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Architecture of a 5G Mobile Private Network Research Infrastructure for the Future Railway Mobile Communication System (FMRCS)

28. Fachtagung Mobilkommunikation
5G Lösungen und 6G Ausblick
Osnabrück, 15./16.05.2024



Outline

1. 5G, MPN (Mobile Private Networks) and MEC (Multiple Access Edge Computing)
2. 5G infrastructure on rail track in ore mountains
3. Infrastructure for 5G-RACOM (5G for Resilient and Green RAil COMmunications)
4. First measurements and summary



5G, MPN (Mobile Private Networks) and MEC (Multiple Access Edge Computing)

01



5G, MPN and MEC – cutting edge technologies

This combination of three technology pillars enables new applications



Cloud Computing

Advantages:

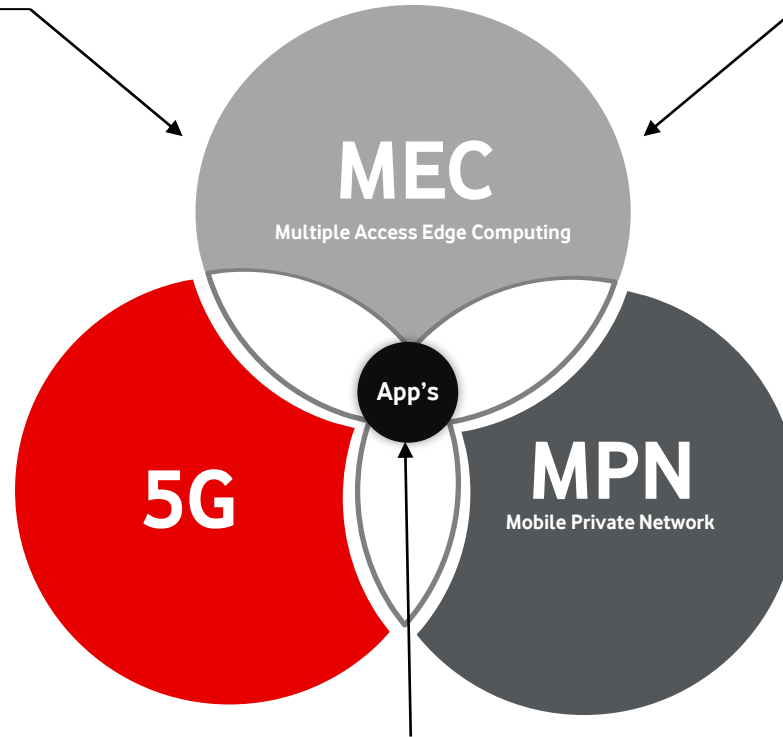
- Flexibility
- Scalability
- Cost efficiency

On premise or on edge



Advantages:

- Low Latency
- High data rates
- Data protection



Applications with high Quality of Service requirements

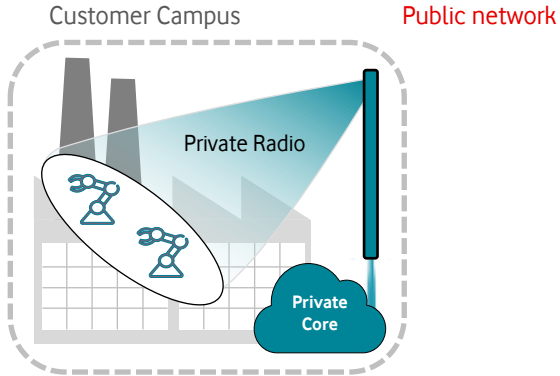


Mobile Private Networks

Different architectures provide tailored solutions with QoS (Quality of Service)

Dedicated MPN

Physical isolated mobile private network



Assured QoS



Keep your data on your campus



100% control through customer

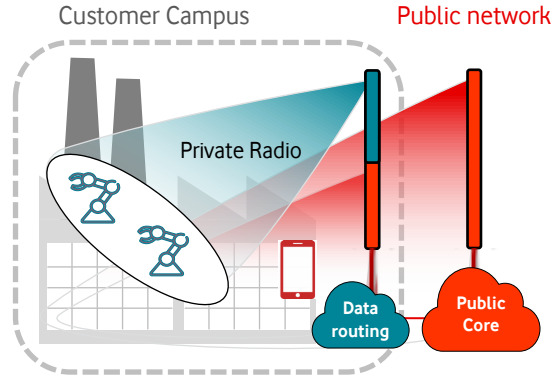


Interworking with public network



Hybrid MPN

Physical private network elements deployed in conjunction with the public network



Assured QoS



Keep your data on your campus



100% control through customer

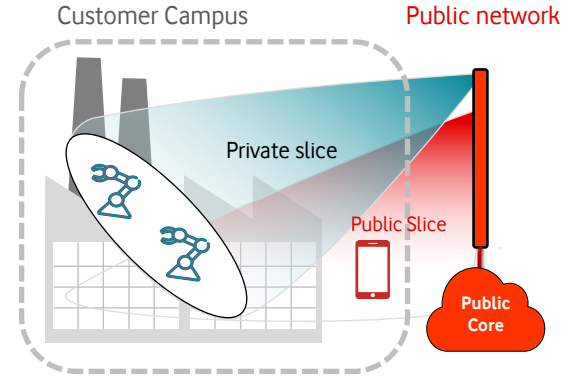


Interworking with public network



Virtual MPN

QoS in the Vodafone network with Network Slicing



Assured QoS



Keep your data on your campus



100% control through customer



Interworking with public network



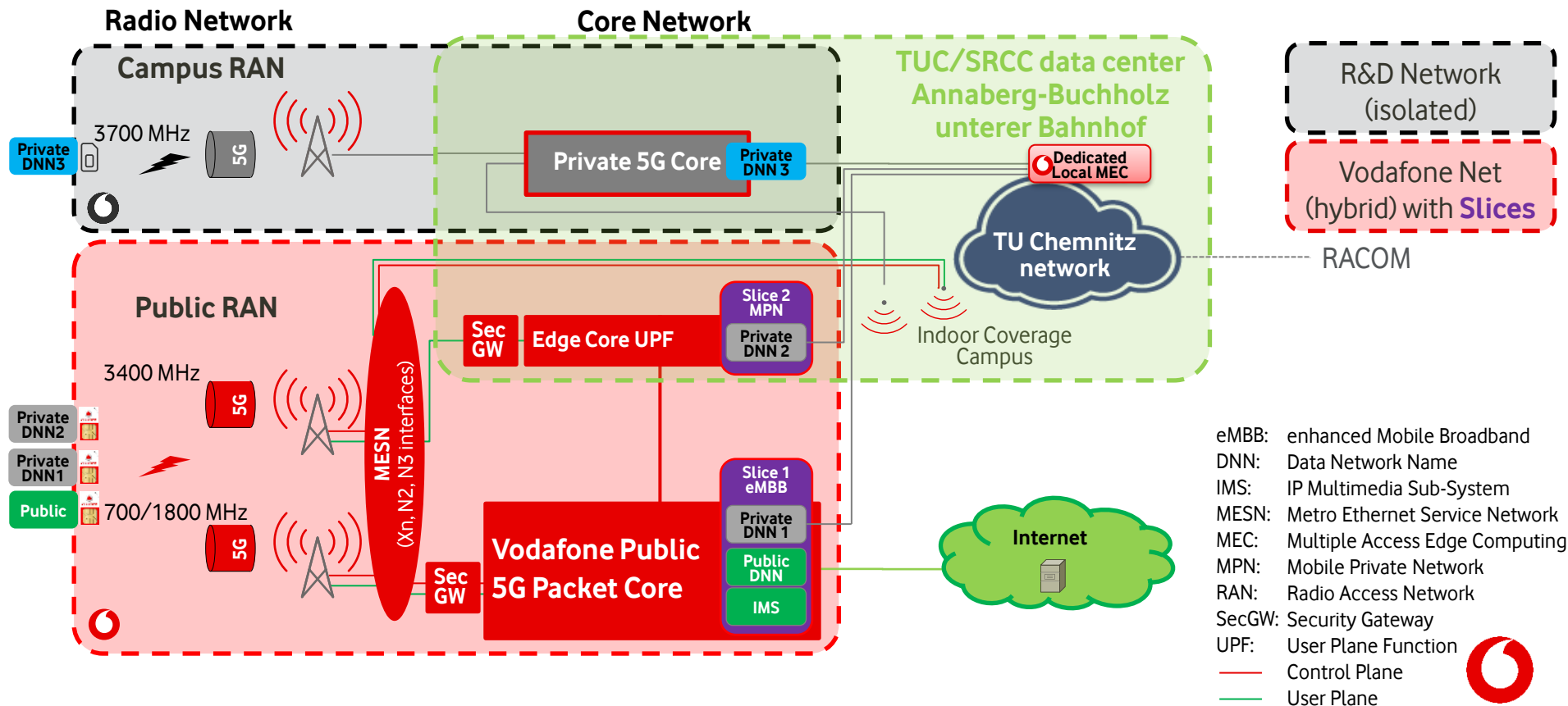
5G infrastructure on rail track in ore mountains

02



Modern 5G MPN & MEC infrastructure supporting innovative research

High Level Overview



Deployment of cutting-edge networks along the rail track

Creates best conditions for innovative research



Core Network in Local Technology Center

Transport Network
(fibre and radio relay links) to all sites

TU Chemnitz Data Center
Annaberg-Buchholz unterer Bahnhof

Local Core Network
Function Vodafone



Core Network
R&D

11 existing and 2 new Base Station sites
700/1800 MHz



2 new Base Station sites
3,4/3,7 GHz

7 new Base Station Sites
3,4/3,7 GHz

Public Vodafone frequency:

-  700/1800 MHz
-  3,4 GHz

Private (industrial) Frequency:

-  3,7 GHz (F&E), isolated MPN outdoor
-  3,7 GHz (F&E), isolated MPN indoor

Digital Testfeld Bahn (DTB)



22 Base Station sites on the rail track for high coverage and capacity

Examples of existing, new, and temporary sites



MRT: Mobile Radio Trailer
MGT: Mobiler Gitterturm



Temporary MGT

The heart of the telecommunications infrastructure

Customer Data Center Annaberg-Buchholz unterer Bahnhof



Rack with hybrid 5G MPN
Redbox – edge core User Plane Function (UPF)

Rack with isolated 5G MPN
Nokia Digital Automation Cloud (NDAC)

Rack with MEC systems
Microsoft Azure HCI on 2 Dell servers with GPUs

**Rack with transport network elements
and indoor coverage system (Lampsite)**



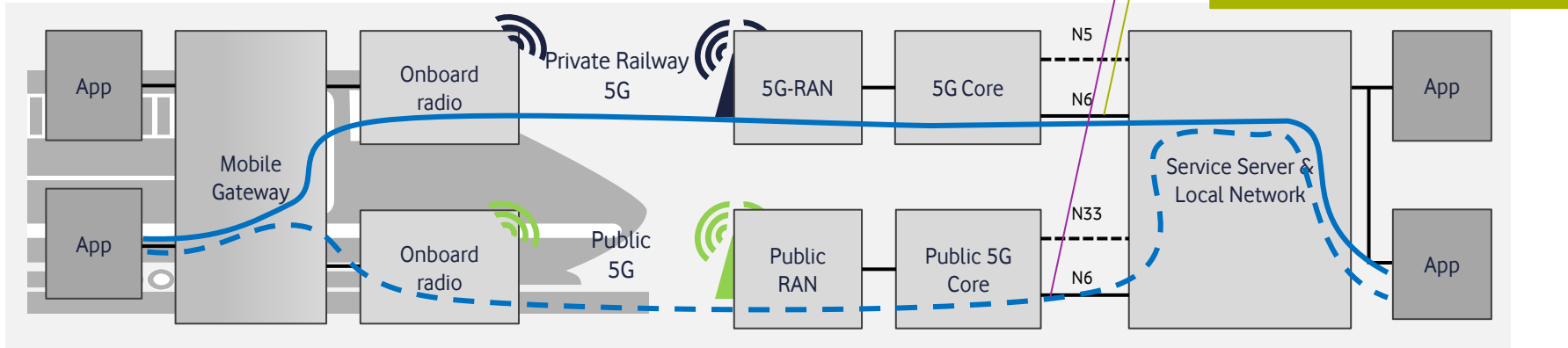
Infrastructure for 5G- RACOM (5G for Resilient and Green RAIL COMMunications)

03



5G-RACOM | Hybrid FRMCS Networks

Multipath technology provides seamless connectivity



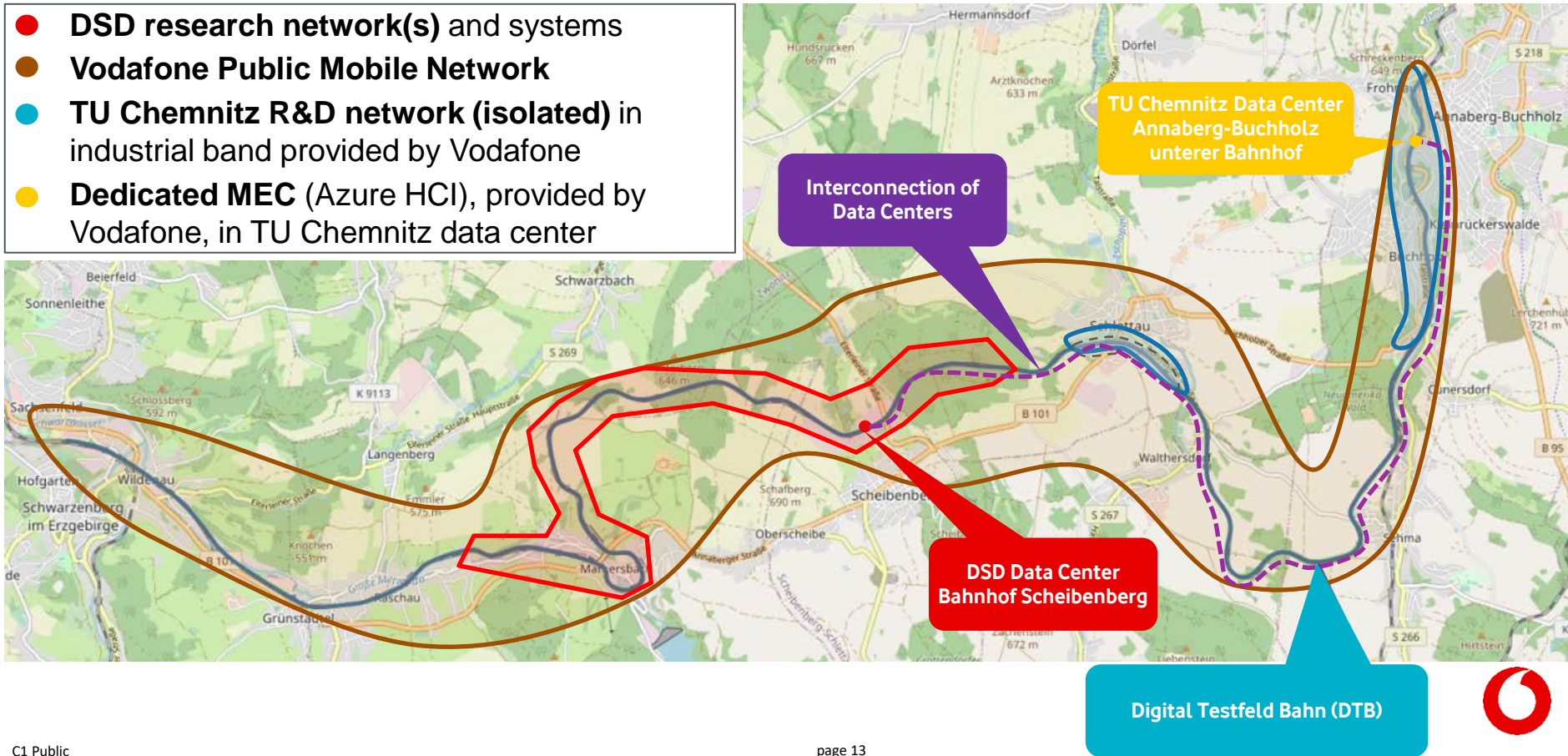
- **Hybrid networks** allow for **parallel usage** of private railway 5G based FRMCS and public 5G network
- **Multipath** technology enables **seamless switching** between the networks based on real-time connectivity conditions and the quality-of-service requirements of the applications
- 5G-RACOM targets create the concept as well as the implementation, integration, test, measurement and demonstration of hybrid network in the **Digital Testfeld Bahn (DTB)** in Germany



Combining Private and public networks for best connectivity

Hybrid Network for 5G RACOM

- **DSD research network(s) and systems**
- **Vodafone Public Mobile Network**
- **TU Chemnitz R&D network (isolated) in industrial band provided by Vodafone**
- **Dedicated MEC (Azure HCI), provided by Vodafone, in TU Chemnitz data center**



First measurements and summary

04



MPNs for Technical University of Chemnitz | Achievements

Indoor measurements in week 8, outdoor with Advanced Train Lab of DB in week 11/24

Achievements – Key facts

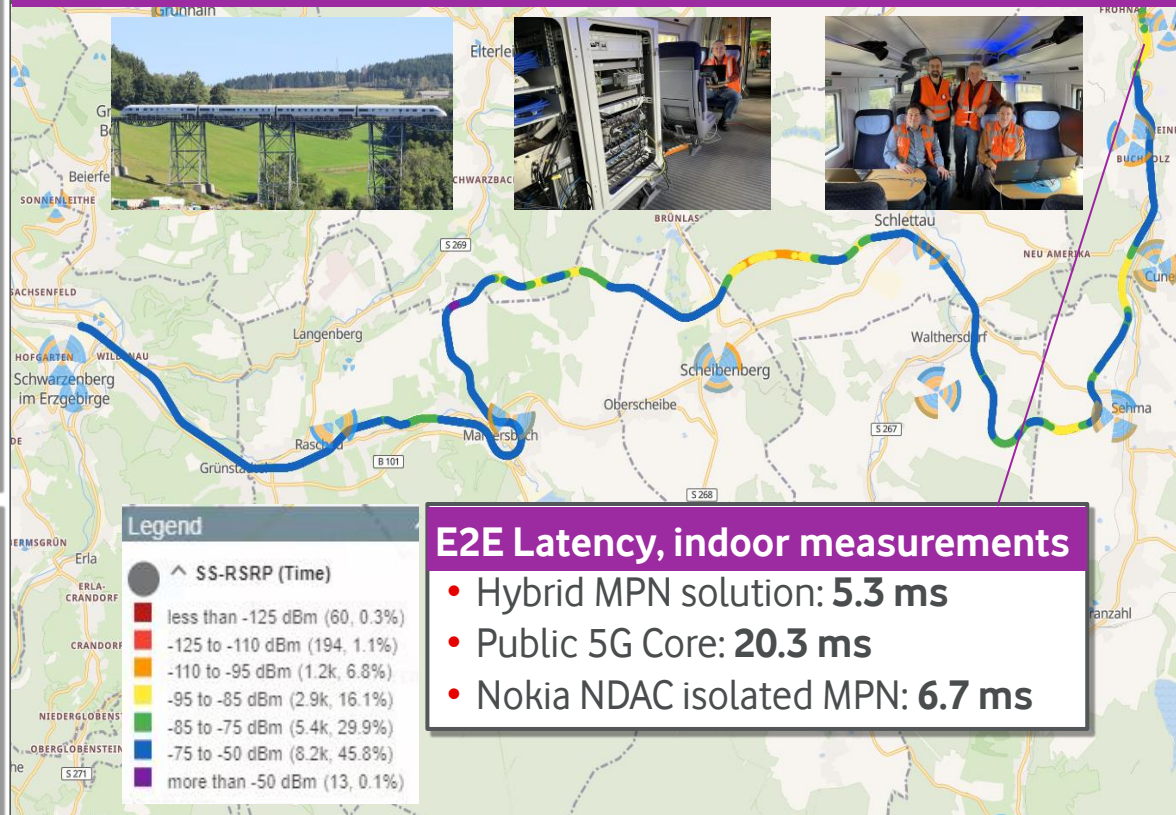
- Worldwide **5G first teleoperated train** in 09/2019
- First commercial 5G SA network slicing** within Vodafone in 12/2022
- Largest MPN/MEC deployment within Vodafone:**
22 macro stations,
3 networks (isolated, hybrid, virtual)

Inaugurating 5G infrastructure 02/24

- Volker Wissing**, Federal Minister for Transport
- Michael Kretschmer**, Prime Minister of state Saxony
- Daniela Gerd tom Markotten**, Board Member of DB
- Alexander Saul**, VBG et al.



RSRP, outdoor measurements



E2E Latency, indoor measurements

- Hybrid MPN solution: **5.3 ms**
- Public 5G Core: **20.3 ms**
- Nokia NDAC isolated MPN: **6.7 ms**

Thank you for your attention!



**Advanced TrainLab meets Erzgebirgsbahn
and Vodafone's site in Schlettau**