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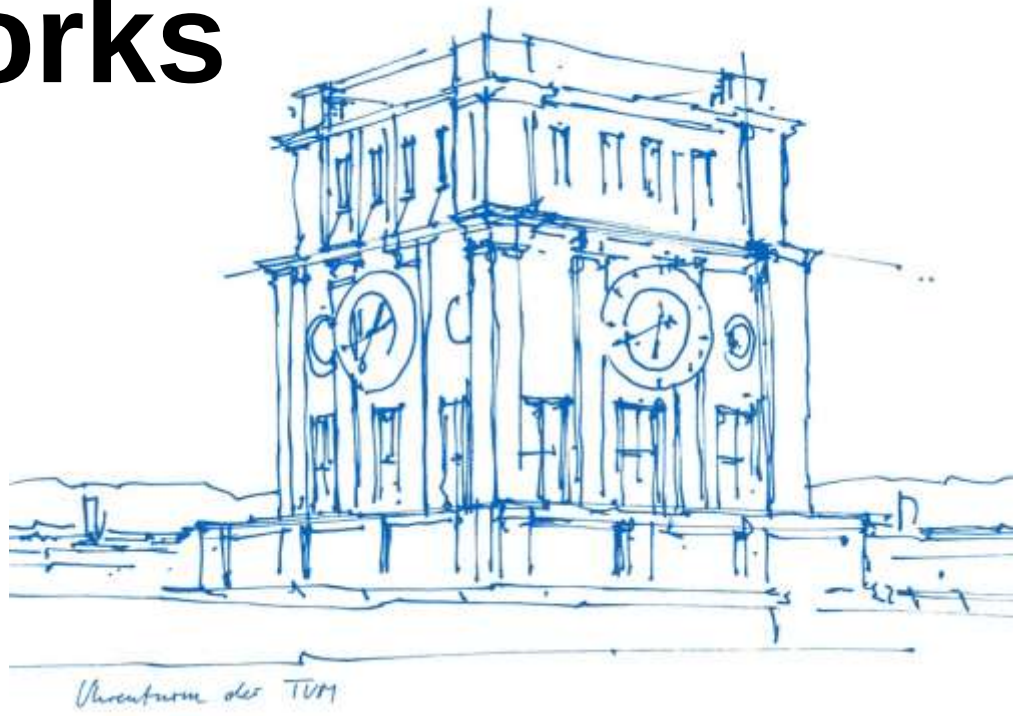
Technological Sovereignty in Communication Networks



Prof. Dr.-Ing. Wolfgang Kellerer

Thinknet 6G Summit

Munich, Germany

Oct. 17, 2024

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Bundesministerium für Bildung und Forschung

6G-life

Gefördert durch Bayerisches Staatsministerium für Wirtschaft, Landesentwicklung und Energie

6G BAVARIA

Motivation

[1]

CROWDSTRIKE

[2]

[1] M. J. Loveridge, G. Remy, N. Kourra, R. Genieser, A. Barai, M. J Lain, Y. Guo, M. Amor-Segan, M. A. Williams, T. Amietszajew et al., “Looking deeper into the galaxy (note 7),” Batteries, vol. 4, no. 1, p. 3, 2018.

[2] CrowdStrike, “Executive Summary: CrowdStrike Preliminary Post Incident Review (PIR): Content Configuration Update Impacting the Falcon Sensor and the Windows Operating System (BSOD)”, 2024.

[3] L. Kelion, “Huawei 5G kit must be removed from UK by 2027,” BBC News, July 2020. [Online]. Available: https://www.bbc.com/news/ technology-53403793.

How does sovereignty affect network operators?

LA VANGUARDIA

Economy

POCKET / PERSONAL FINANCE / ENTREPRENEURS / INNOVATION / LEGAL / FREE ZONE CONSORTIUM SUBSCRIBE

TELECOMMUNICATIONS

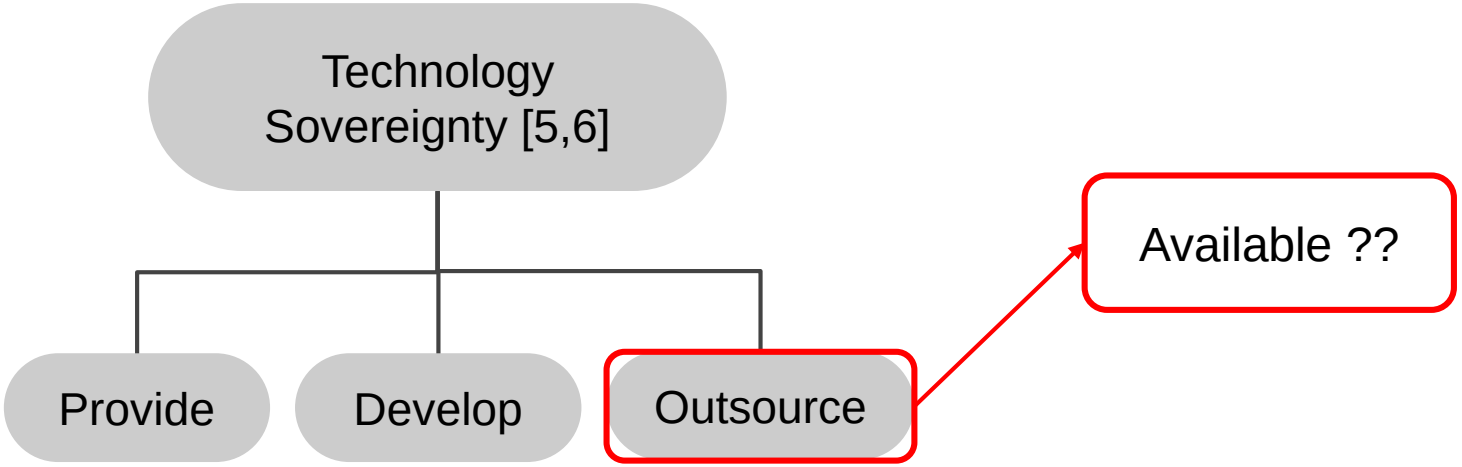
The Government launches the call for rural 5G with anti-Chinese clause

• The Executive also prevents an operator from monopolizing more than between 30 and 35 provinces

If a supplier is declared "high risk" the operator will have to change the material at his own expense.

[4] Jaume Masdeu for Econmoia, La Vanguardia, dated 09.10.2023.

What is sovereignty in networks?



Sovereignty = Ability of an institution to provide a service **without any structural dependencies**.

[5] Edler, Jakob, et al. Technology Sovereignty: from demand to concept. No. 02/2020. Perspectives-Policy Brief, 2020.
[6] Weber, Arnd, et al. "Sovereignty in information technology." Security, safety and fair market access by openness and control of the supply chain. Karlsruhe: KIT-ITAS, 2018.

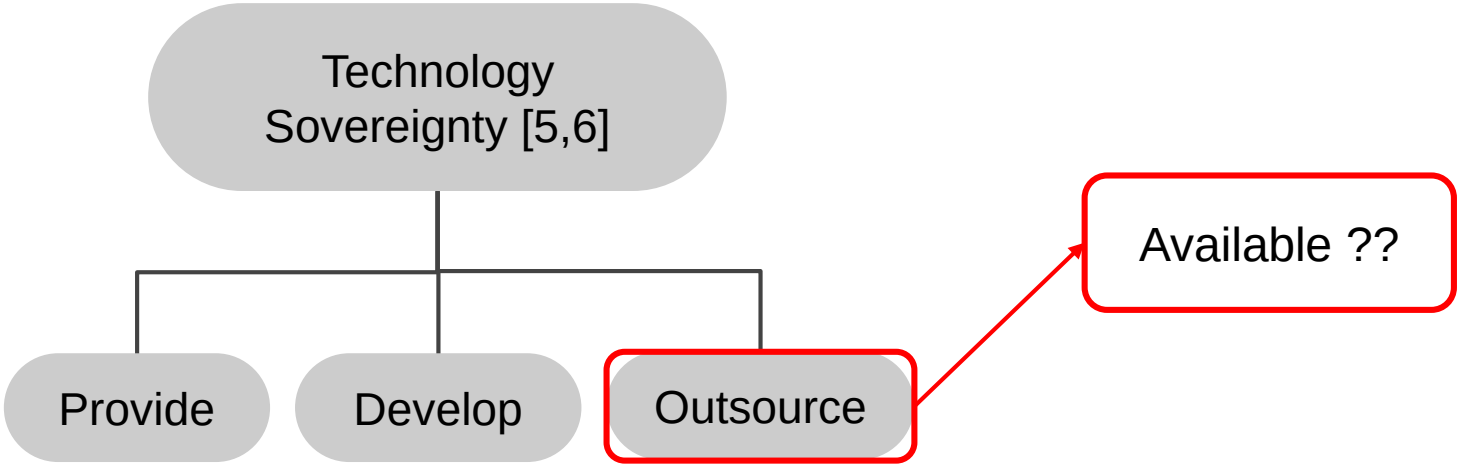
Technological Sovereignty in Communication Networks

Our contribution

1. A novel metric to capture network sovereignty
   - ➢ Network planning besides availability

2. Realization of network sovereignty
   - ➢ An end-to-end cellular system
     based on products of three local startups
     (see demo tomorrow)

What is sovereignty in networks?



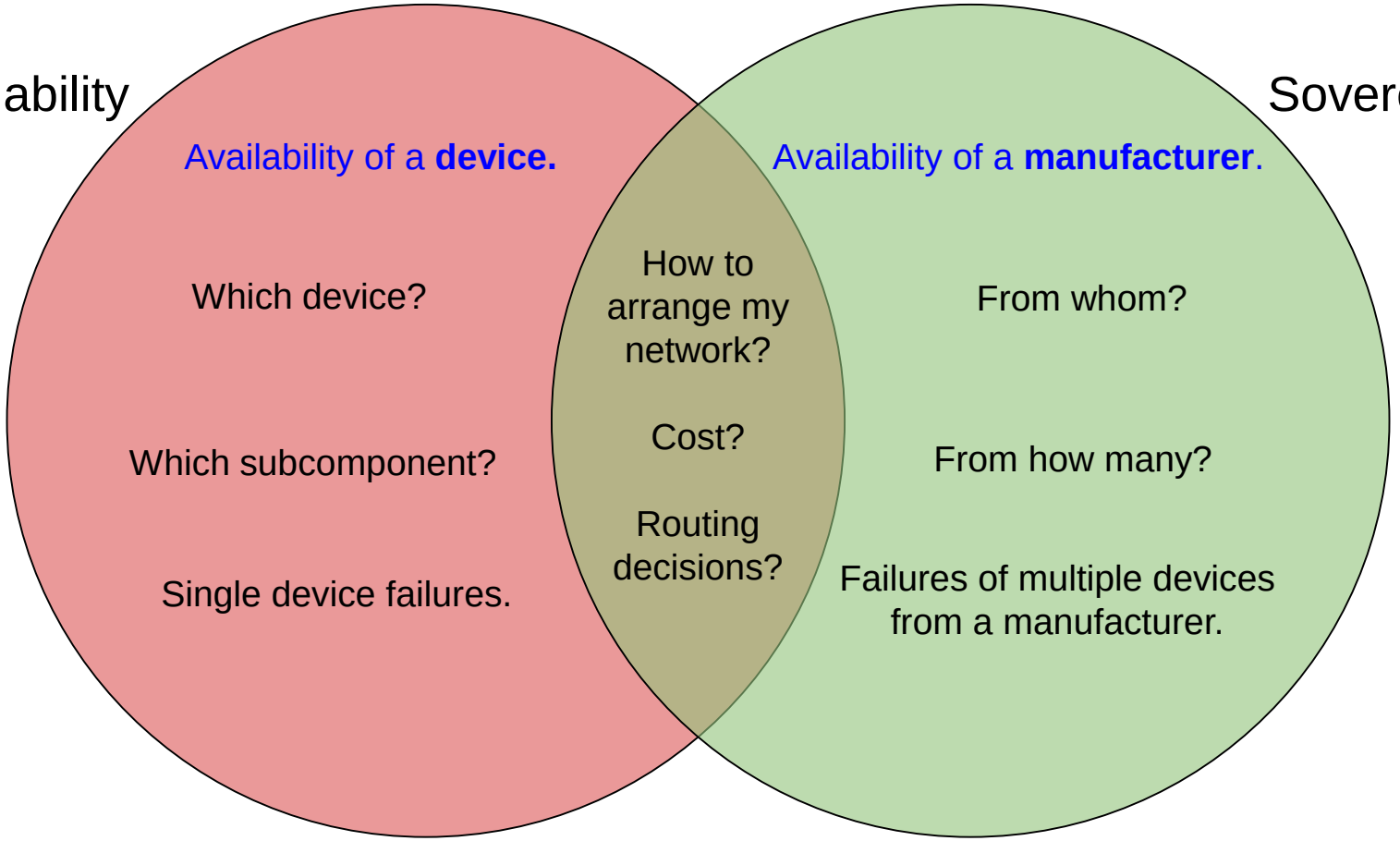
Sovereignty = Ability of an institution to provide a service **without any structural dependencies**.

Availability = Probability that a device delivers its service at a particular time instant.

Reliability = Ability of a device to deliver uninterrupted service over a period of time.

[5] Edler, Jakob, et al. Technology Sovereignty: from demand to concept. No. 02/2020. Perspectives-Policy Brief, 2020.
[6] Weber, Arnd, et al. "Sovereignty in information technology." Security, safety and fair market access by openness and control of the supply chain. Karlsruhe: KIT-ITAS, 2018.

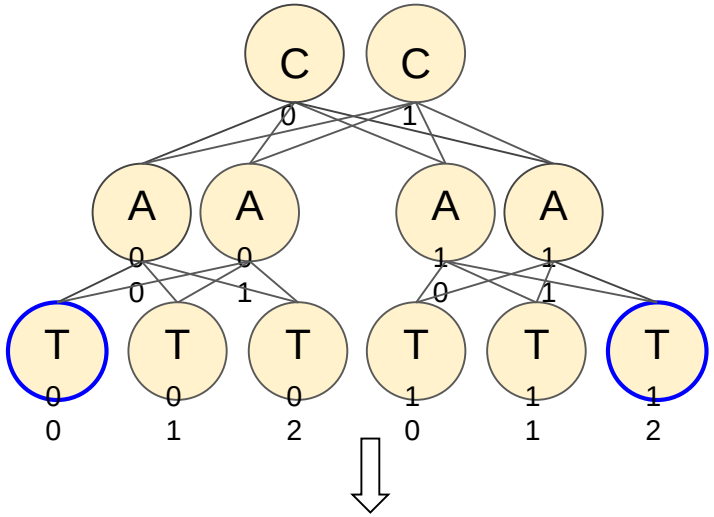
Availability vs Sovereignty



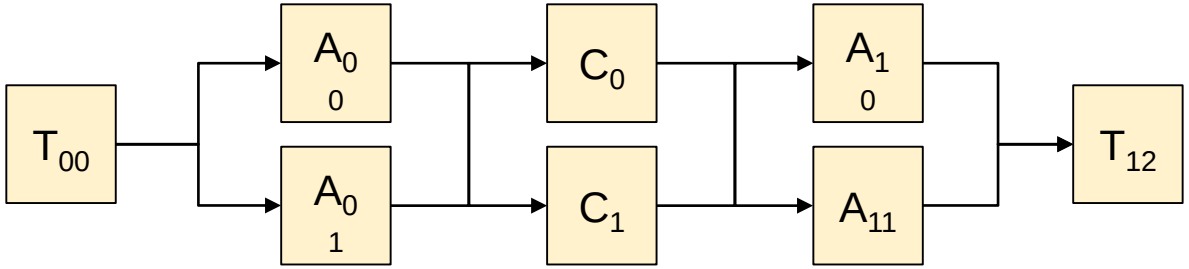
Network operator

Are they the same?

Availability vs Sovereignty



RBD

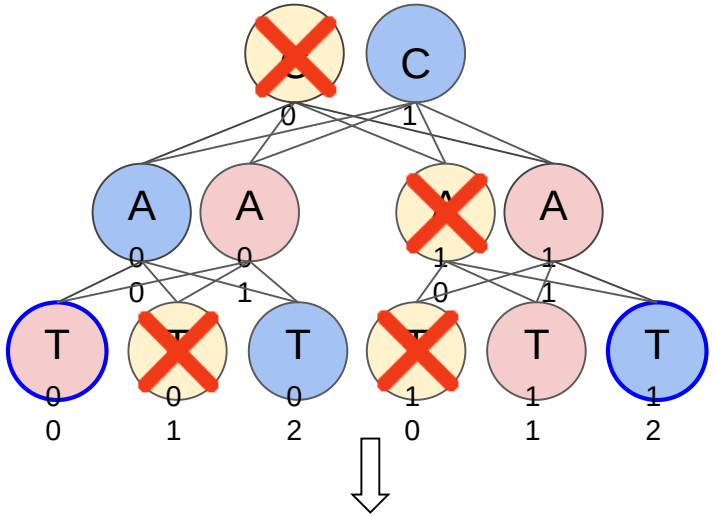


For all components,
A = 0.999

A_F = 0.997998006

Availability	0.998
Sovereignty	-

Availability vs Sovereignty

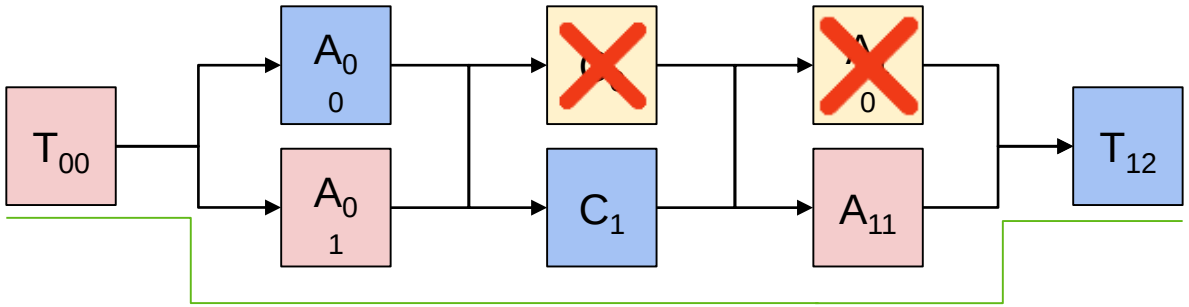


A = 0.999

A = 0.999

A = 0.999

RBD



Now,
A_F = 0.984985973

Previous case:
A_F = 0.997998006

Availability	0.998
Sovereignty	+

→ A special attribute of dependability

For communication networks, we define network sovereignty as a network operator's ability to operate a network without any dependencies on component manufacturers

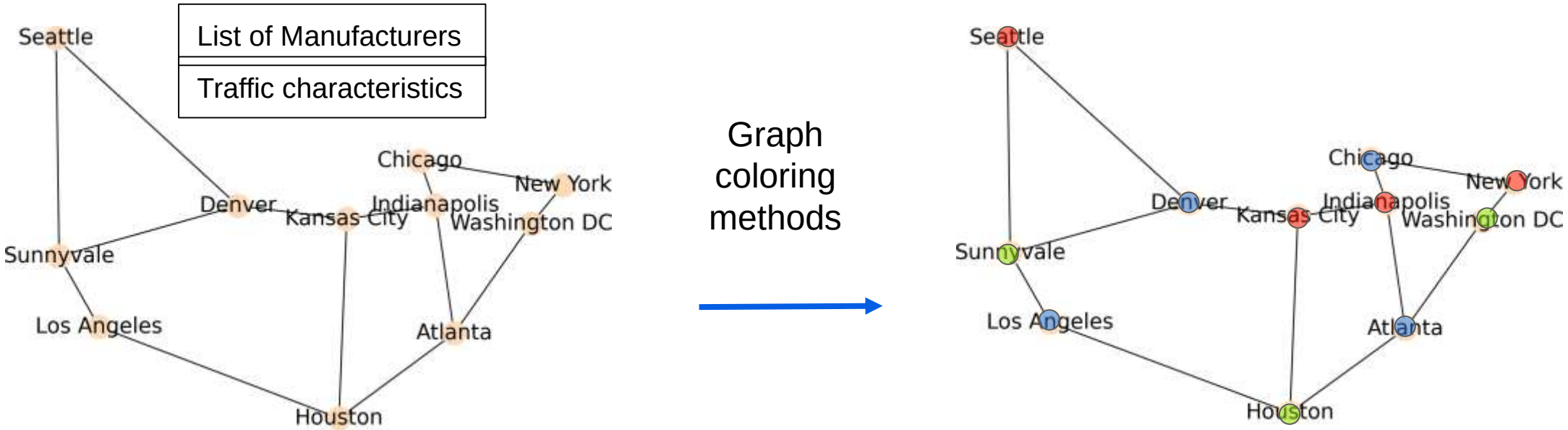
[7] S. Janardhanan, M. Samonaki, P. E. Heegaard, W. Kellerer and C. Mas-Machuca, "Network Sovereignty: A Novel Metric and Its Application on Network Design," in IEEE Transactions on Reliability, 2024, doi: 10.1109/TR.2024.3434560.

Example application of network sovereignty

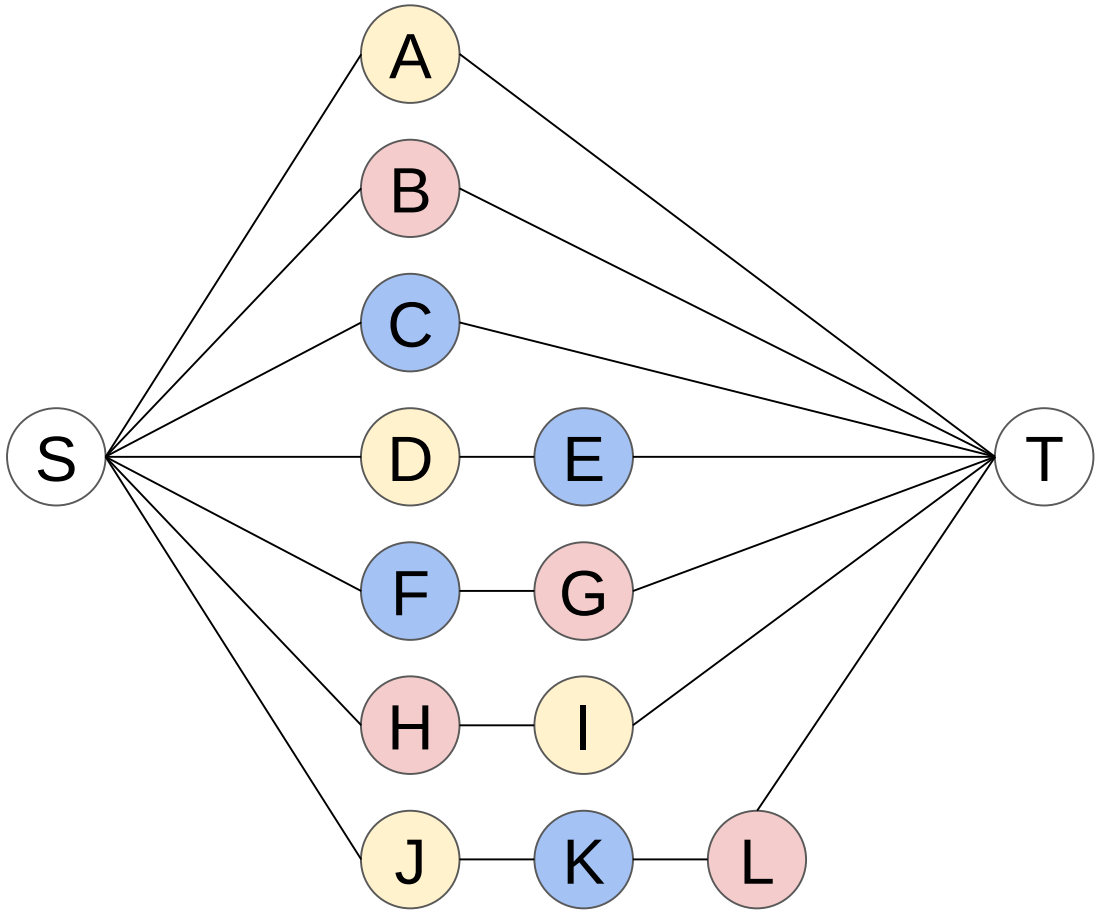
Manufacturer Assignment for Sovereignty (MAS) problem

Given a network, the expected traffic, the number of manufacturers in the market,

What is the best manufacturer assignment possible such that the impact of manufacturer failures is minimized?

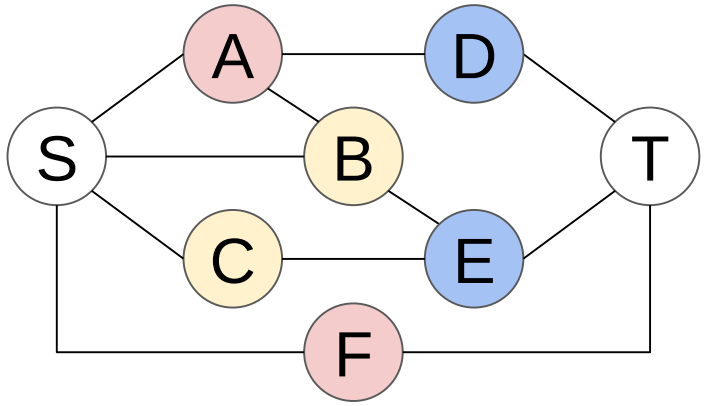


Path Set Diversity Score (PSD Score)



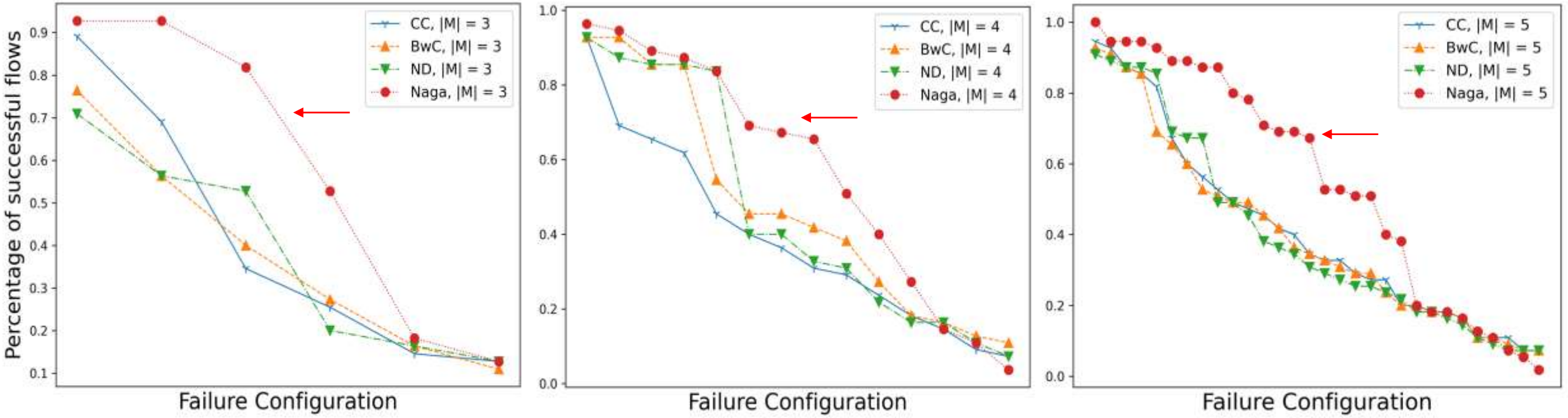
Path no.	Path	*M* in Path		s = 1 / |*M*| in path
		Label	Number	
1	S-A-T	Y	1	1/1
2	S-B-T	R	1	1/1
3	S-C-T	B	1	1/1
4	S-D-E-T	Y,B	2	1/2
5	S-F-G-T	B,R	2	1/2
6	S-H-I-T	R,Y	2	1/2
7	S-J-K-L-T	Y,B,R	3	1/3
PSD Score for flow from S to T				**4.83**

Path Set Diversity Score (PSD Score)



Path no.	Path	*M* in Path		s = 1 / |*M*| in path
		Label	Number	
1	S-F-T	R	2	1/2
2	S-A-D-T	R,B	2	1/2
3	S-B-E-T	Y,B	2	1/2
4	S-C-E-T	Y,B	Removed, redundant to Path 3	
5	S-A-B-E-T	R,Y,B	3	1/3
6	S-B-A-D-T	Y,R,B	Removed, redundant to Path 5	
7	S-C-E-B-A-D-T	Y,R,B	Removed, redundant to Path 5	
PSD Score for flow from S to T				2.33

Path set approach - Initial Results, Abilene Topology



Naga is our algorithm to plan for network sovereignty

Naga outperforms all heuristics for any number of manufacturers.
Results are consistent across other topologies.
|M| : number of manufacturers

[7] S. Janardhanan, M. Samonaki, P. E. Heegaard, W. Kellerer and C. Mas-Machuca, "Network Sovereignty: A Novel Metric and Its Application on Network Design," in IEEE Transactions on Reliability, 2024, doi: 10.1109/TR.2024.3434560.

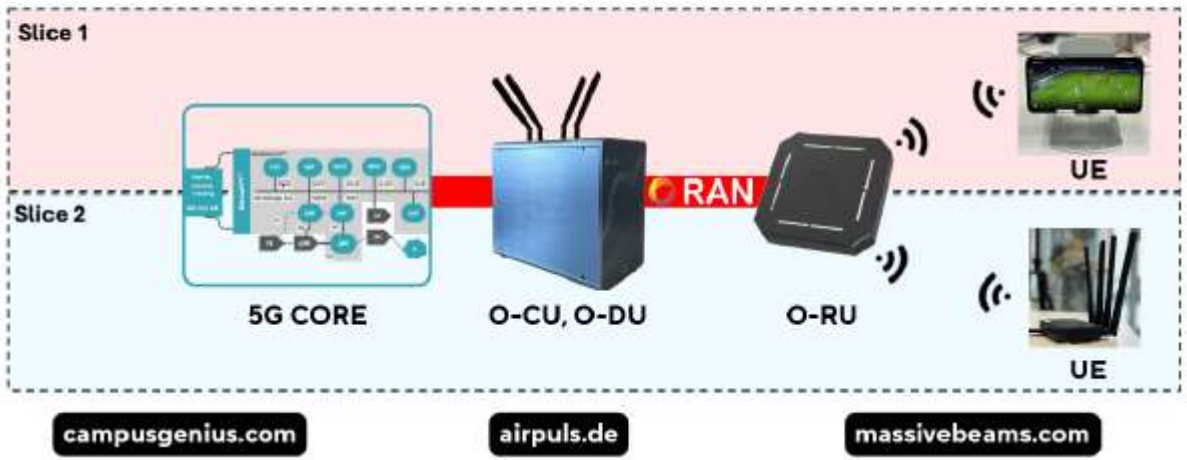
How can we improve network sovereignty in practice?

Increase reliability and trustworthiness of manufacturers - local manufacturers!

6G

TECHNOLOGICAL SOVEREIGNTY MADE IN GERMANY.

ADAPTIVE NETWORK SLICING LIVE DEMO



CAMPUS GENIUS

airpuls

MASSIVE BEAMS

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