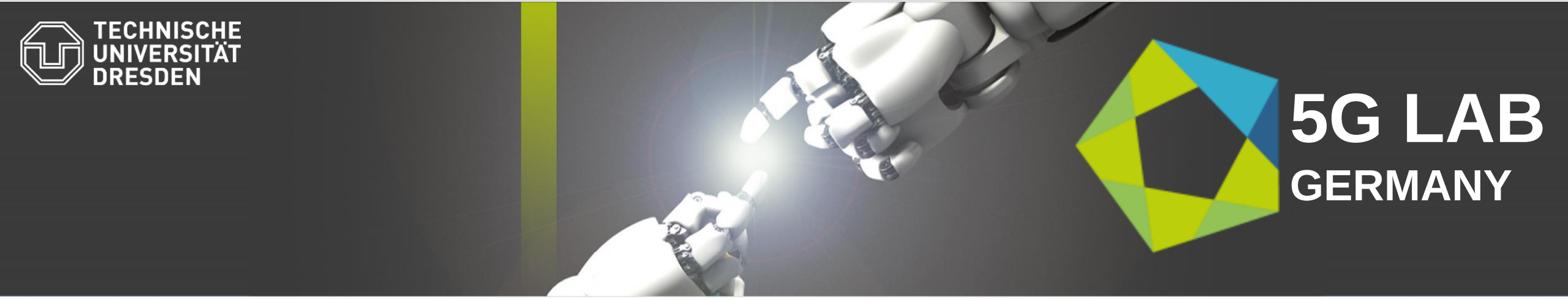


On the Tactile Internet Standardization Activities –

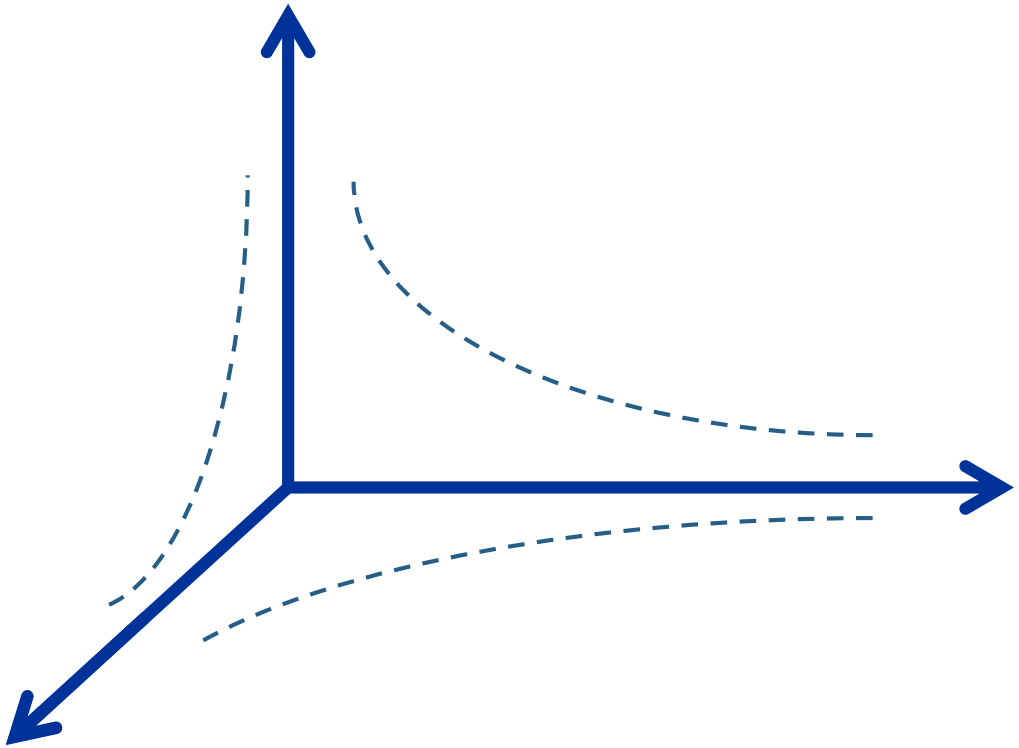
An Overview of IEEE, ETSI, and IETF Standards

Dr. Meryem Simsek
Group leader at Vodafone Chair, TU Dresden
Chair of IEEE ComSoc Tactile Internet Technical Sub-Committee

A 5G Hyperplane

Speed: >10 Gb/s ➔ Tb/s

Massive Content



Massive Sensing
1b/s over 10 years
off an AAA battery

Massive Control
Response: 1 ms

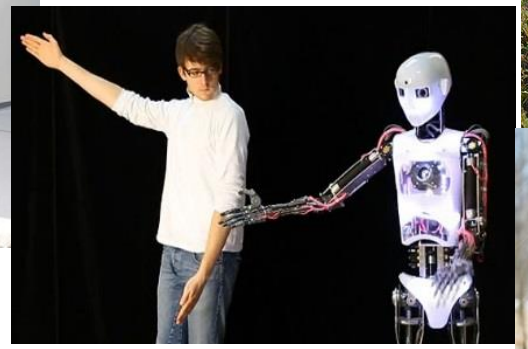
The Tactile Internet

5G LAB GERMANY

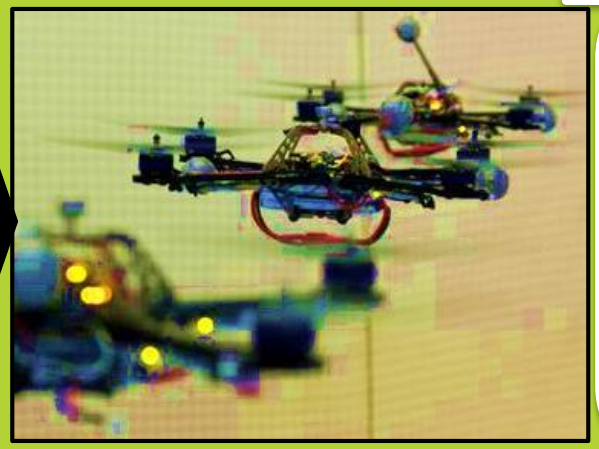
Moving from 50ms round-trip time → 1ms tomorrow

http://ostsee-spezial.de/?p=148

Revolution Ahead: The Tactile Internet



5G



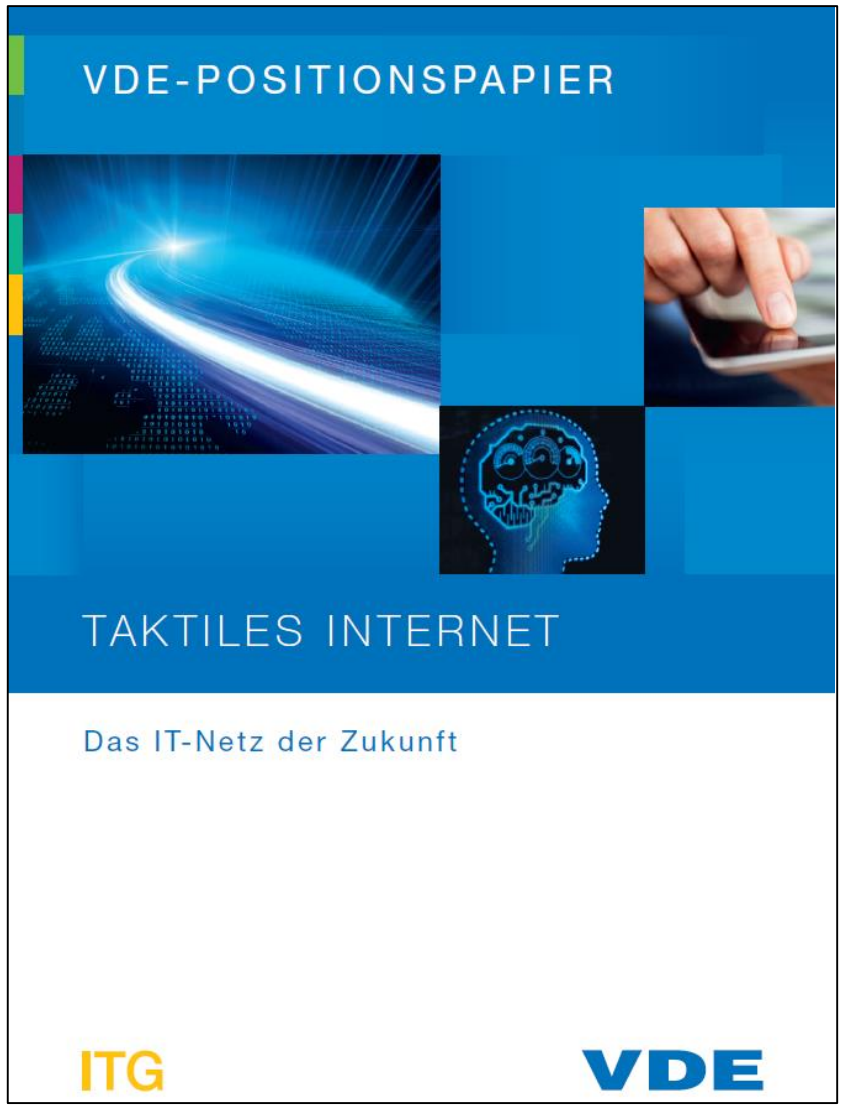
Ubiquitous

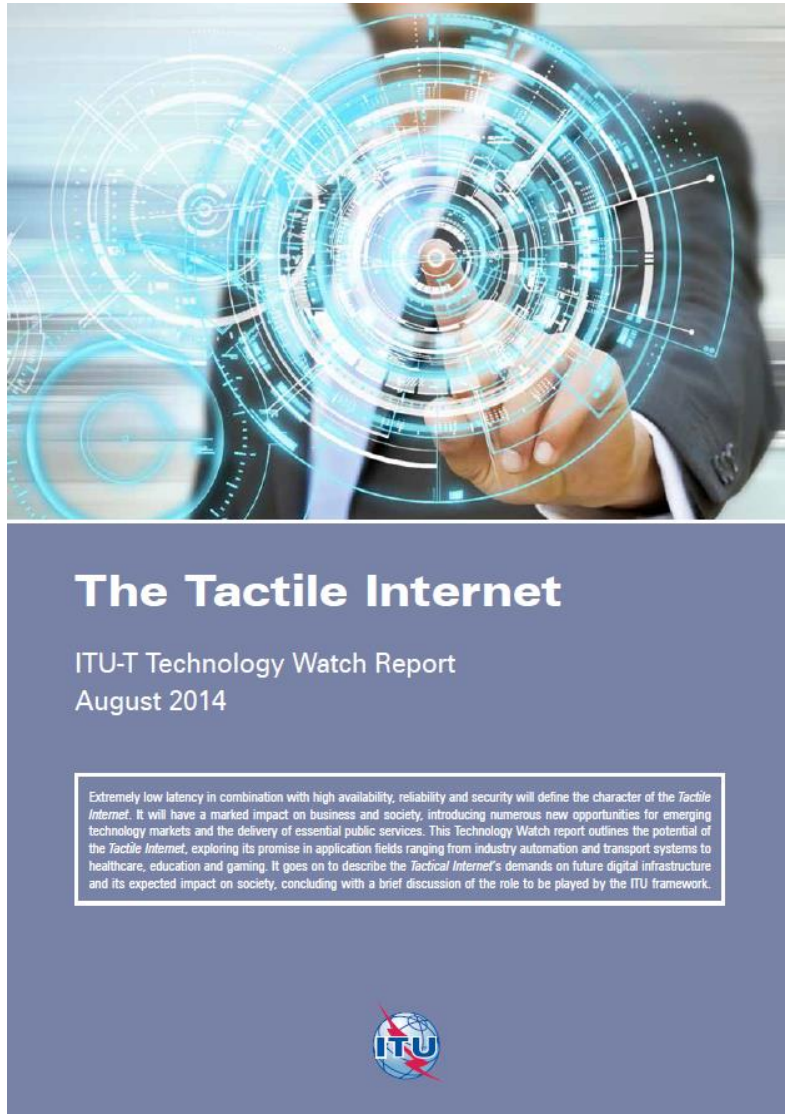
Steering & Control

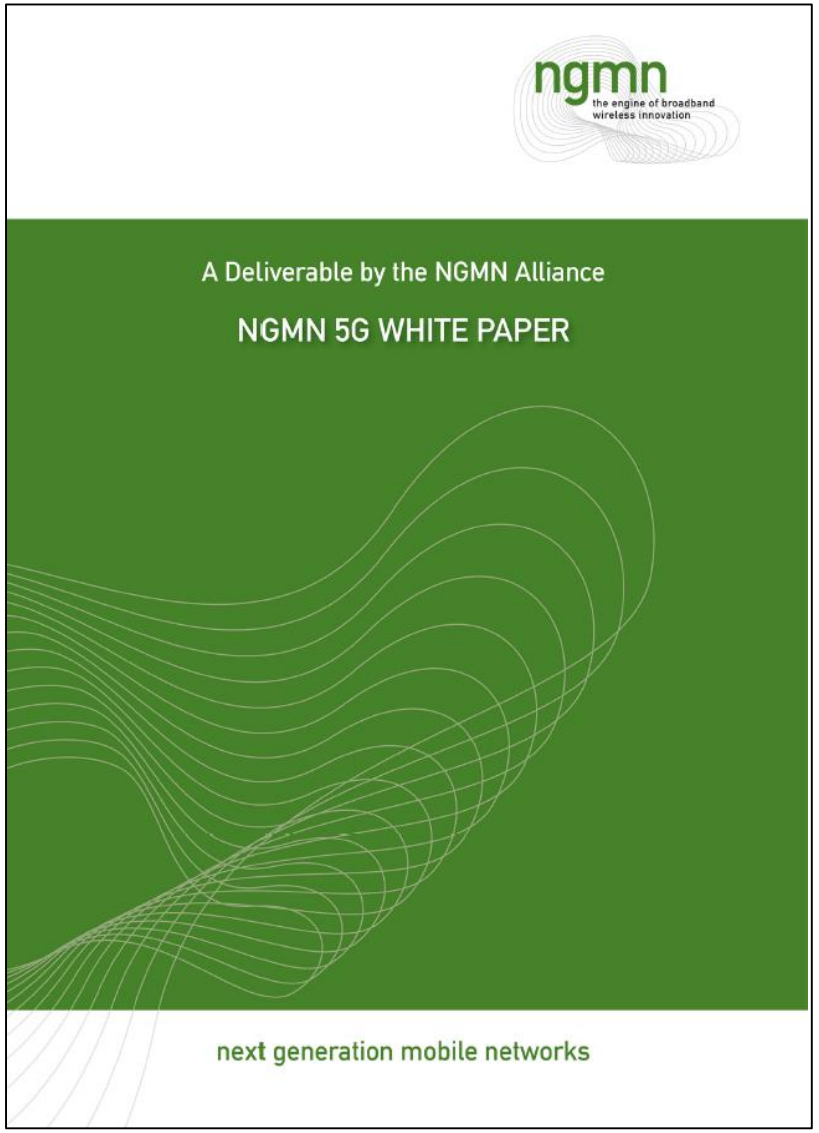
Communications

Health & Care
Traffic & Mobility
Sports & Gym
Edutainment
Manufacturing
Smart Grid,...

Tactile Internet: From Vision to Realization







IEEE Tactile Internet Sub-Committee

IEEE Tactile Internet Sub-Committee

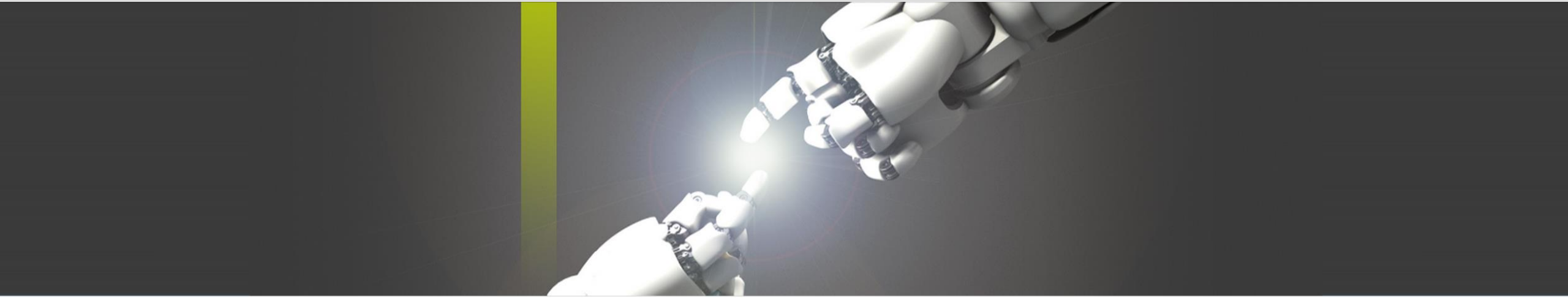
Globecom 2015: Workshop on Ultra-Low Latency and Ultra-High Reliability in Wireless Communications http://www.ultra-wireless-workshop.com/

WCNC 2016: Workshop on 5G & Beyond - Enabling Technologies and Application with focus on the Tactile Internet & Vertical Industry http://www.ctr.kcl.ac.uk/5G2016/WCNC/

Globecom 2016: Ultra-Reliable and Low-Latency Communications in Wireless Networks (URLLC) http://www.urllc-wireless-workshop.com/

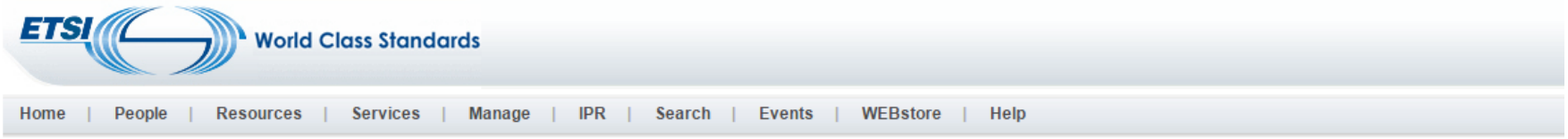
Globecom 2016: Wireless Networking, Control and Positioning for Unmanned Autonomous Vehicles http://www.wi-uav.org/

WCNC 2017: Workshop on 5G & Beyond - Enabling Technologies and Application with focus on the Tactile Internet & Vertical Industry http://www.ctr.kcl.ac.uk/5G2017/WCNC/ under preparation



ETSI World Class Standards

ETSI IPv6 ISG



IP6
- IP6 Participant Agreement
- IP6 Member Agreement
- Signature Instructions
- Terms of Reference
- List of IP6 Members
- GS Template
- IP6 Activity Report

IP6 ▸ List of IP6 Members

LIST OF IP6 MEMBERS

Organisation Name	URL
Bell Mobility (CA)	www.bell.ca
China Telecommunications (CN)	www.chinatelecom.com.cn
Cisco Systems Belgium (BE)	www.cisco.com
Cosmote S.A (GR)	www.cosmote.gr
Hewlett-Packard (FR)	www.hp.com
Huawei Sweden (SE)	www.huawei.com
Huawei UK (UK)	www.huawei.com
University of Athens (GR)	www.uoa.gr
University of Luxembourg (LU)	www.snt.uni.lu

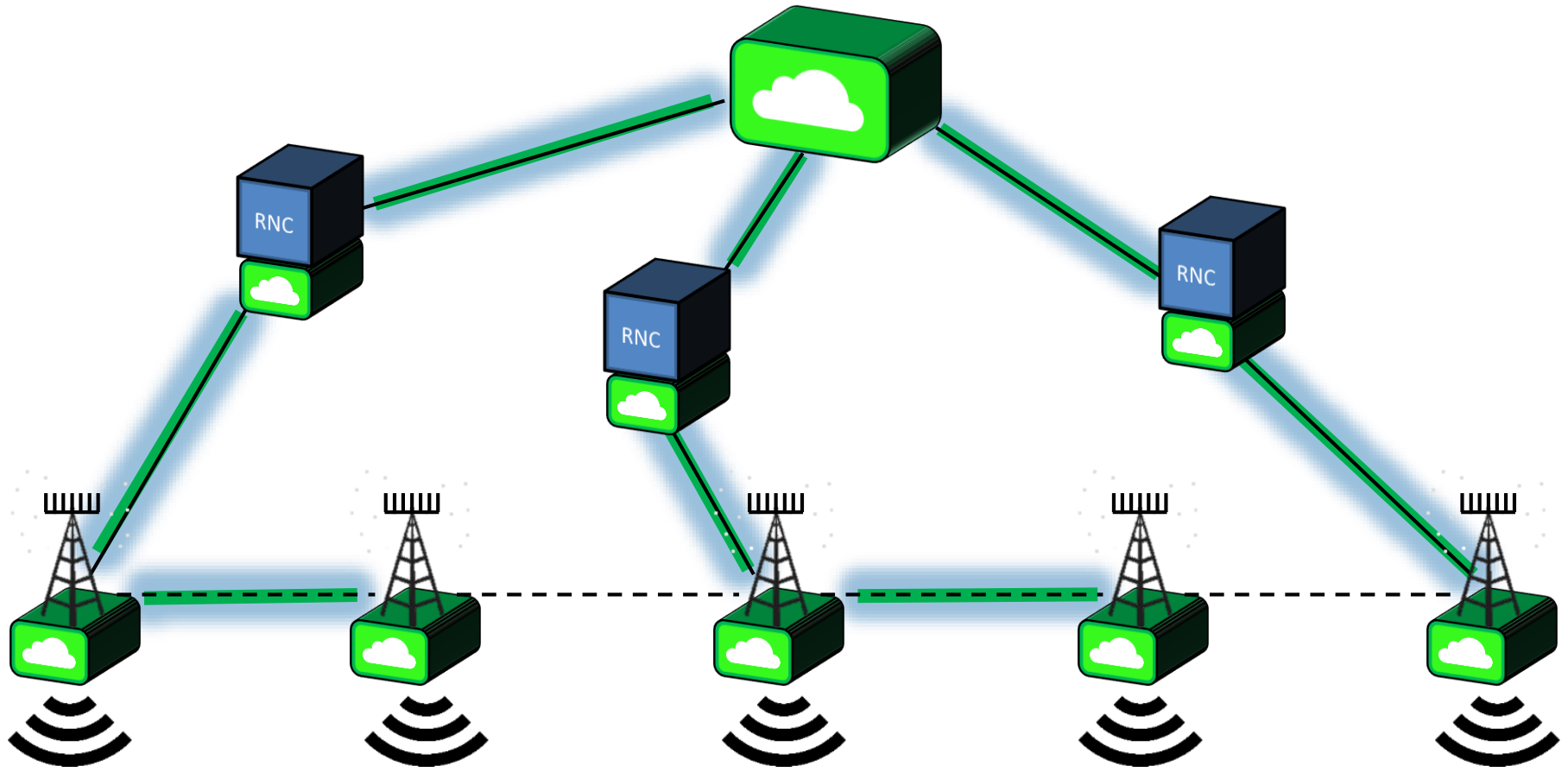
LIST of IP6 PARTICIPANTS

Beijing Internet Institute -BII - (CN)	www.biigroup.com
Celenium (US)	www.celenium.com
Citkomm KDVZ (DE)	www.citkomm.de
China Unicom (CN)	eng.chinaunicom.com
Device Gateway SA (CH)	www.devicegateway.com
HOP Ubiquitous S.L. (ES)	www.hopu.eu
Instituto Superior Tecnico IST (PT)	www.tecnico.ulisboa.pt
Mandat International (CH)	www.mandint.org
Microsoft (US)	www.microsoft.com
Nephos6 (US)	www.nephos6
Sixscape (SG)	www.sixscape.com
Technical University of Dresden (DE)	www.tu-dresden.de
University of Ljubljana (SI)	www.ltfe.org
University of Murcia (ES)	www.um.es
VN Telecom Consultancy (US)	www.von20.com

ETSI IPv6 ISG – DGS/IP6-0014

10	Doc. Nb. GS IP6 010 Ver. 0.0.2 Ref. DGS/IP6-0010 Technical Body: IP6 Details and Download	IPv6-based SDN and NFV Deployment of IPv6-based SDN and NFV	Drafting Stage Current Status: Early draft (2015-10-16) Next Status: Stable draft (2016-03-01)
11	Doc. Nb. GS IP6 011 Ver. 0.0.3 Ref. DGS/IP6-0011 Technical Body: IP6 Details and Download	IPv6-Based 5G Mobile Wireless Internet Deployment of IPv6-Based 5G Mobile Wireless Internet	Drafting Stage Current Status: Early draft (2016-01-28) Next Status: Stable draft (2016-03-01)
12	Doc. Nb. GS IP6 012 Ver. 0.0.1 Ref. DGS/IP6-0012 Technical Body: IP6 Details and Download	IPv6 Deployment and Security IPv6 Deployment and Security	Drafting Stage Current Status: Early draft (2015-10-06) Next Status: Stable draft
13	Doc. Nb. GS IP6 013 Ver. 0.0.1 Ref. DGS/IP6-0013 Technical Body: IP6 Details and Download	IPv6 Deployment in Privacy IPv6 Deployment in Privacy	Drafting Stage Current Status: Early draft (2015-10-06) Next Status: Stable draft
14	Doc. Nb. GS IP6 014 Ver. 0.0.1 Ref. DGS/IP6-0014 Technical Body: IP6 Details and Download	IPv6 based Tactile Internet IPv6 based Tactile Internet	Drafting Stage Current Status: Early draft (2015-07-09) Next Status: Stable draft (2016-03-28)
15	Doc. Nb. GS IP6 015 Ver. 0.0.1 Ref. DGS/IP6-0015 Technical Body: IP6 Details and Download	Impact of Mobile IPv6 Deployment of Mobile IPv6	Drafting Stage Current Status: Early draft (2015-07-08) Next Status: Stable draft (2016-03-30)
16	Doc. Nb. GS IP6 017 Ref. DGS/IP6-0017 Technical Body: IP6 Details and Download	6TiSCH Interoperability Test Specifications 6TiSCH Interoperability Test Specifications	Drafting Stage Current Status: TB adoption of WI (2015-07-09) Next Status: Start of work (2015-07-09)

Mobile Edge Cloud / Micro Cloud / Cloud



ETSI Contributions

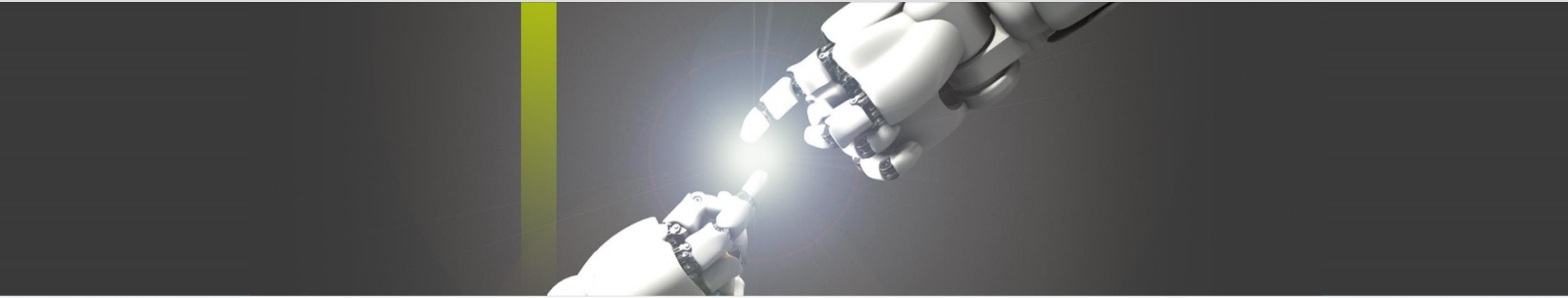
- Proximity through anycast addressing
- Caching through neighbor discovery
- Low latency through fast forwarding and routing
- Agility: mobile edge clouds
- Impact of Tactile Internet

Upcoming White Paper

Tactile Internet

- Mobile Edge Cloud
- 5G
- …

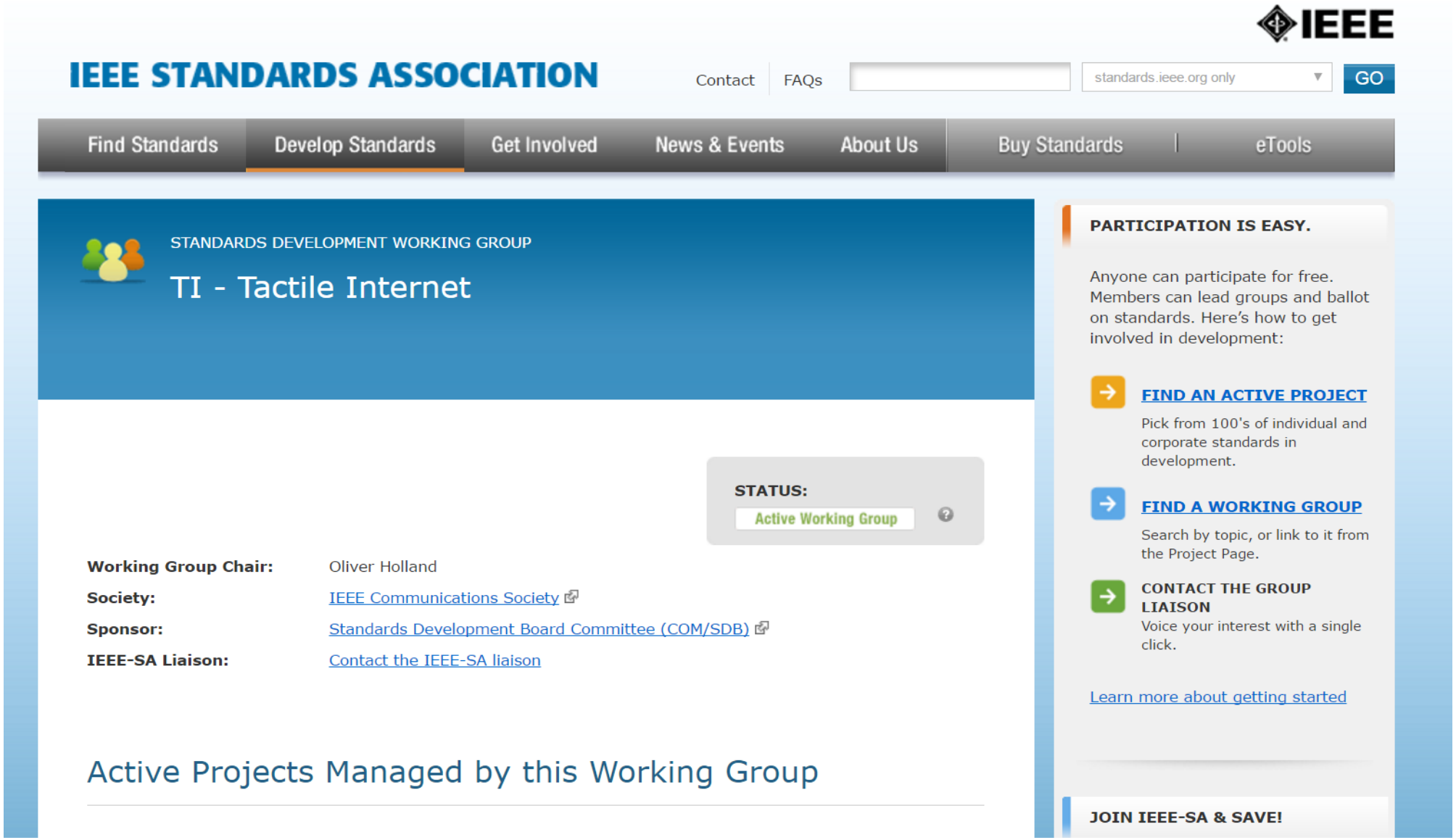
➢ Contributions are welcome!



IEEE ComSoc™

IEEE Communications Society

IEEE – Tactile Internet Working Group



IEEE

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STANDARDS DEVELOPMENT WORKING GROUP

TI - Tactile Internet

STATUS: Active Working Group

Working Group Chair: Oliver Holland

Society: IEEE Communications Society

Sponsor: Standards Development Board Committee (COM/SDB)

IEEE-SA Liaison: Contact the IEEE-SA liaison

Active Projects Managed by this Working Group

PARTICIPATION IS EASY.

Anyone can participate for free. Members can lead groups and ballot on standards. Here's how to get involved in development:

FIND AN ACTIVE PROJECT
Pick from 100's of individual and corporate standards in development.

FIND A WORKING GROUP
Search by topic, or link to it from the Project Page.

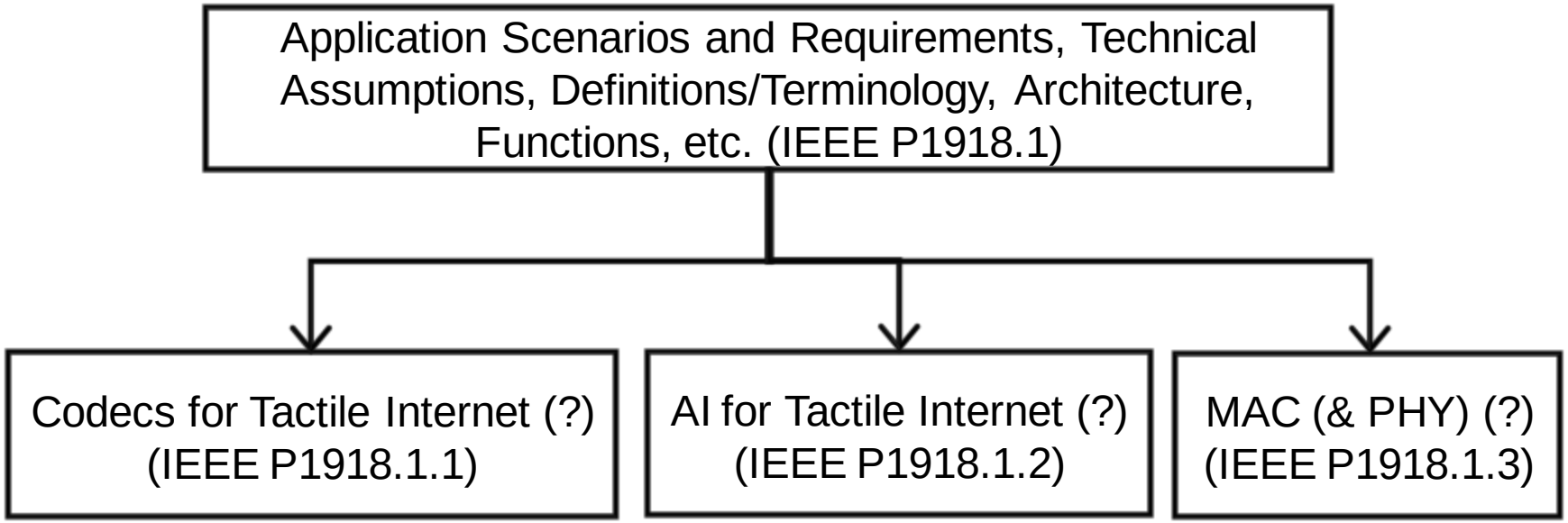
CONTACT THE GROUP LIAISON
Voice your interest with a single click.

Learn more about getting started

JOIN IEEE-SA & SAVE!

IEEE – Tactile Internet Working Group

- There have been a number of proposals for further work under this scope. To be decided whether they are within the current standard (some might be), or should be amendments after the current standard is completed, or should be parallel standards under the scope of this working group.
- For the latter, an example of how this might look.



- The IEEE P1918.1 working group‘s mission is to describe an end-to-end framework for the Tactile Internet comprising the joint consideration of Communication, Computing, and Control (CCC)

Proposed Tactile Internet Definition

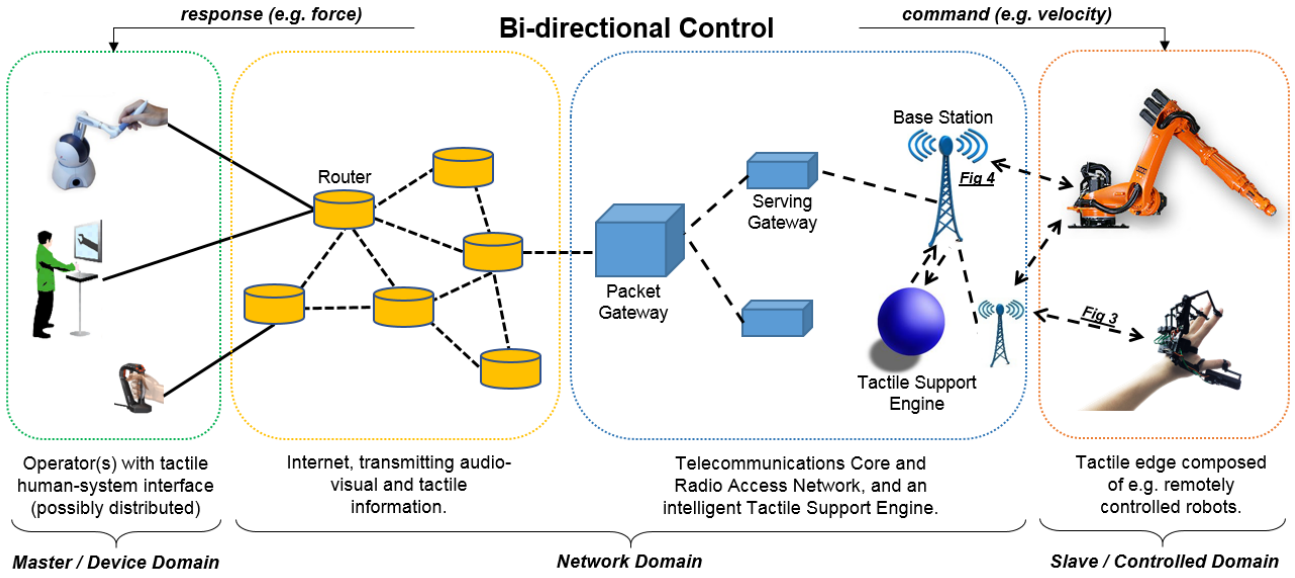
„A network or network of networks to remotely accessing or controlling virtual and/or real objects in perceived real-time“

Functional Architecture

The end-to-end functional architecture comprises three distinct domains.

- Master/Device Domain
- Network Domain
- Slave/Controlled Domain

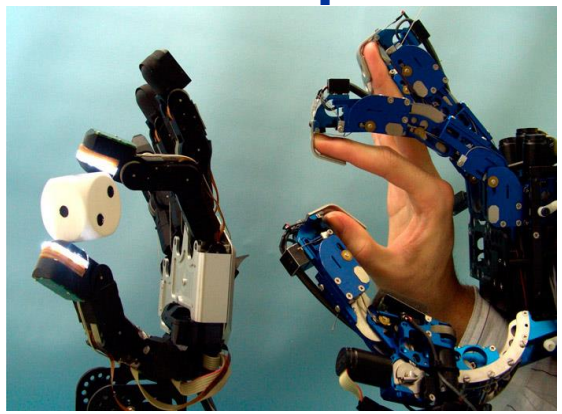
Information exchange is bi-directional and usually closes a global control loop



Codes

- Protocol for the Exchange of Device Capabilities (Handshaking)
  - Size of Workspace
  - Degrees of Freedom
  - Maximum Force/Torque
  - etc.
- Perceptual Coding for Closed-loop Kinesthetic Interaction
- Perceptual Coding for Open-loop Tactile Feedback

Kinesthetic Perception



Tactile Perception

Perception of

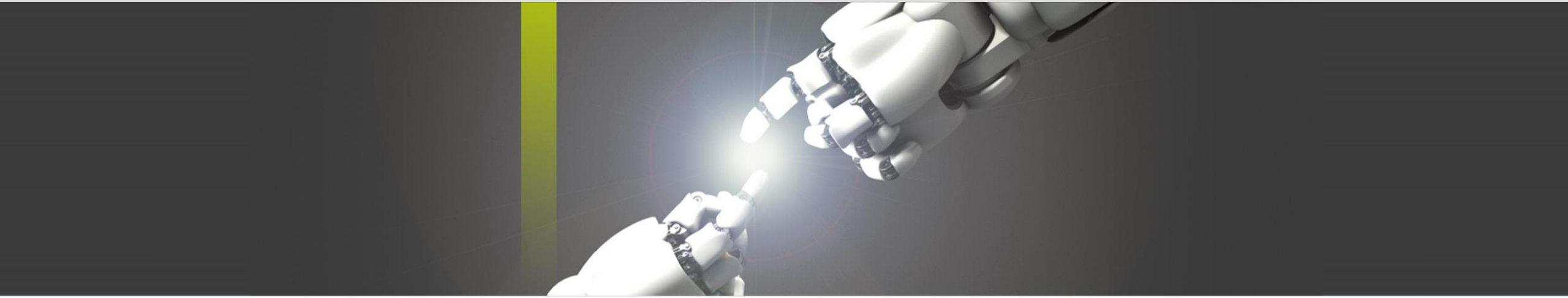
form, position, surface texture, stiffness, friction, temperature, etc.

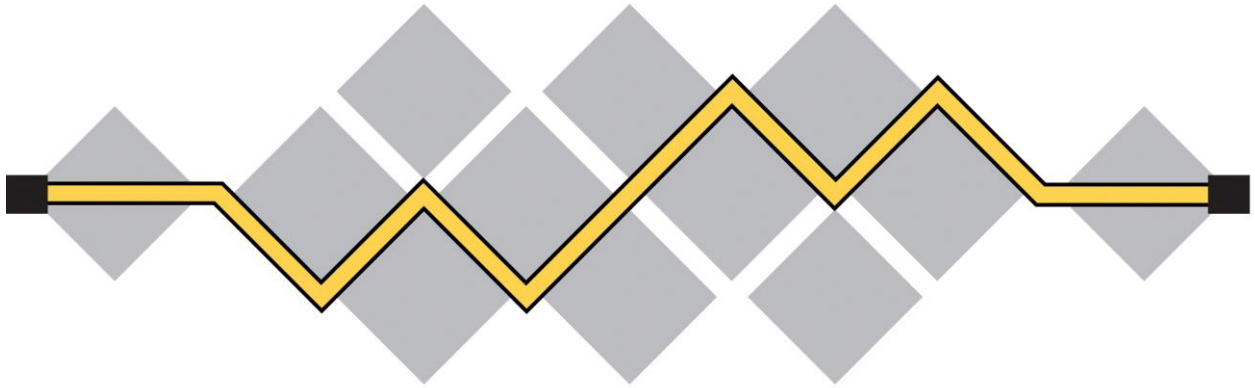
Image Source: Katsunari Sato, Dept. of MEIP, The University of Tokyo/Japan

Further Contributions

- Multi-connectivity architectures supporting Tactile Internet
- Use cases and requirements
- KPI studies
- Tactile Internet for extreme environments
- …

- Next meeting: June 27, 2016





IETF®

Contributions by Frank Fitzek

- IETF/IRTF
- No direct Tactile Internet standard, but related contributions

5G LAB GERMANY

THANK YOU!

meryem.simsek@tu-dresden.de