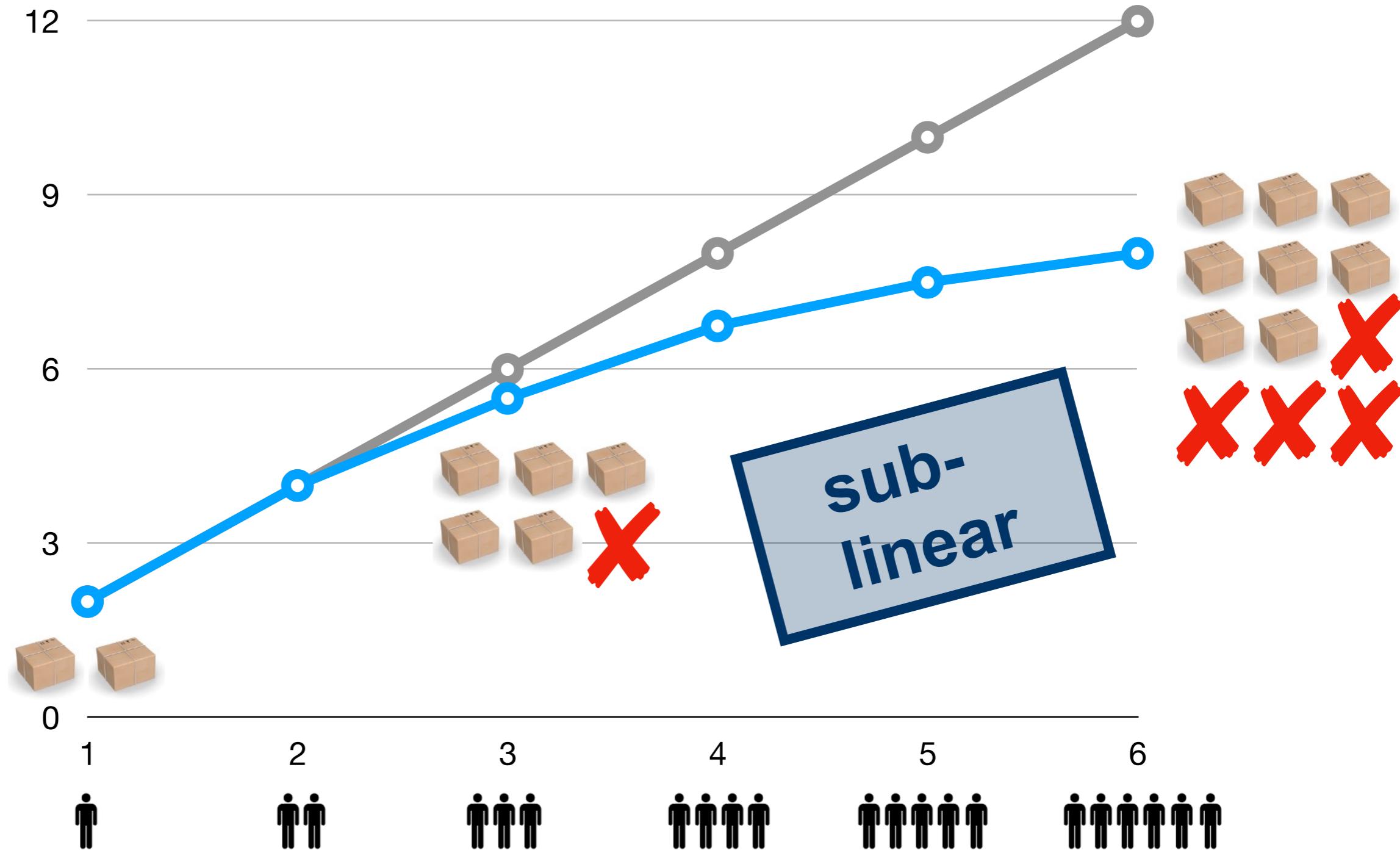
SWNS



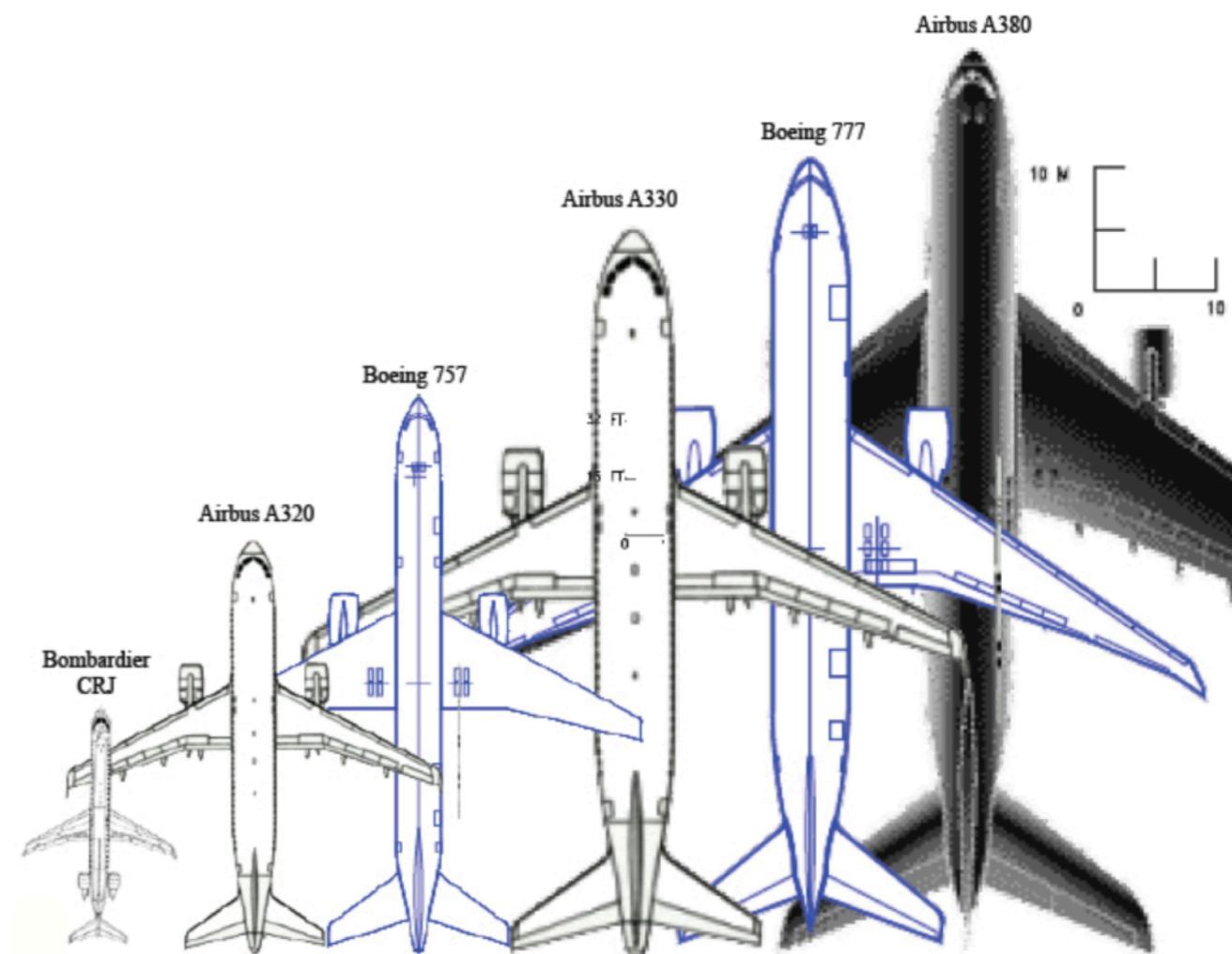
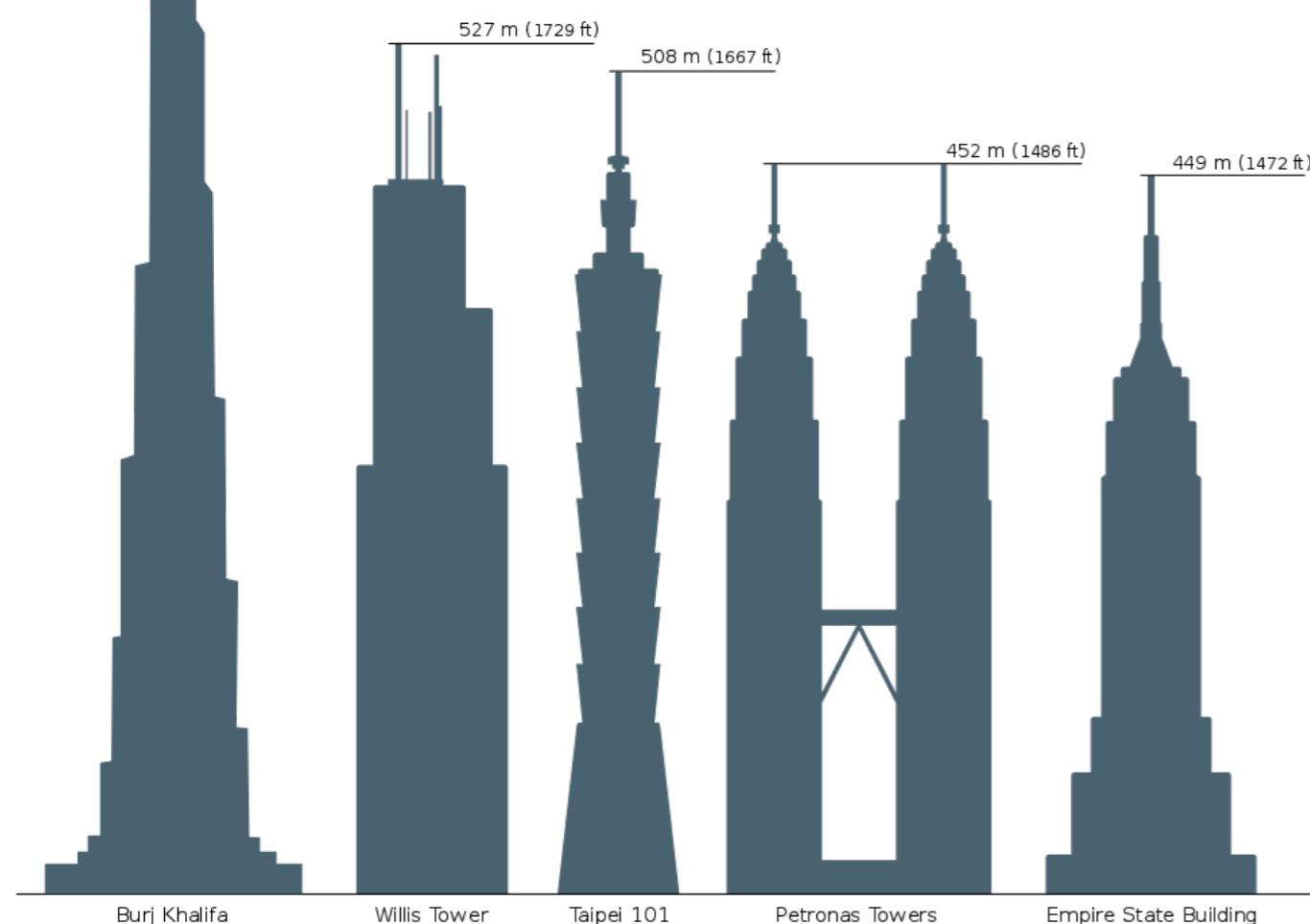
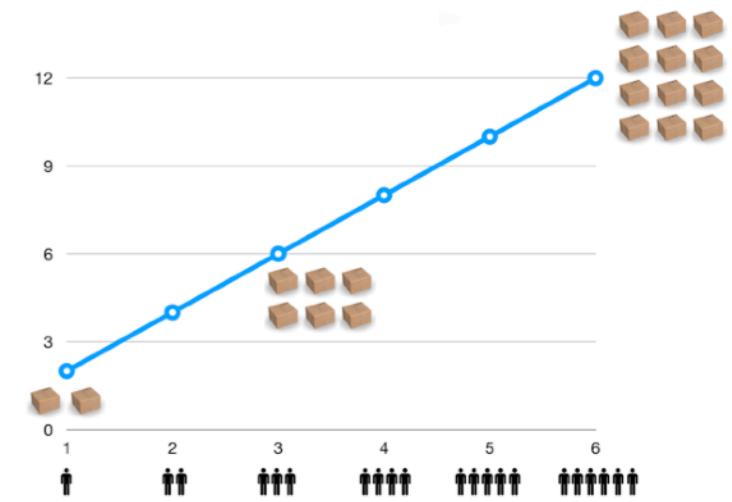
Gruppenleistung



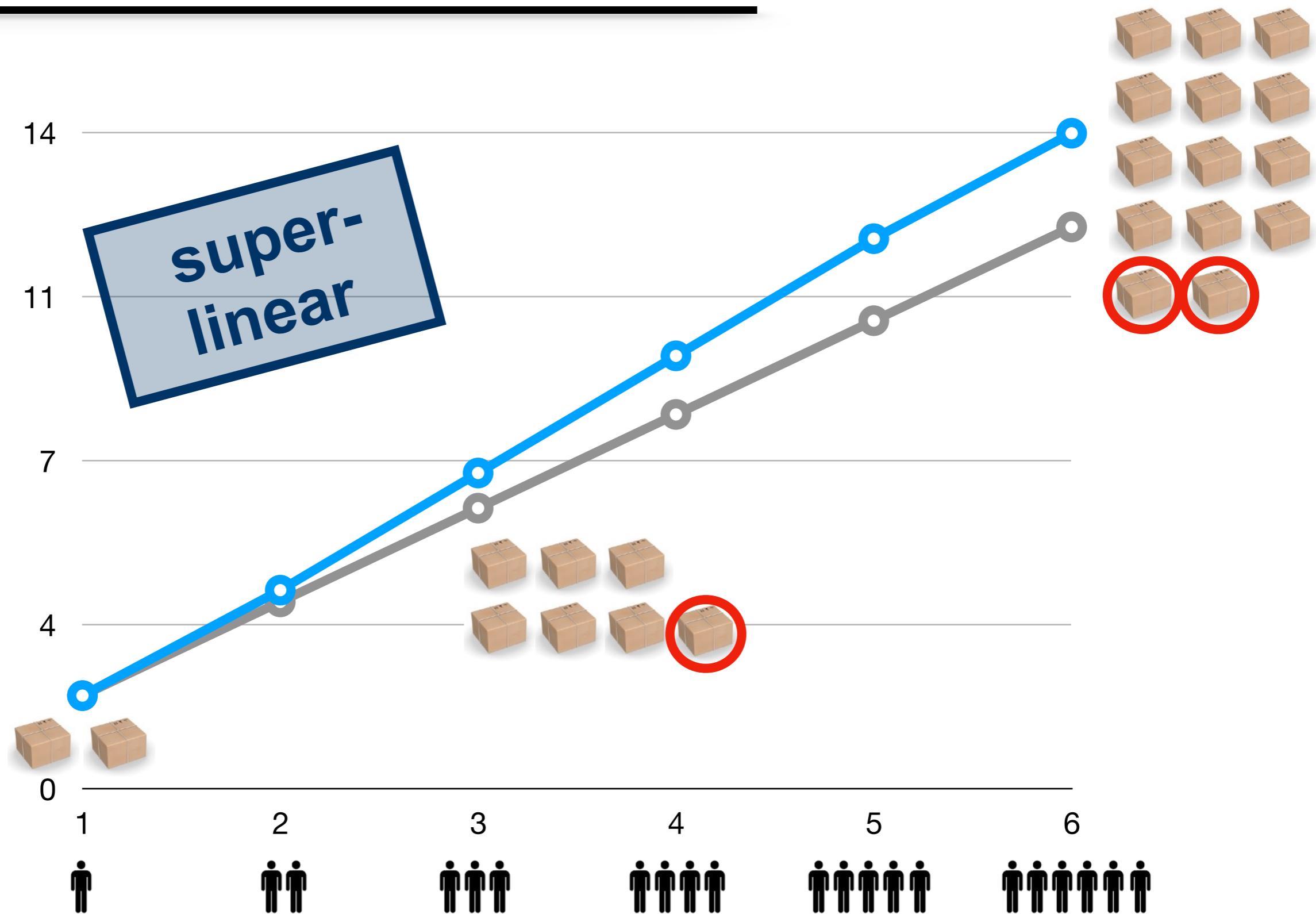
Gruppenleistung - Variante B



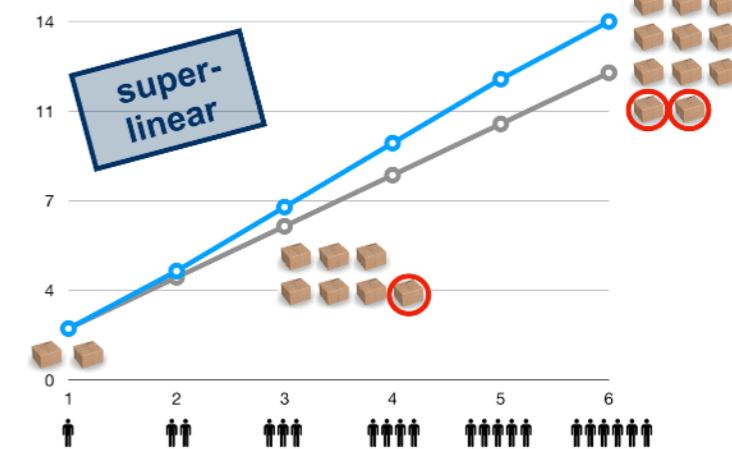
Skalierbarkeit



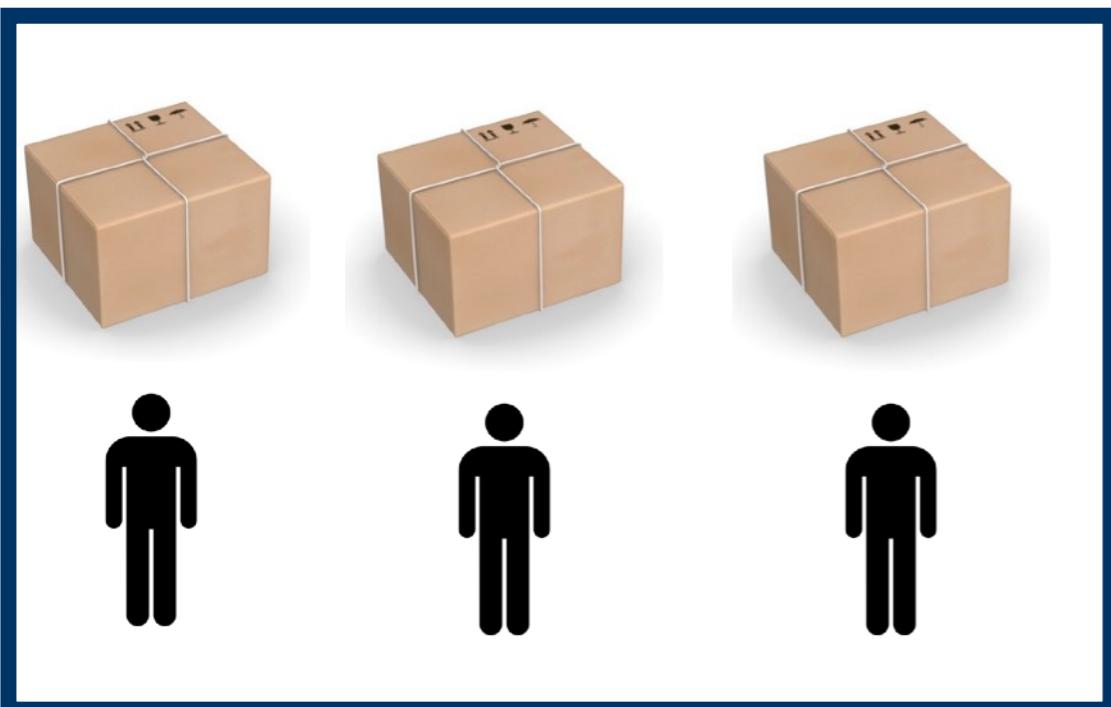
Gute Nachricht: super-lineare Leistung



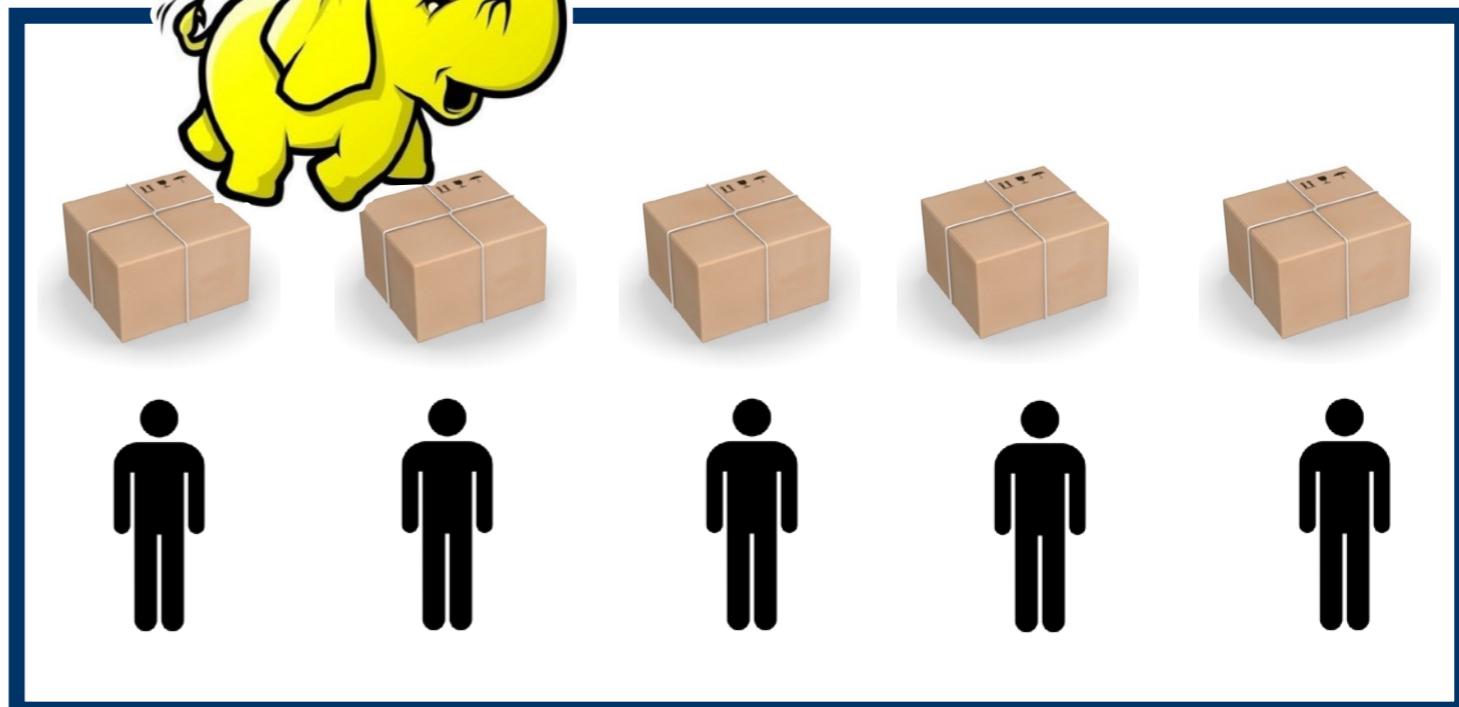
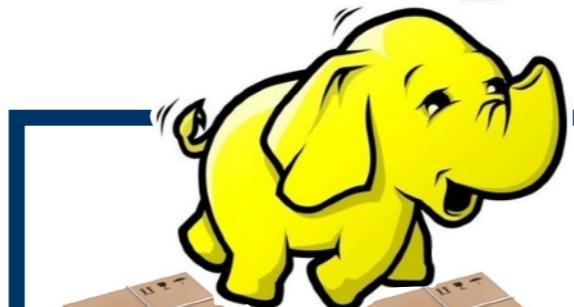
Schwarze Magie? Perpetuum mobile?



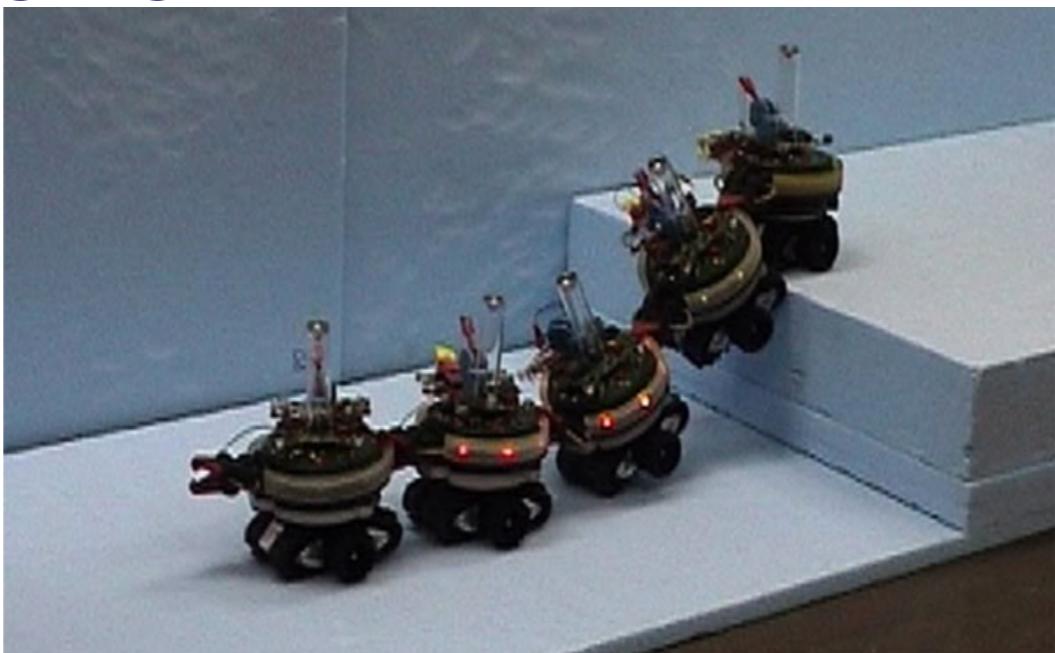
1 - Größe der Arbeitspakete



hadoop

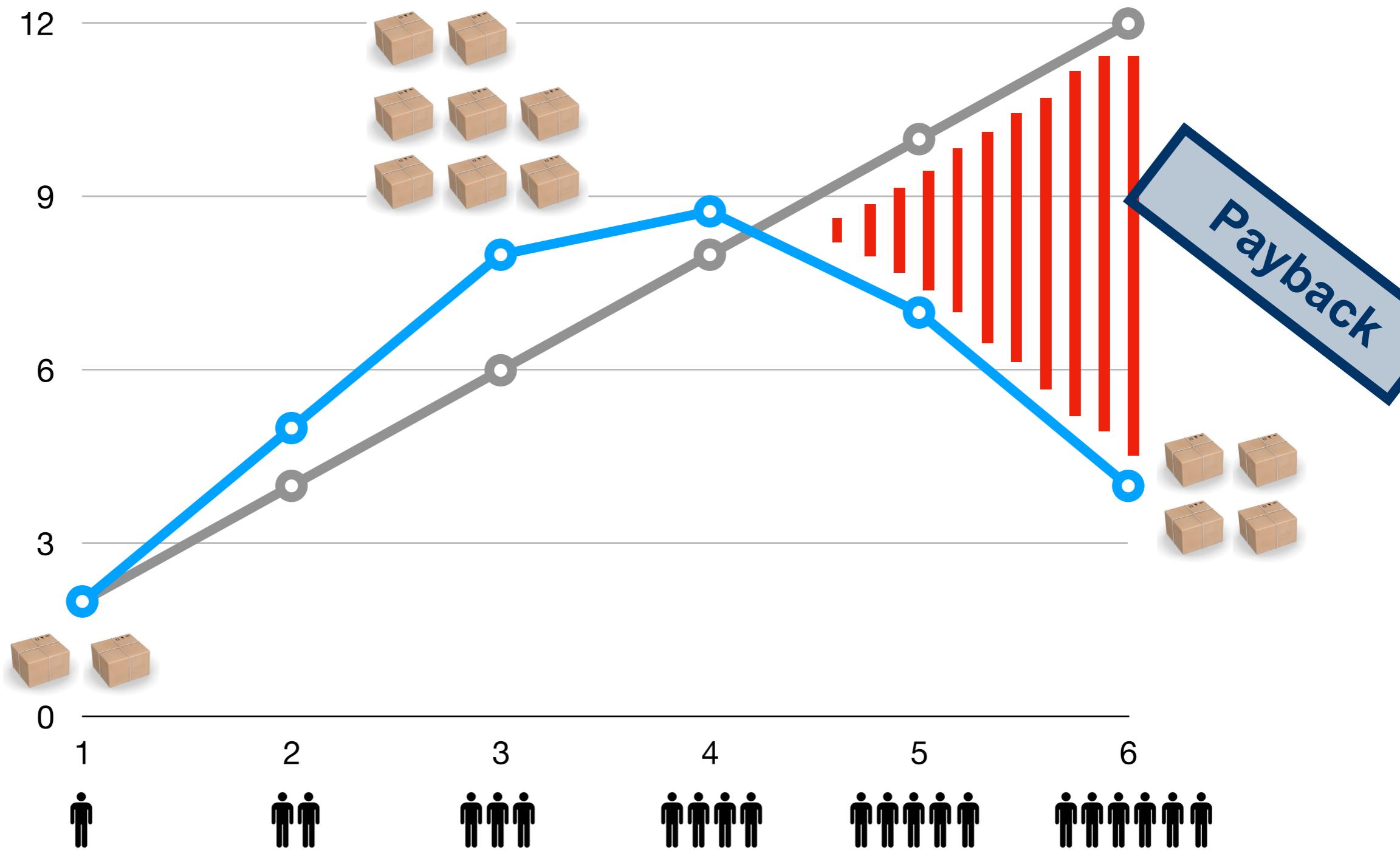


2 - physikalische Bedingungen

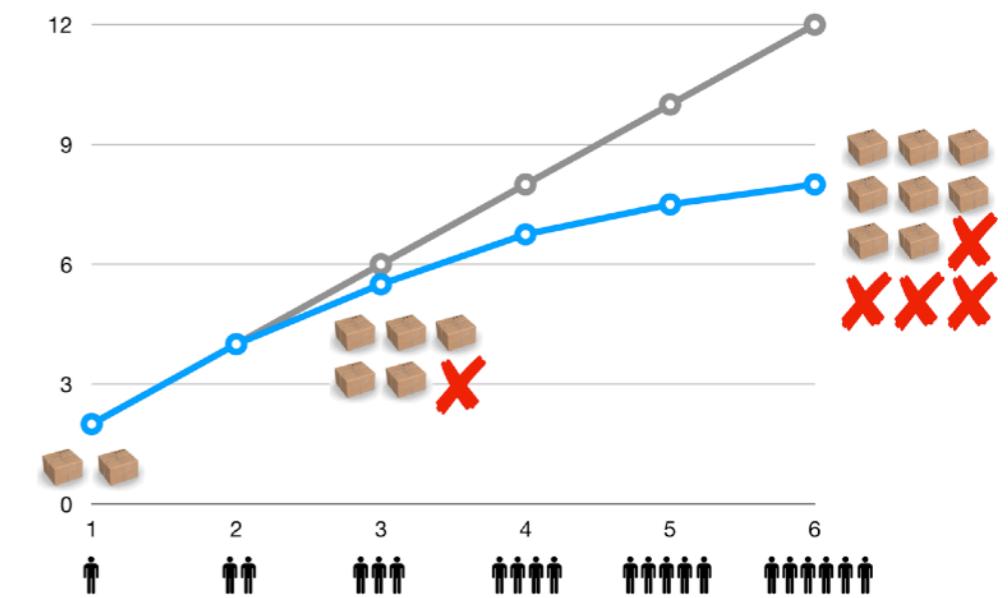
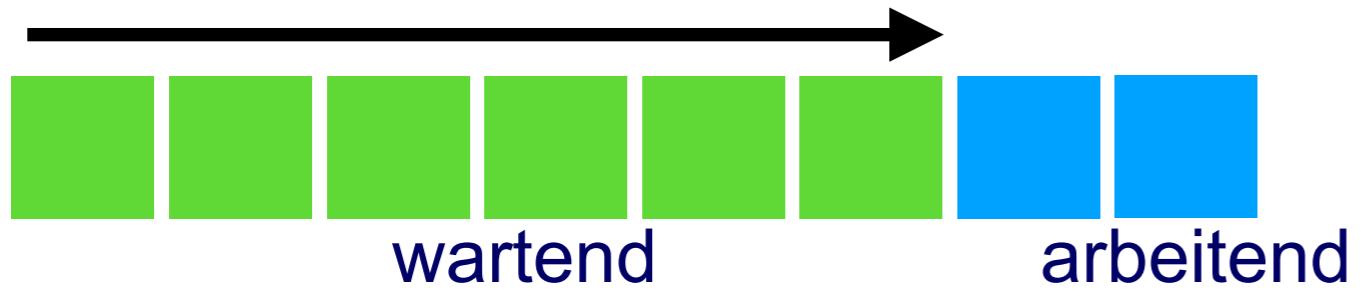


Marco Dorigo et al., ULB

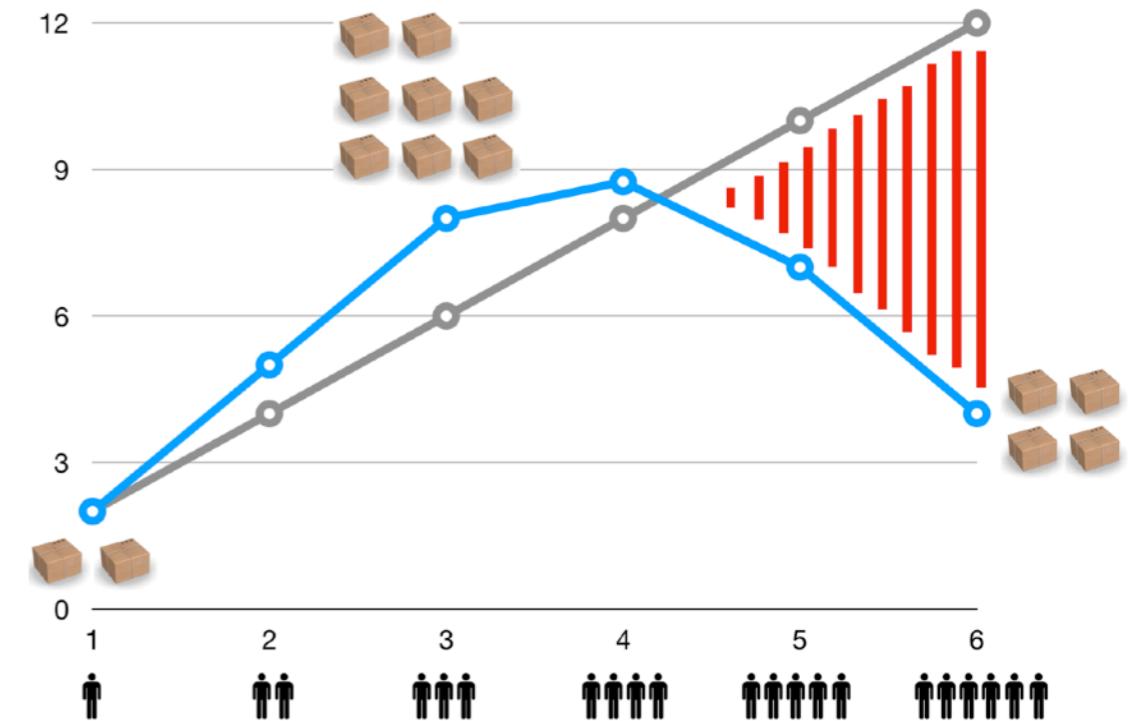
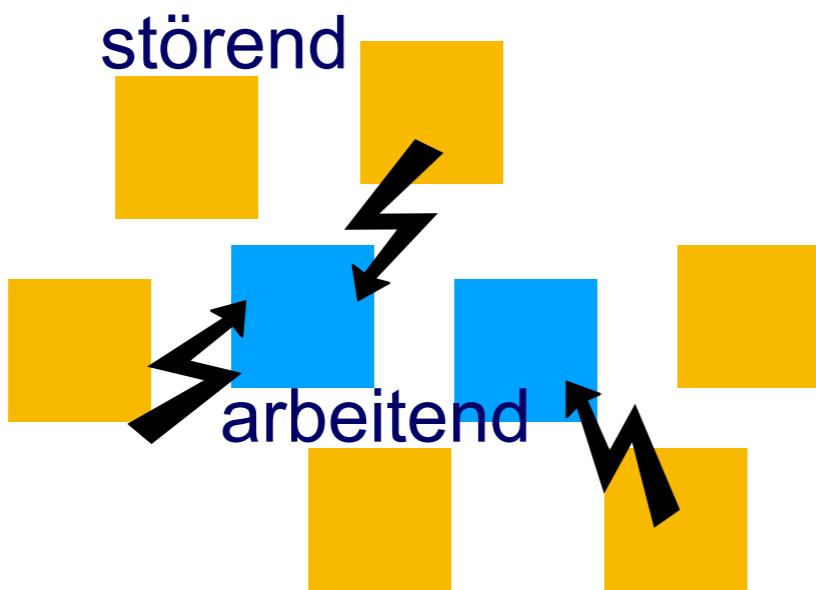
Schlechte Nachricht: Payback!



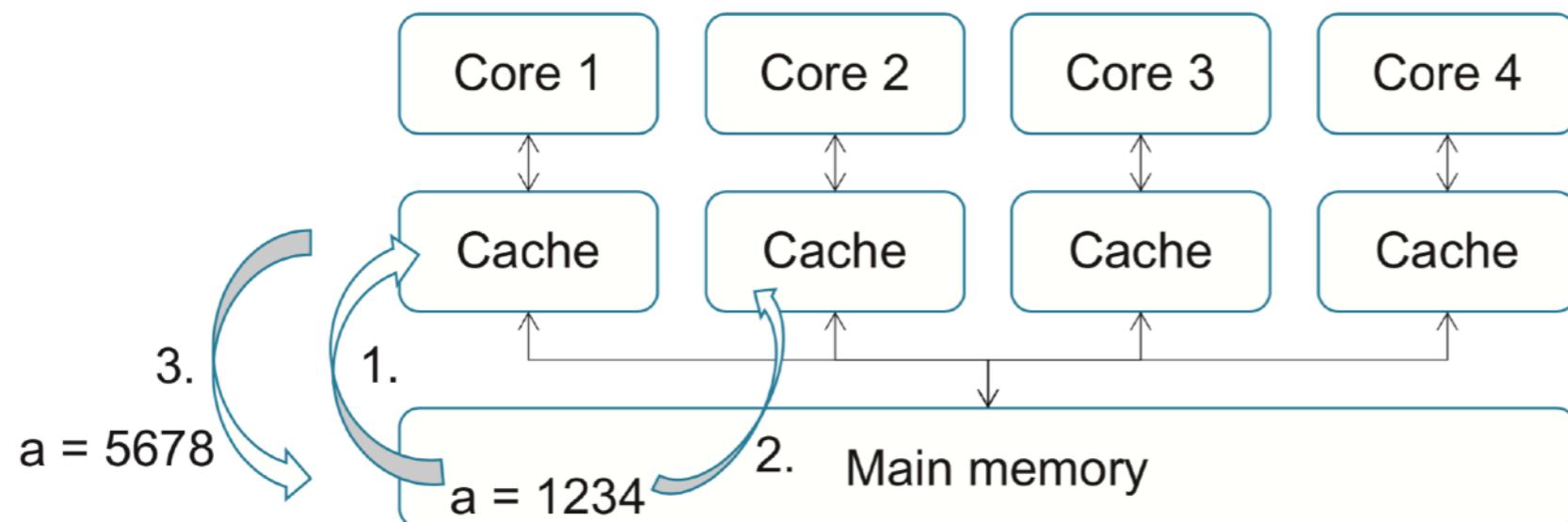
Geteilte Ressourcen und Warteschlangen



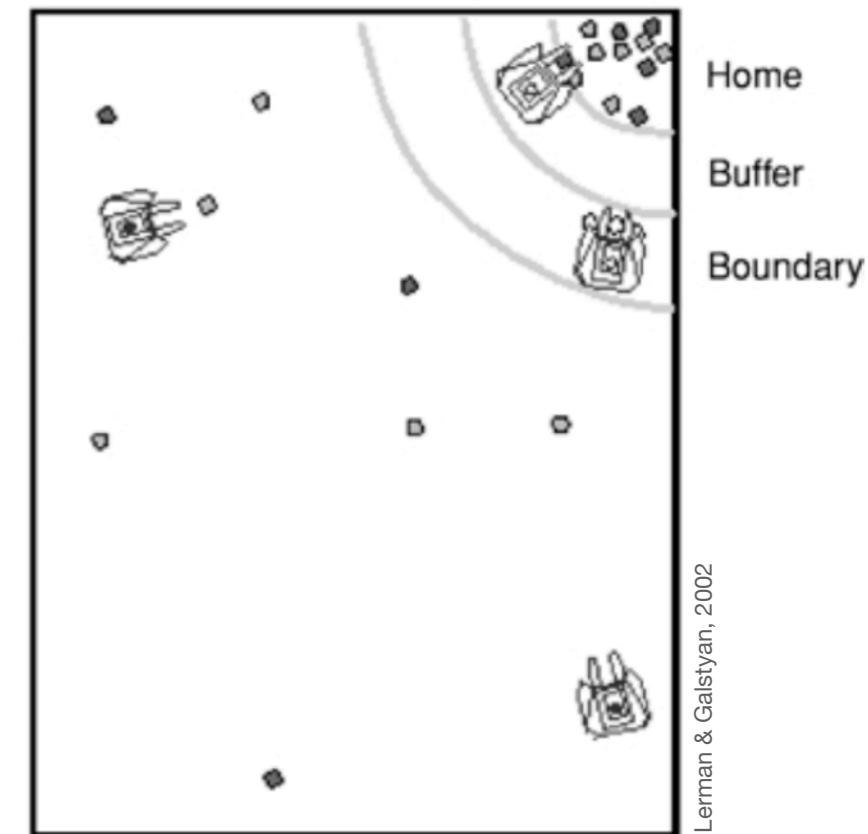
Kosten für Warteschlangen/Systemgröße



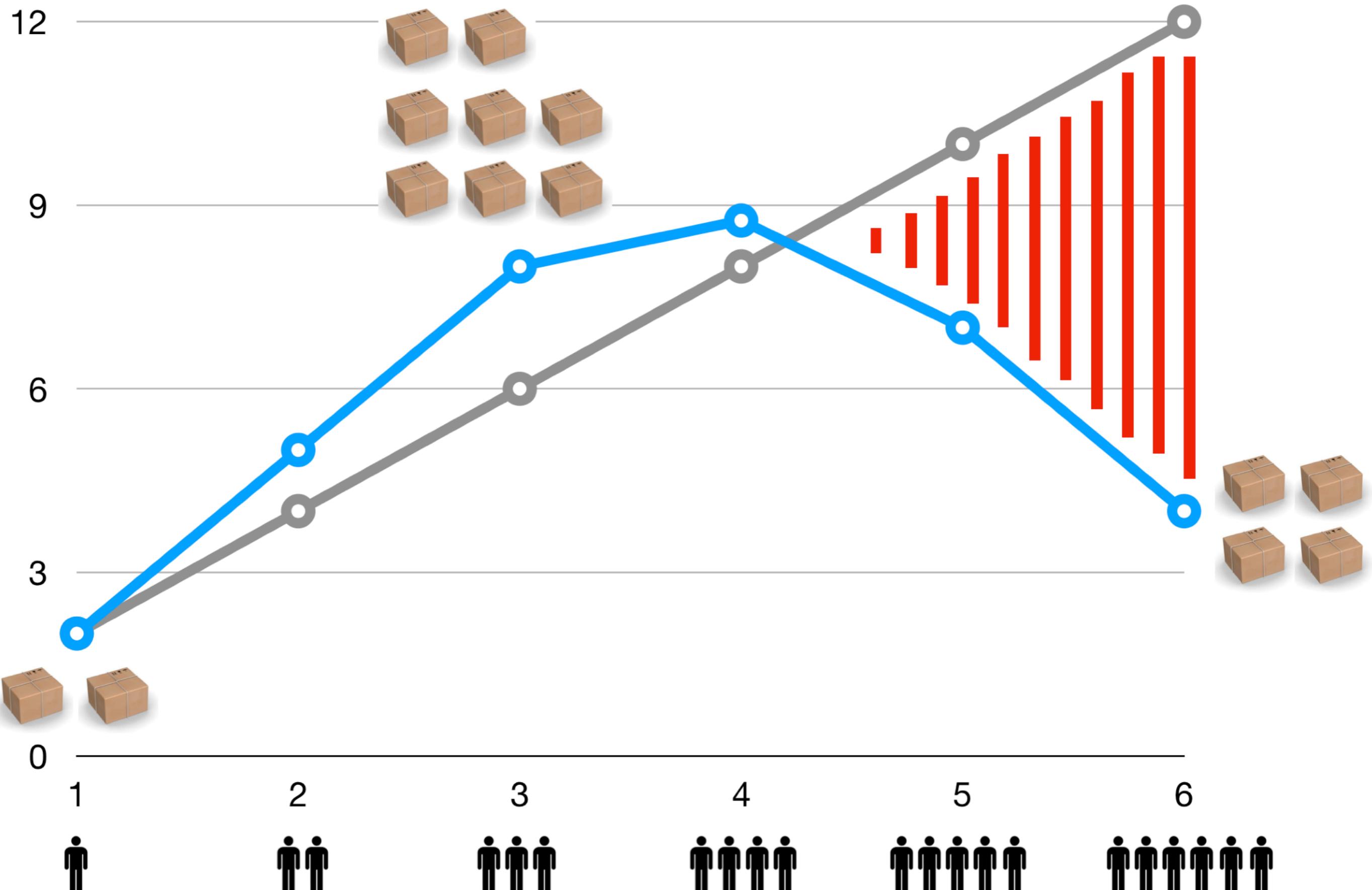
Aufwand für Speicher-Kohärenz:



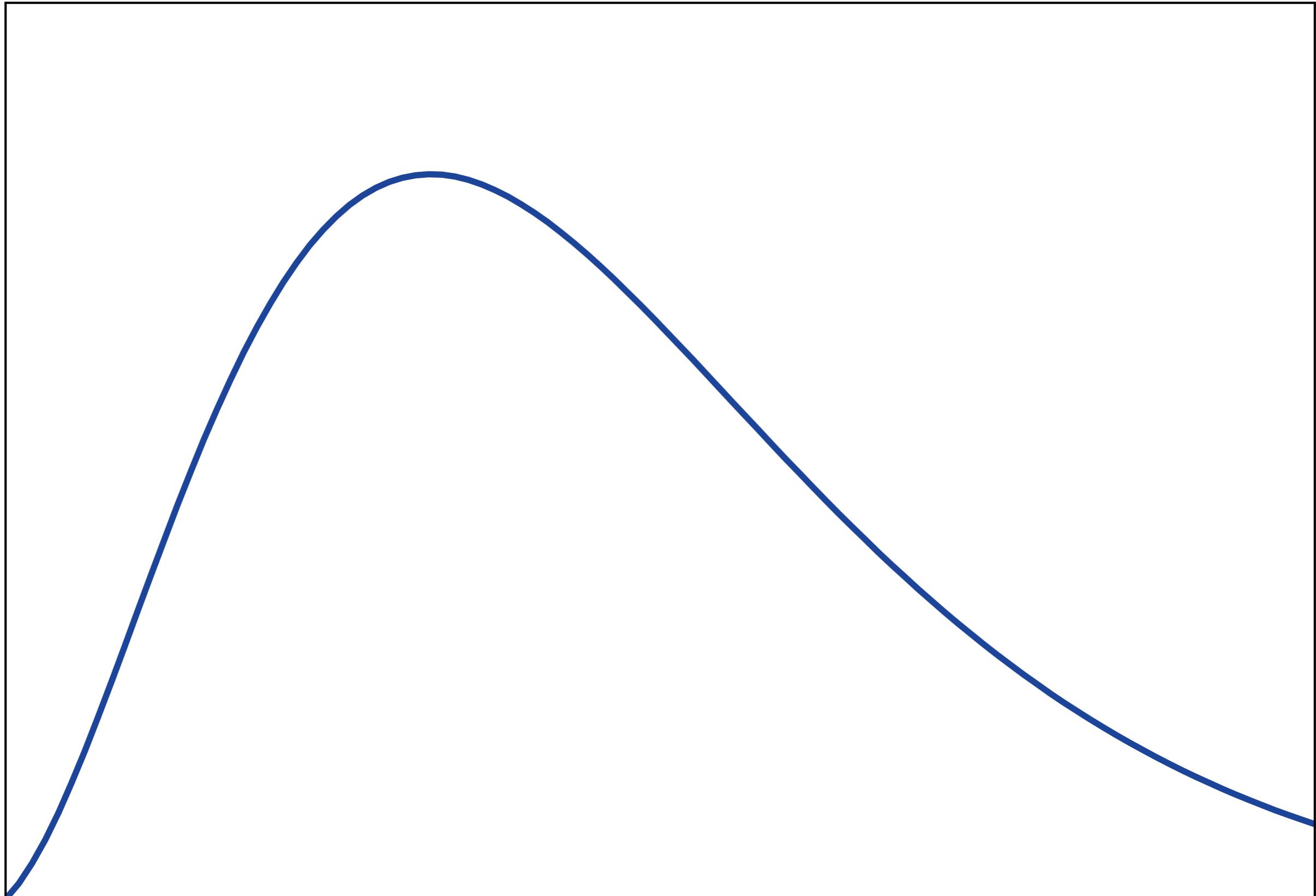
Multicore Software Development Techniques. DOI: <http://dx.doi.org/10.1016/B978-0-12-800958-1.00003-6>
© 2016 Elsevier Inc. All rights reserved.



Lerman & Galstyan, 2002

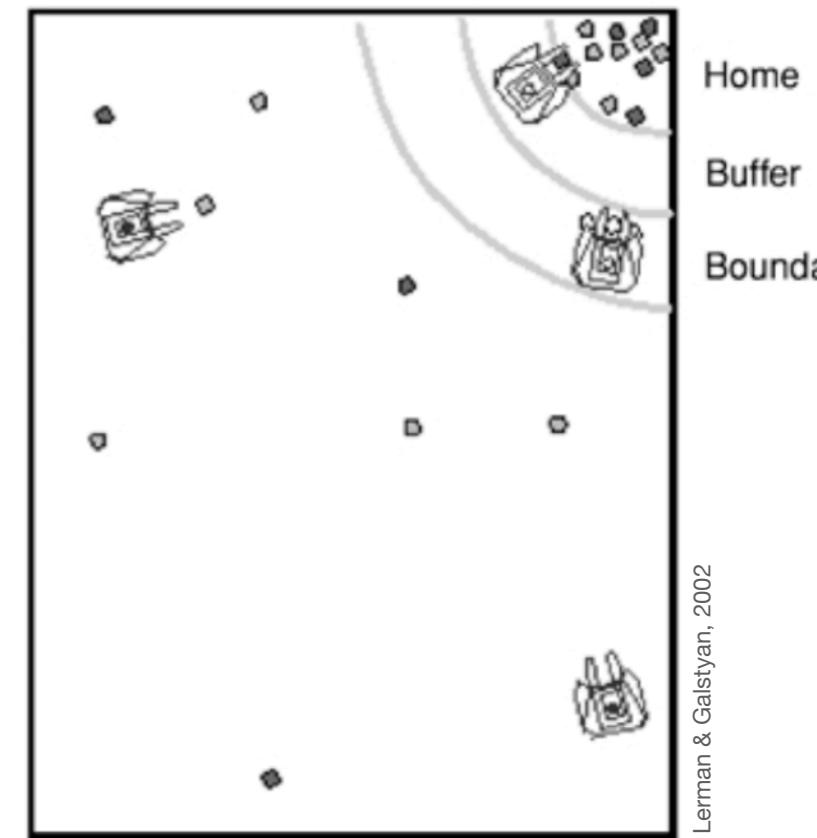
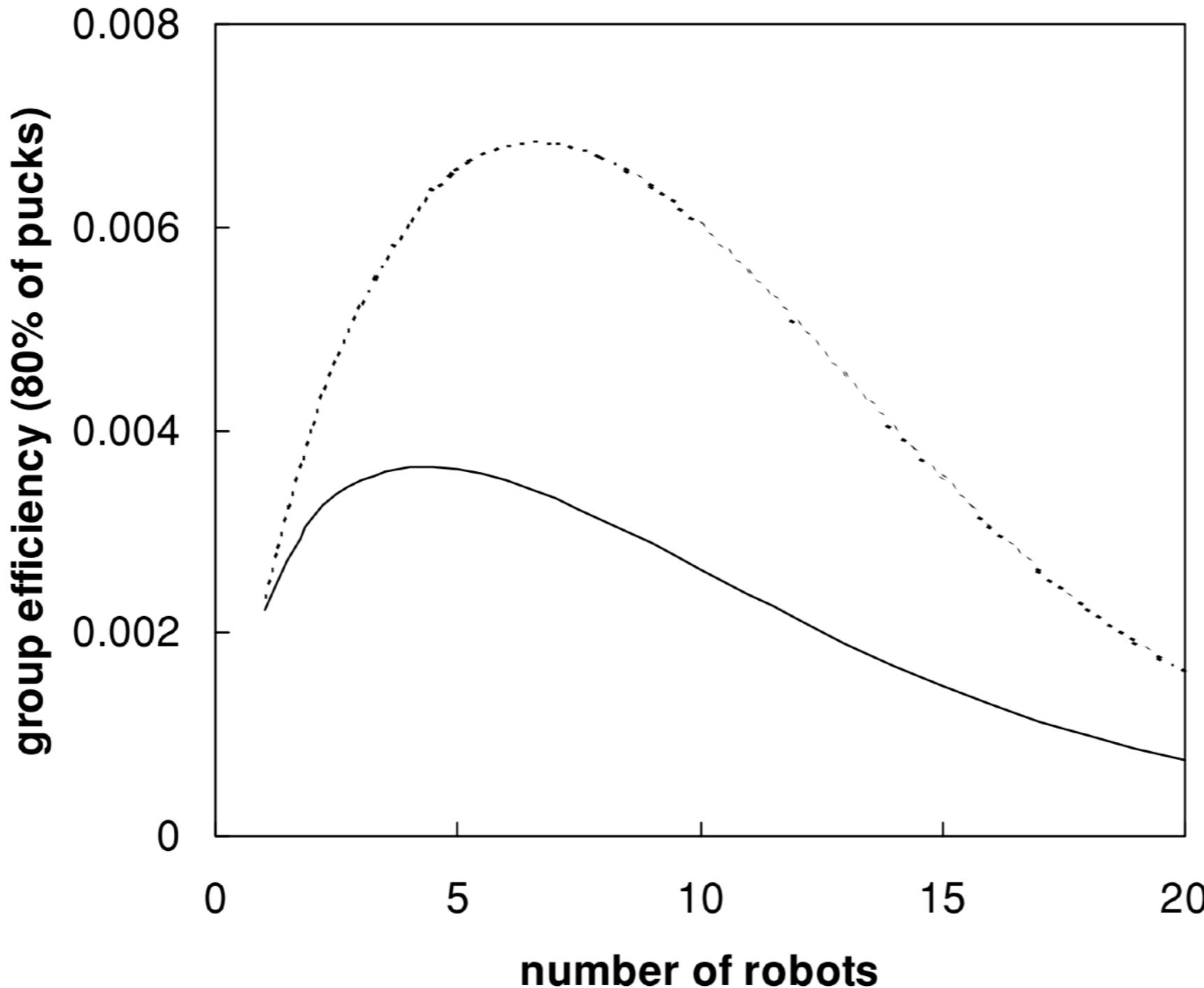


Leistung

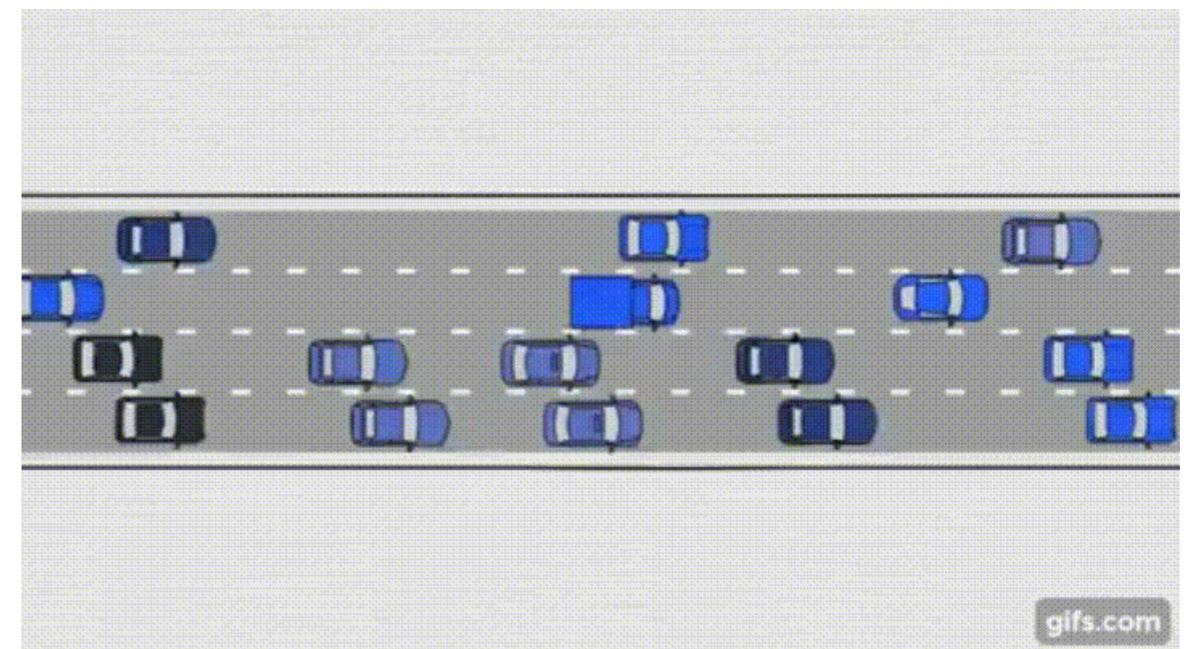
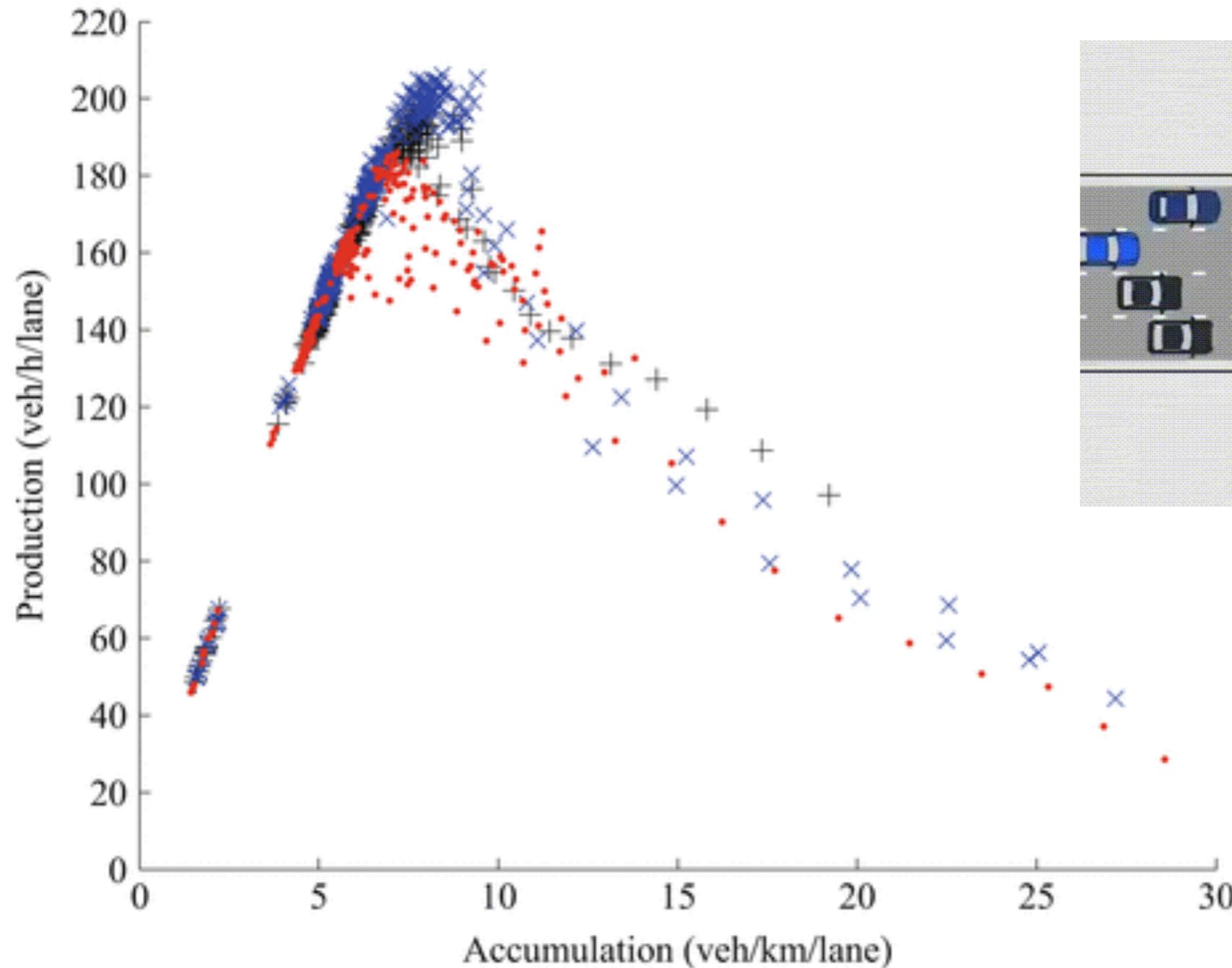


Systemgröße

Beispiel: Roboter-Team

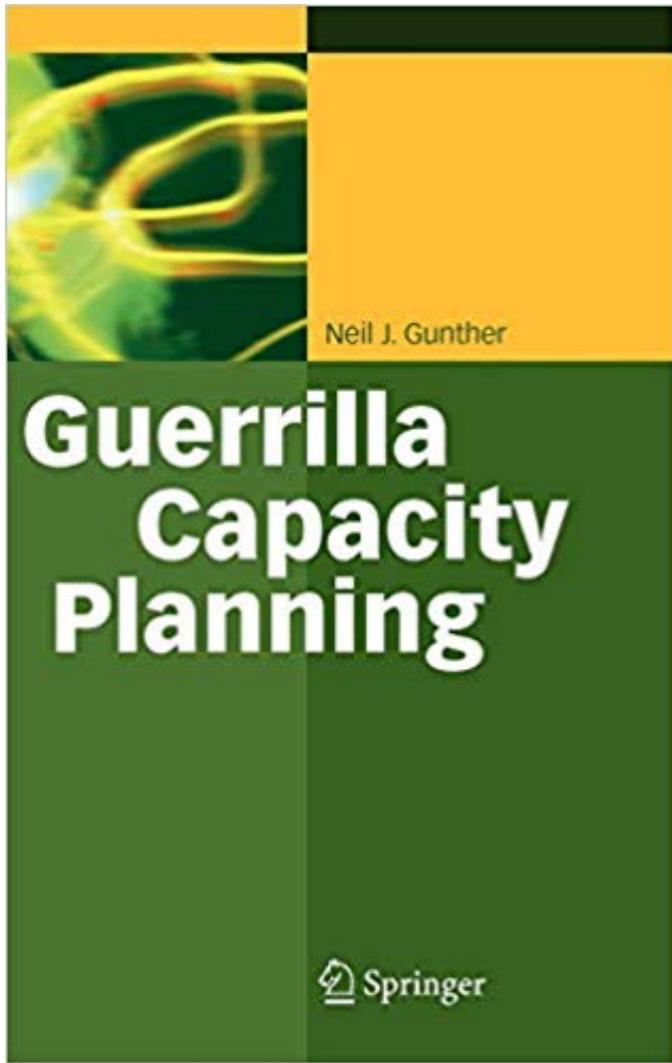


Beispiel: Straßenverkehr



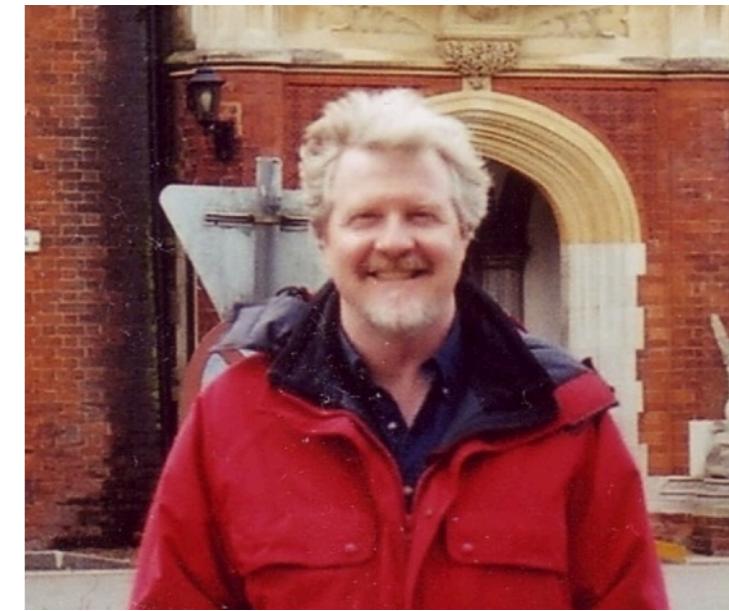
Stamos et al., Int.
Journal of Traffic
and Transp. Eng.,
2015

gesucht: Skalierungsgesetz



Universal Scalability Law

- Neil J. Gunther



$$L(N) = \frac{N}{1 + \alpha(N - 1) + \beta N(N - 1)}$$

L: Leistung

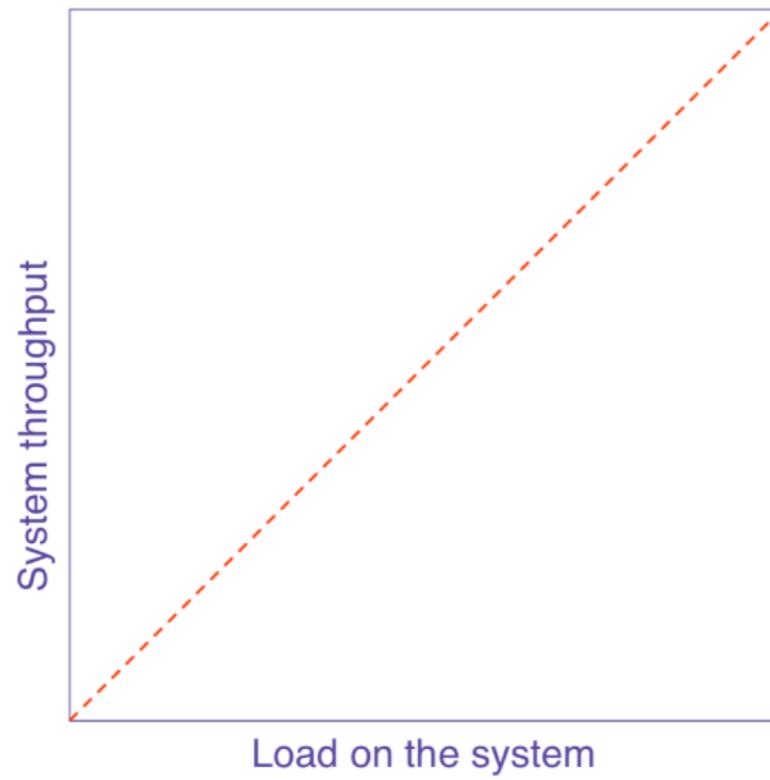
N: Systemgröße

α: Wettstreit um Zugriff auf geteilte Ressourcen

β: Aufwand durch mangelnde Kohärenz

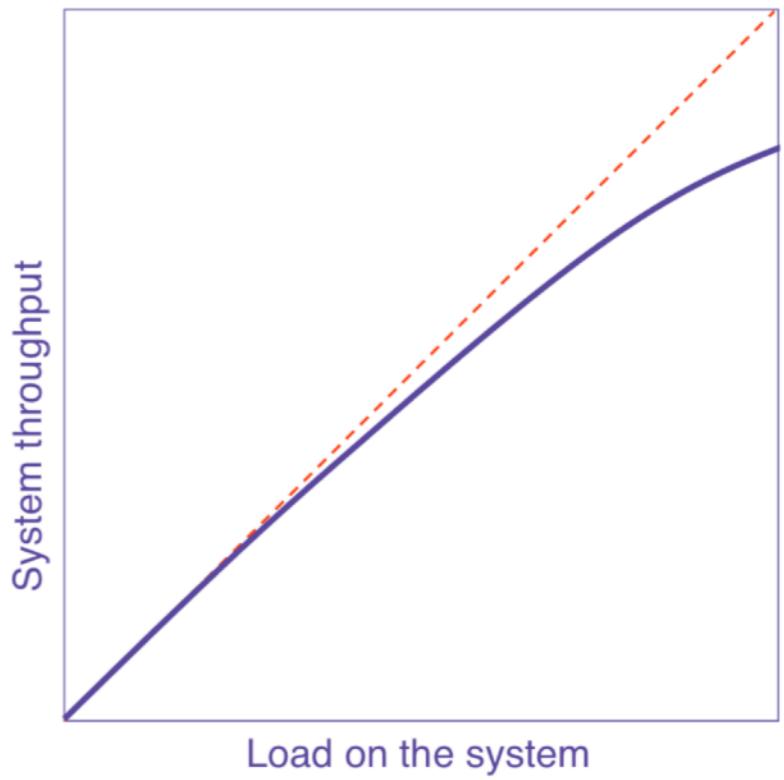
4+1 Szenarien

$$\alpha = 0, \beta = 0$$

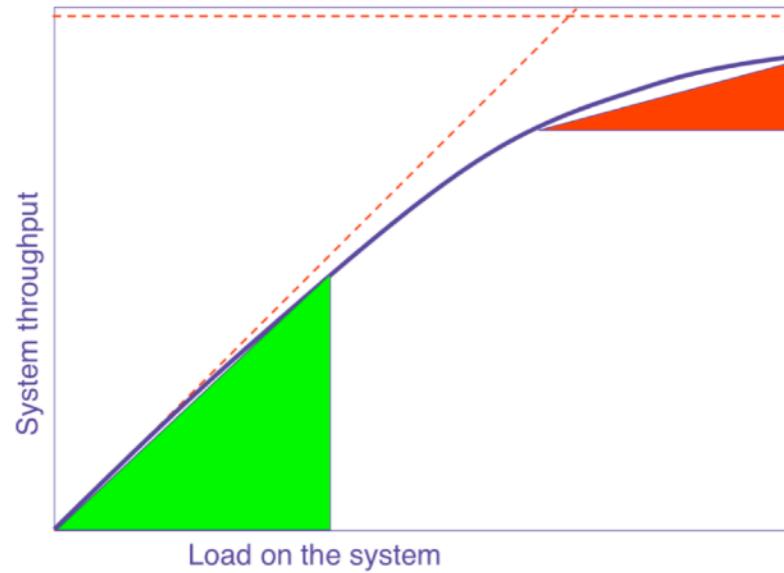


Load on the system

$$\alpha > 0, \beta = 0$$

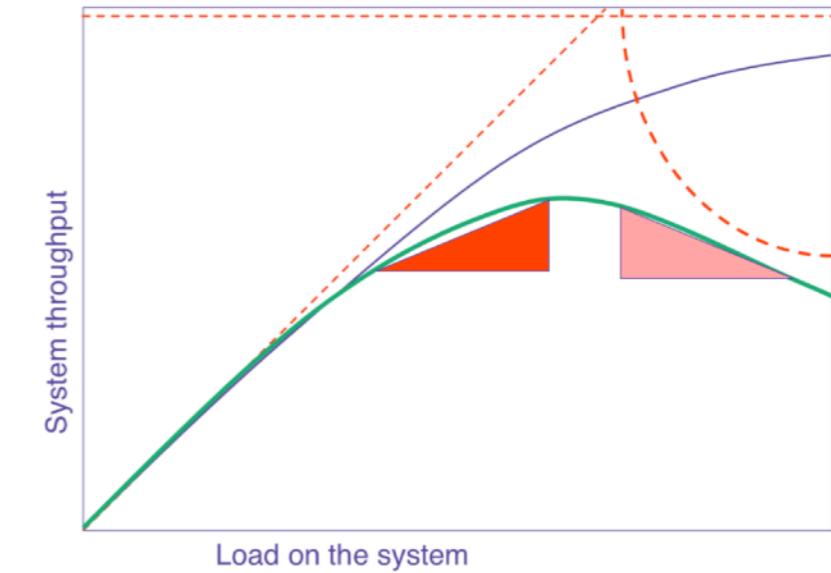


Load on the system



Load on the system

$$\alpha \gg 0, \beta = 0$$



Load on the system

$$\alpha \gg 0, \beta > 0$$

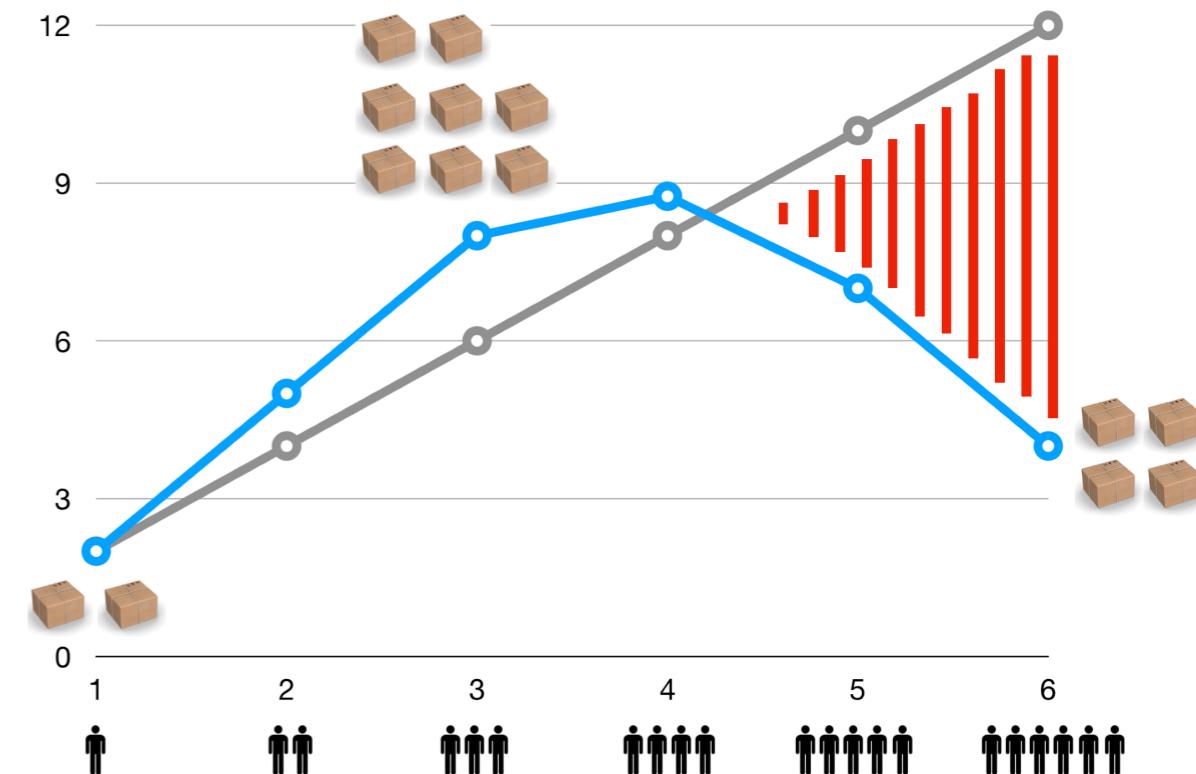
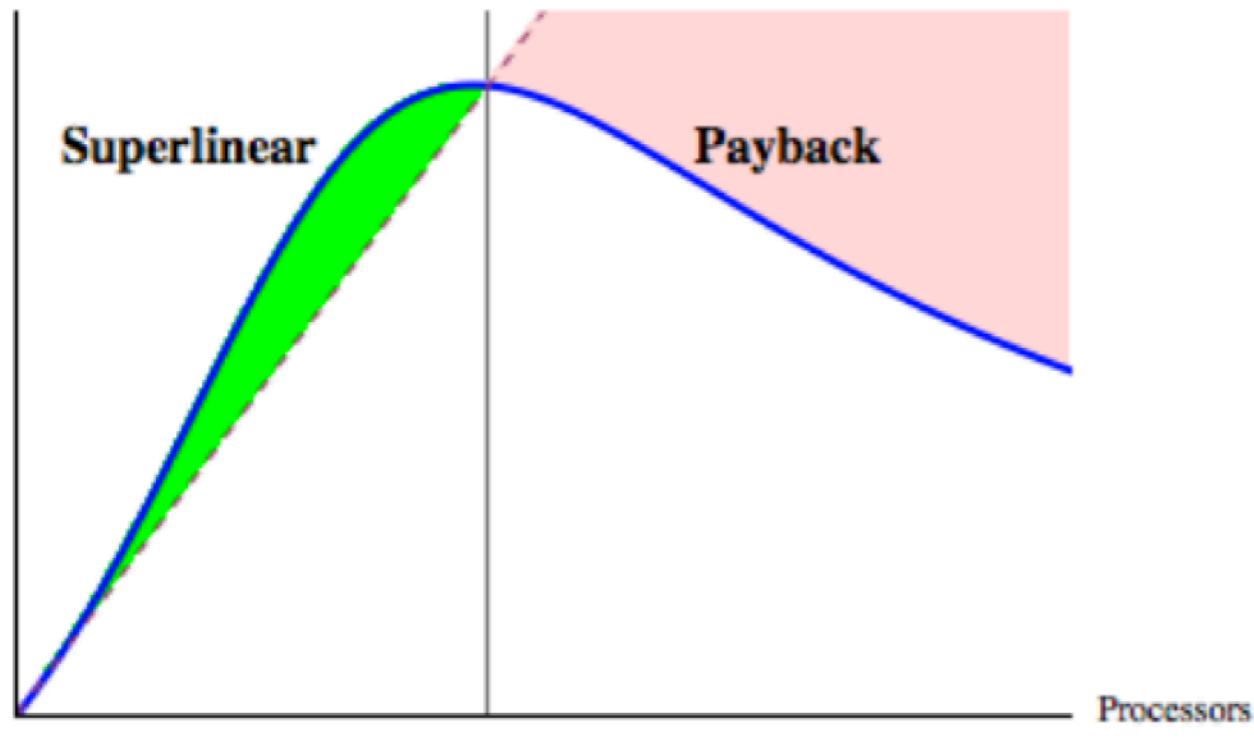
Szenario 5: super-linear

$$\alpha < 0, \beta > 0$$

negatives α : “negativer Wettstreit”
→ Kooperation



Speedup



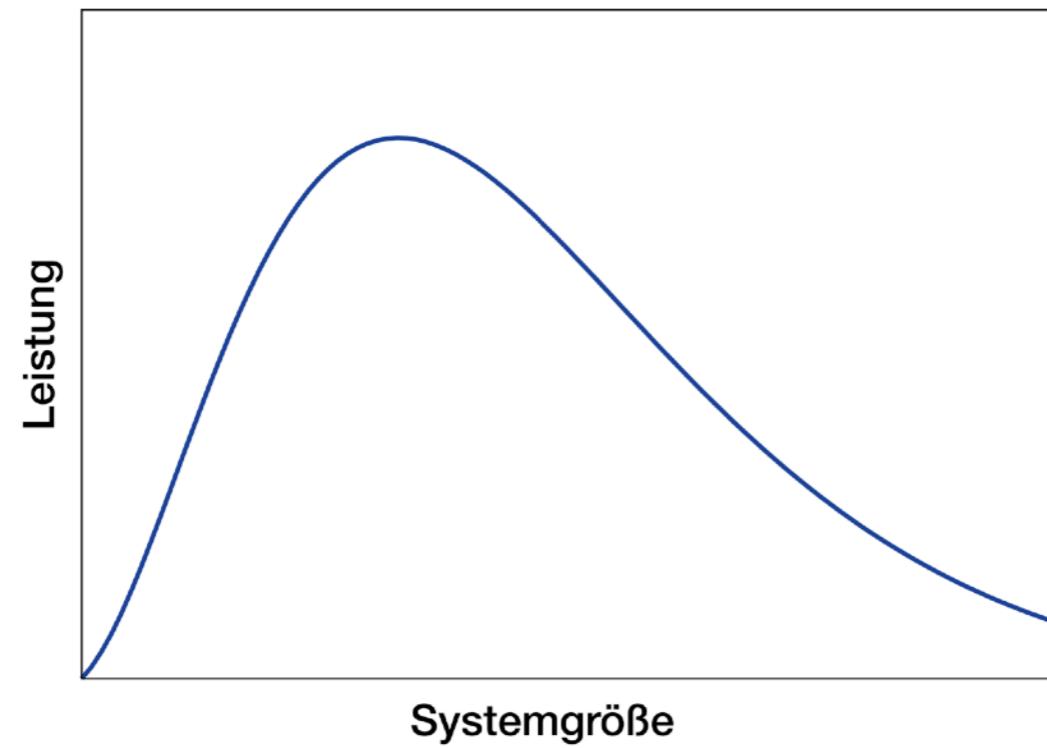
“Dort zahlen wir die Zeche für die (scheinbar) kostenlose super-lineare Fahrt.”

- Neil J. Gunther

“That’s where you pay the piper for (apparently) getting a super-linear ride for free.”

- Neil J. Gunther

Fazit



Gruppe ermöglicht **Kooperation**

zu viel ist zu viel (Interferenz und Payback)

Skalierbarkeit

Potential für **super-linearen** Leistungsanstieg

Arbeitspakete in **idealer Größe**

