REALITY CHECK: LOOK IN THE REAR MIRROR

- 5G is still an *Access Network*

  - TelcoCloud is NOT user cloud

- 5G Philosophy: Three Musketeers

  - **Slicing is the new IMS**: operator has to provide the right service or slice for all

    - Operator-provided slice to make somebody else happy? Economic "externality"

- Observations and implications

  - You have 10 devices but with 5G, you still can't download a file from one to another

  - Operators have a lucrative business but need to engage with 1000 new industries to make them all happy

    - 5GAA, 5GACIA, 5GHA, 5GTHIS, 5GTHAT, …. is 3GPP underachieving?

  - Verticals can buy 5G devices, but no core dedicated to their needs

    - Instead they end up with EPC/5GC designed by telcos for telcos

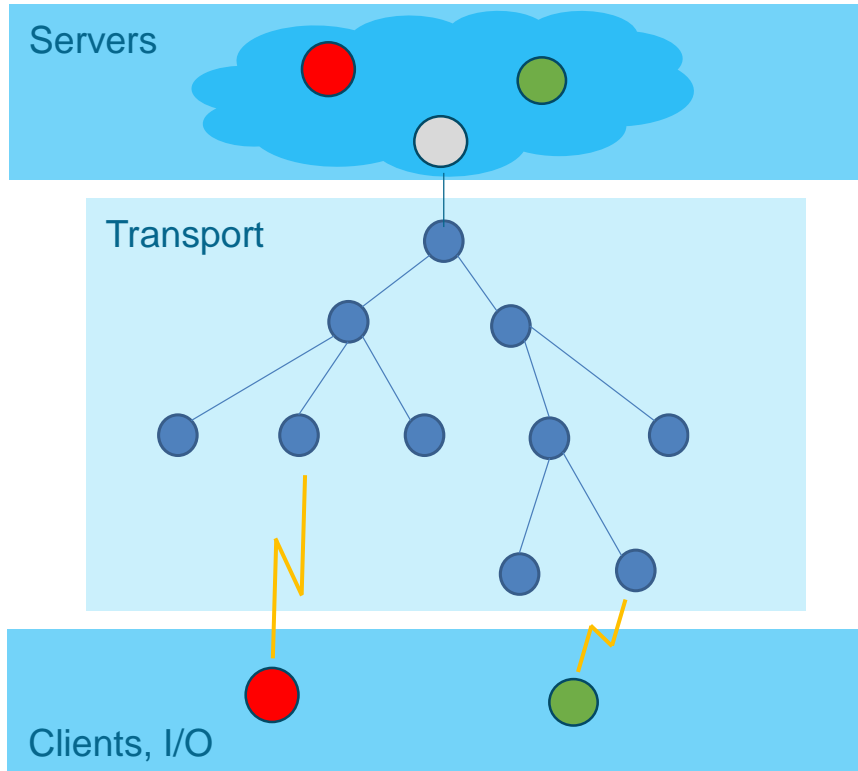 - Nobody takes care of E2E service, but everybody claims it's so important

The Three Musketeers
Alexandre Dumas
xist classics
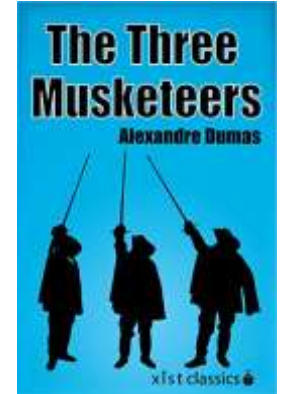
All for Bell, Bell for All

MENTAL PICTURES

Until 5G: Sandwich

Servers

Transport

Clients, I/O

Strict separation of compute/connectivity
In principle, solved and obsolete

Emerging reality

Cloud / Network Provider A
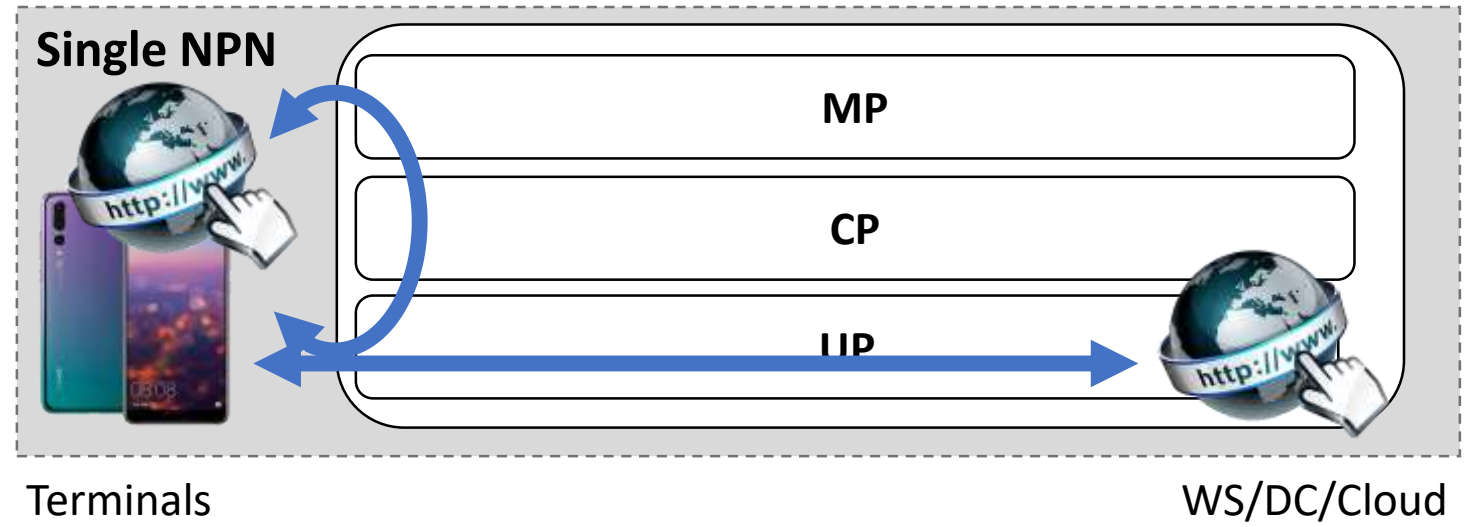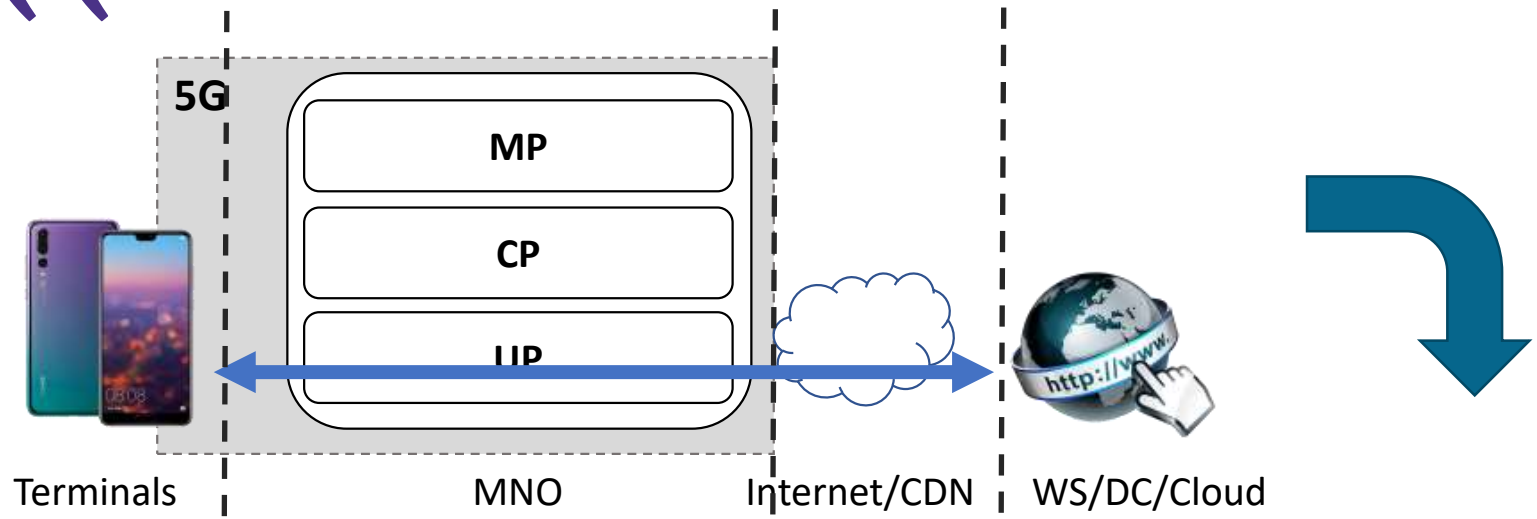
Network Provider 1

NPN1
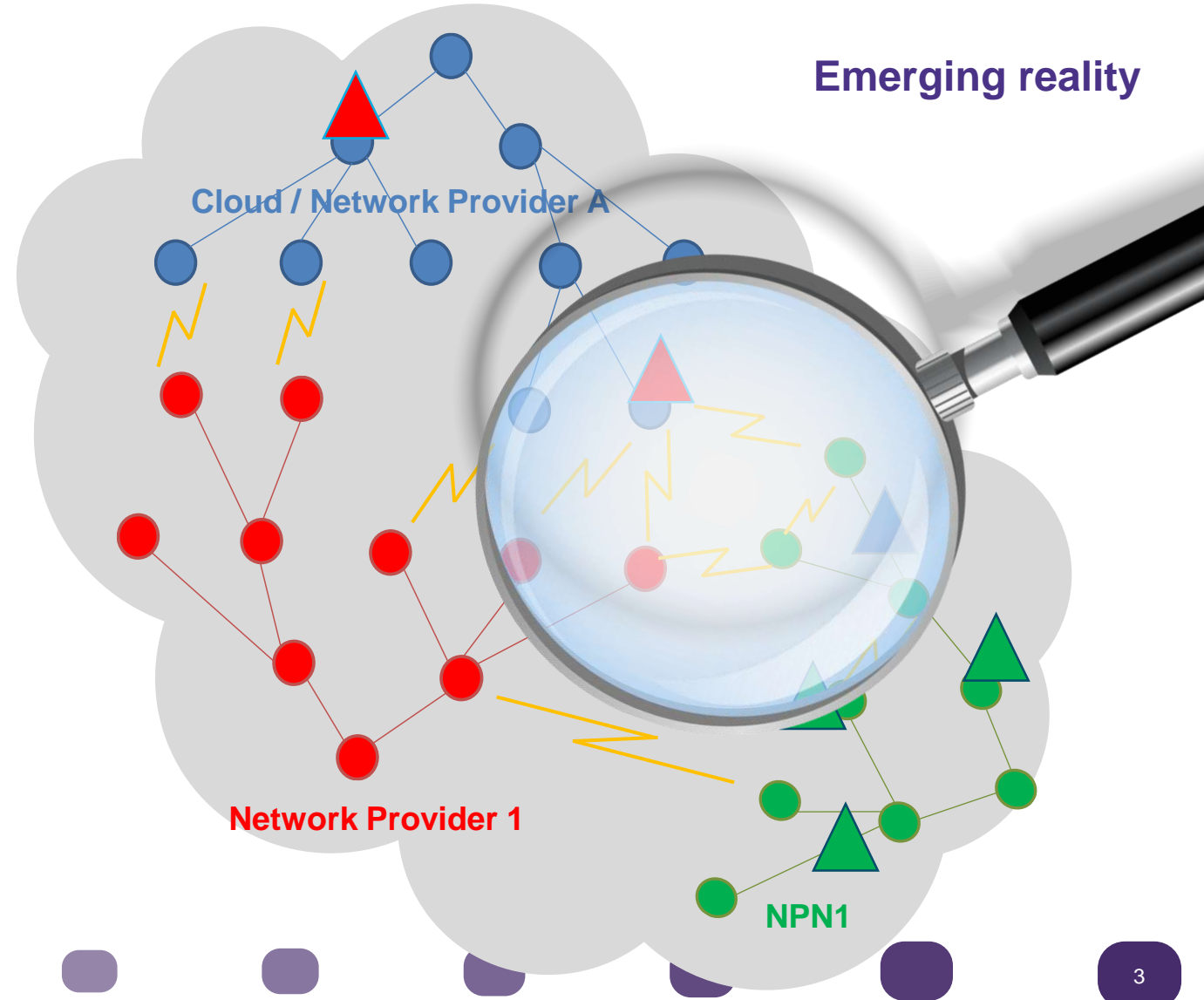
Open Multitenancy

Full Local Service
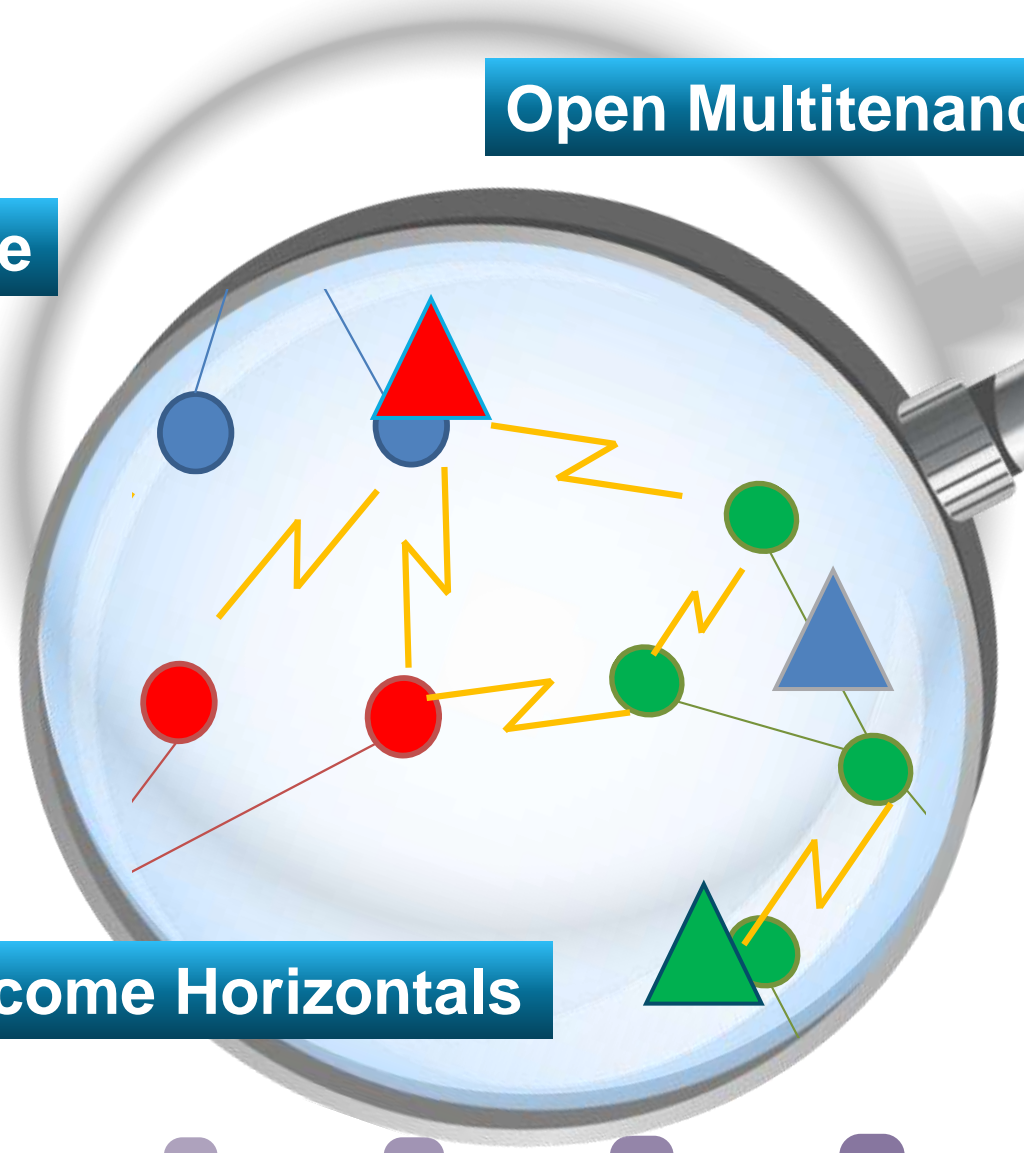
Distributed:
Death of the Central Office

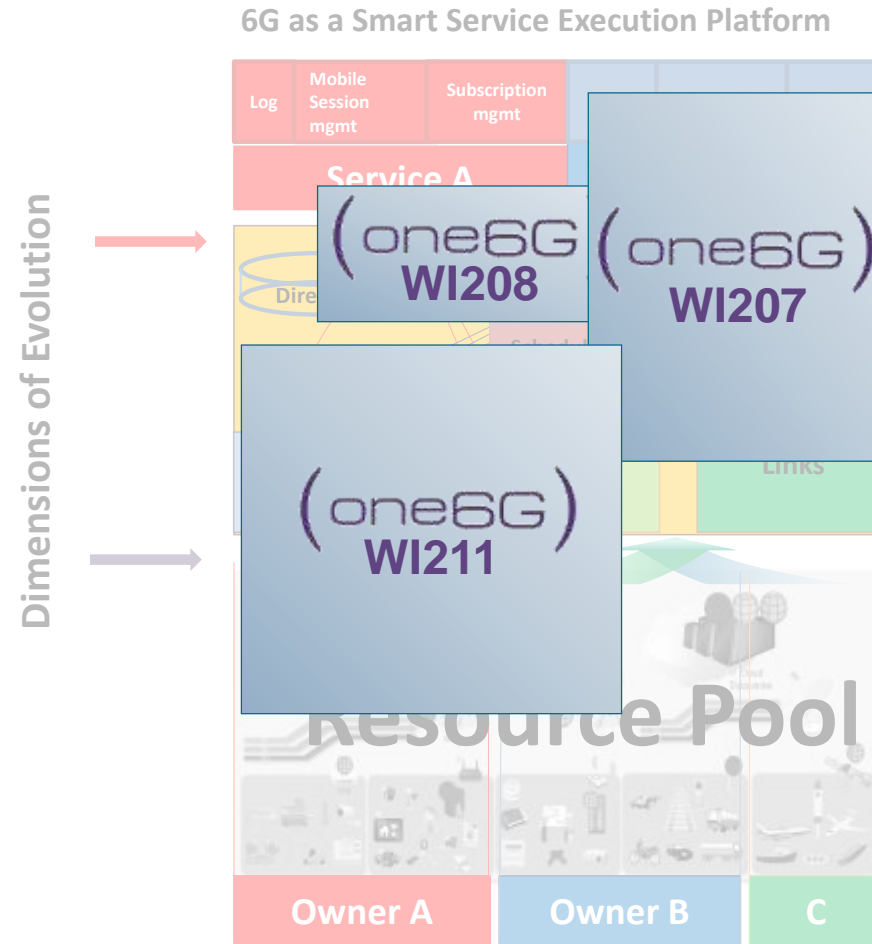NPN: Verticals become Horizontals

NPN: VERTICALS BECOME HORIZONTALS

Terminals   MNO   Internet/CDN   WS/DC/Cloud

Single NPN

Terminals   WS/DC/Cloud

INDUSTRIAL CONSENSUS IN THE EU

- 5GIA Vision&SC WG
  - Has published a WP
  - June 7, 2021
  - Includes:
    - System Arch
    - Enabling Tech

- Consensus achieved between 30+ participating companies

6G as a Smart Service Execution Platform

Dimensions of Evolution

Log | Mobile Session mgmt | Subscription mgmt

Service A

WI208 WI207

WI211

Resource Pool

Links

Owner A | Owner B | C

Mobile System Architecture

Novel service requirements, **expected novel capabilities** and the **push of the programmable elastic system**
- Emergence of new types of functions within the user, control and management planes.
- **Mobile system architecture**, now **allocated as a service chain**, will preserve and uphold flexibility of the modern infrastructures
- **Mobile system** will look like a **computer program executed within the programmable infrastructure**.

Infrastructure
- **flexible on-demand provision.**
- **capable of resource control**
- **full-service platforms**, natively offering capabilities B E2E

  Required Developments in :
  - novel resource control plane scheme,
  - integration of suitable distributed secure computations,
  - autonomic and distributed conflict resolution
  - distributed resource scheduling
  - Distributed AI

RELEVANT ONE6G WORK ITEMS

- WI208

  - Integration of networking and ML platforms, AI-as-a-Service

- WI207

  - Novel interfaces and functions for compute integration into the 3GPP domain

- WI211

  - Full integration of networking, compute, storage to a coherent programmable resource pool

OBSERVATIONS AND REMARKS

- Participatory networking increases the degrees of freedom

  - Enables new use cases, **faster and cheaper adoption and deployment**, improves availability

  - Opens up the eco-system beyond anything proposed so far

- Services must **enforce their extra-functional properties dynamically** and not blindly rely on the underlying infrastructure

  - Methods exist to achieve many security/reliability properties on unreliable hardware

  - Infrastructure can be used, but it should be dynamically inspected from the service layer

- The Full Service orientation transforms the network platform to an **open market place**

- The overall system becomes a versatile ML platform: **AI can be offered as-a-service** to all

  - Together with participatory networking, this requires truly distributed ML realizations

- Need more opportunistic, **node-centric thinking** in the overall design

  - Need to fully abandon the obsolete "infrastructure = service" thinking

  - Nodes become more capable every year (CPU, memory, special accelerators, I/O)

  - Many classical autonomics principles apply, check, e.g., the newest standards from the IETF ANIMA WG

- Using ML to augment systems has a lot of potential, but with **ML as integral system part**

  - Usage of ML: System optimization, Conflict resolution, System verification and correction

  - On a mid term: system function creation from given stubs

  - Generally: distributed AI, Native AI, explainable AI, Auto-ML in a systemic approach

- We need a holistic approach to system design: **E2E**, but also **resources to services**

Own work / contributions:

1. M. Curić, G. Carle, Z. Despotovic, R. Khalili and A. Hecker, "SDN on ACIDs", in Cloud-Assisted Networking workshop, in proc. of ACM CONEXT 2017, Incheon, South Korea, December 2017.
2. M. Curić, Z. Despotovic, A. Hecker, G. Carle, "Admin or Developer: Solving the SDN Dilemma", IEEE LCN 2019.
3. A. Shukla, K. Hudemann, A. Hecker, S. Schmid, "Runtime Verification of P4. Switches with Reinforcement Learning", NetAI workshop, ACM SIGCOMM 2019.
4. M. Bloecher, R. Khalili, L. Wang and P. Eugster, "Letting off STEAM: Distributed Runtime Traffic Scheduling for Service Function Chaining", IEEE INFOCOM 2020.
5. A. Shukla, K. Hudemann, Z. Vagi, L. Huegerich, G. Smaragdakis, A. Hecker, S. Schmid, A. Feldmann, "Fix with P6: Verifying Programmable Switches at Runtime", IEEE INFOCOM 2021, Vancouver, Canada.
6. S. Schneider, R. Khalili, A. Manzoor, H. Qarawlus, R. Schellenberg, H. Karl, A Hecker, "Self-Learning Multi-Objective Service Coordination Using Deep Reinforcement Learning", in IEEE Transactions on Network and Service Management, 2021.
7. 5GIA, "European Vision for the 6G Network Ecosystem", Whitepaper, online: https://5g-ppp.eu/the-5g-infrastructure-association-5g-ia-publishes-the-white-paper-european-vision-for-the-6g-network-ecosystem/ (last checked Oct 15, 2021)

Upcoming:

- **5GPPP Whitepaper on NPN**

- **November 20–23, 2022, Dagstuhl Seminar 22471 Towards More Flexible and Automated Communication Networks (https://www.dagstuhl.de/22471)**

THANK YOU

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