



Information Session

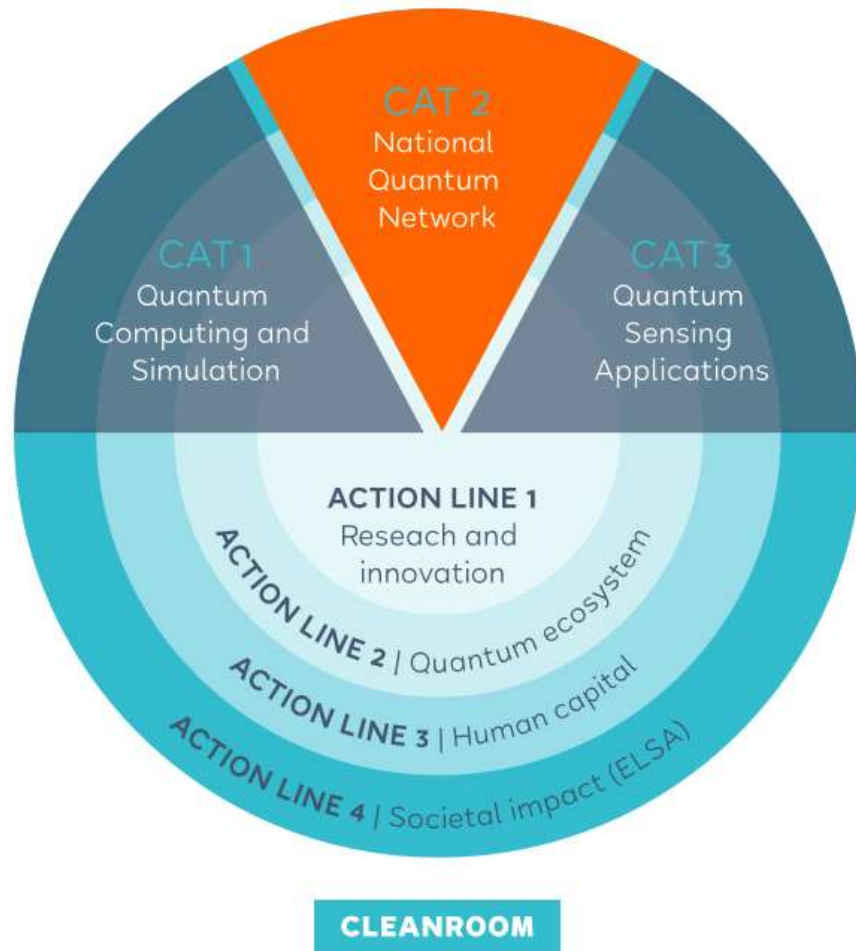
CAT-2 Quantum Networks

Jesse Robbers
Director of Quantum Delta NL & Lead CAT - 2
May 20th 2021





CAT-2 | Ambitious QDNL Programs



CAT-2 | National Quantum Network

- Development of Quantum Networks and Quantum Internet
- Quantum connectivity between different NL locations
- Link potential users
- National testbed for Cloud, 5G/6G, S/W, security application and more
- Connect the industry on the testbed to test H/W, S/W and future applications





Intro | Towards a Quantum Internet



2015: Entanglement irrefutable proven for the first time
2018: Worlds first entanglement “on demand”
2021: Worlds first 3-node quantum network in the lab
→ towards a real quantum internet!

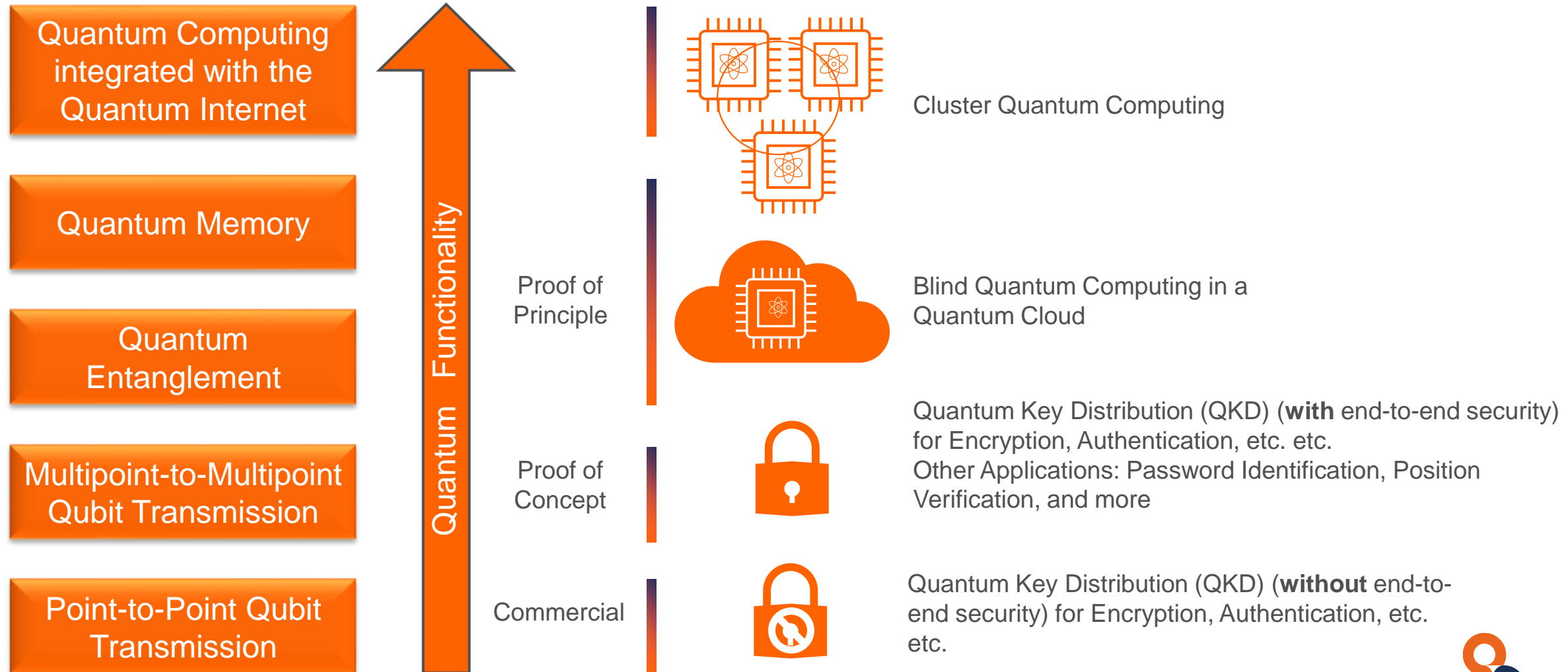
3





Intro | Quantum Internet – What can it bring?

To fundamentally enhance internet technology to enable quantum communication





Intro | Potential First Quantum Network Applications

Financial

- Distribution of Master Keys
- Securing data to disaster recovery centers
- Secure storage of digital tokens

Critical Infrastructure

- Encryption of data for remote monitoring
- Security on the control and/or management plane

DataCenters & Interconnect

- Encryption to/from cloud storage & computing centers
- Encryption through untrusted interconnects

Governmental

- Encryption between ministries
- Secure document exchange
- Encryption to government data centers

Telecommunications

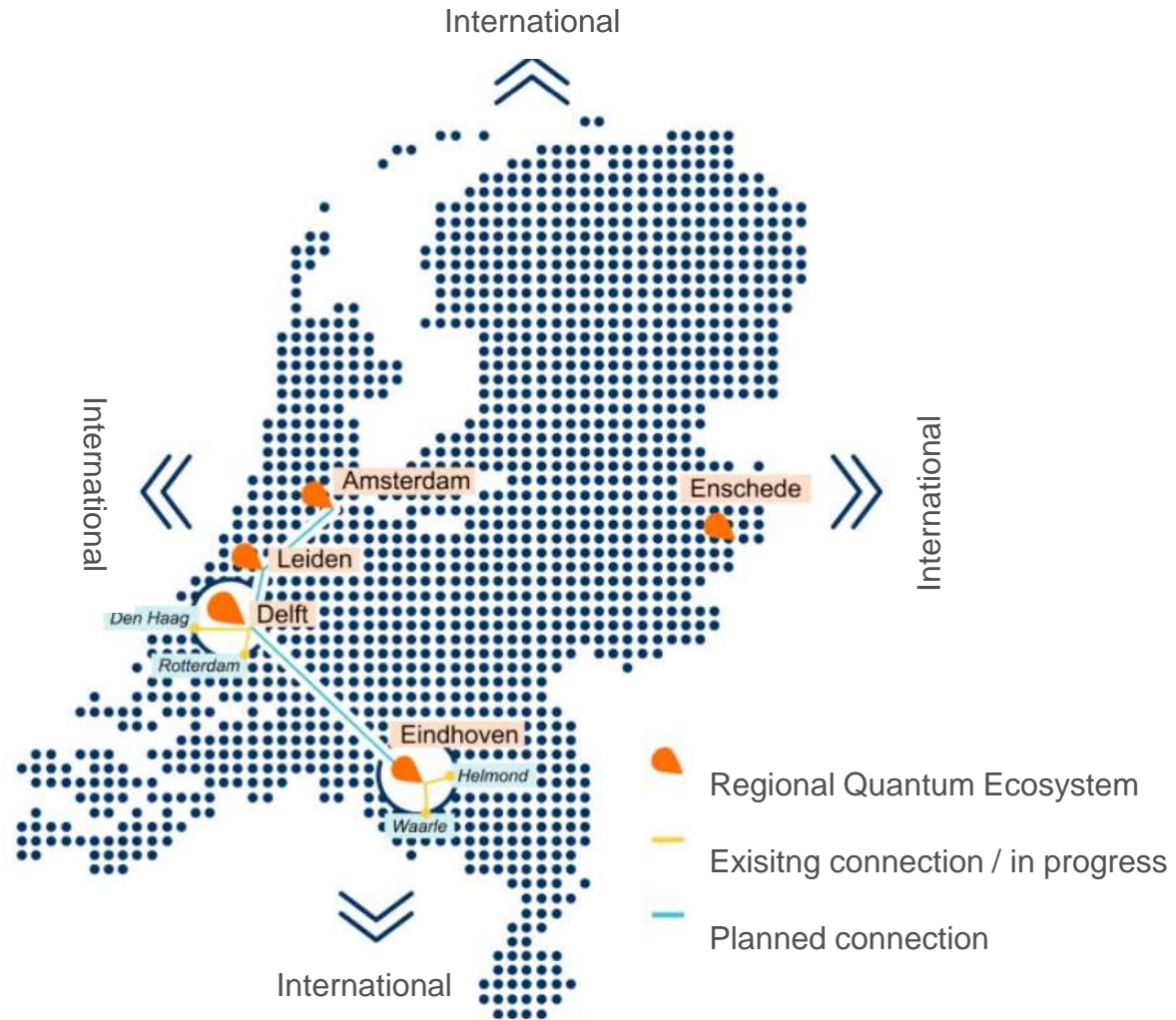
- QKD as a service
- Security for control and/or management plane
- 5G/6G message authentication
- Data encryption at layer-1

Other

- Enterprise Networks
- Health Care
- Vehicle-to-Everything
- Intellectual Property Protection

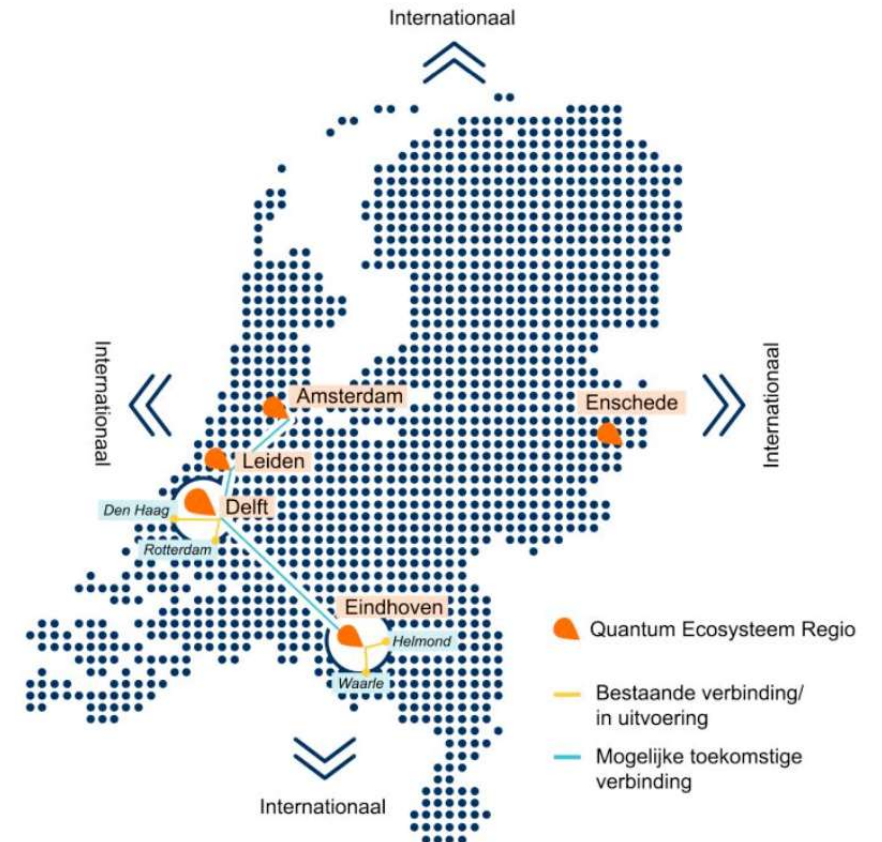


CAT-2 | National Quantum Network



NL Quantum Network | International strategy & vision

- Extend the Quantum Networks in the metro areas of Eindhoven and Delft.
- Realize the **National NL Quantum Staging network**.
- **Take Leadership in the EU** with FPA quantum internet & Euro-QCI
- Realize **cross border connections with neighbouring countries**
- Cooperate with the **Quantum Satellite communication** on National and International level
- Build **new partnerships** to drive the eco-system





CAT2 | Main Goals

1

Build the fundament for a NL National Quantum Network

2

The network will be a testbed and showcase on Quantum Networking

3

Focussing on Hardware, Software and Standardization

4

Develop and execute different use cases / Applications

5

Position the NL on International Level (e.g. EuroQCI, FPA on QI and QKD)

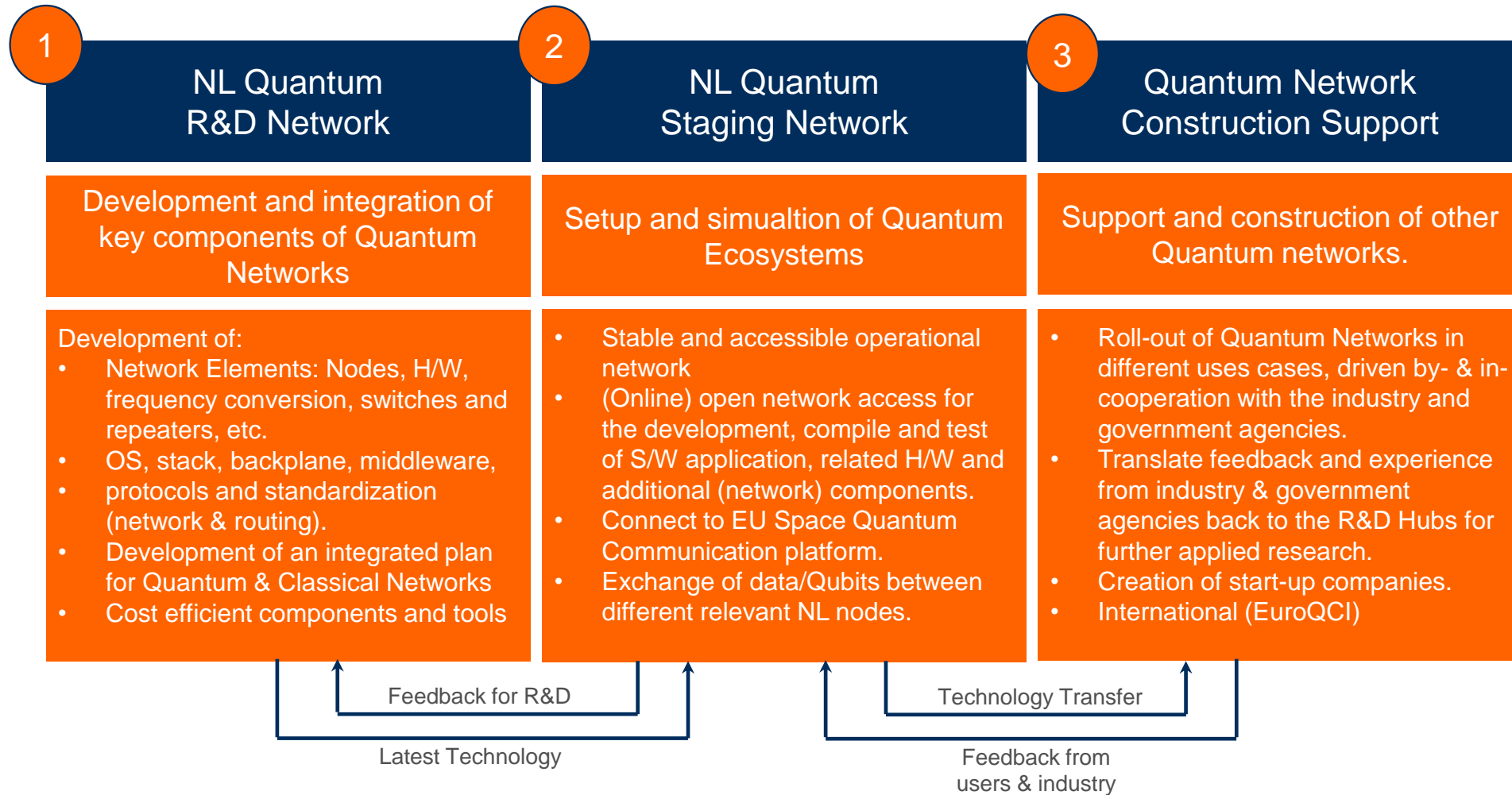
CAT 2 promise:

Robust and secure Quantum Network infrastructure





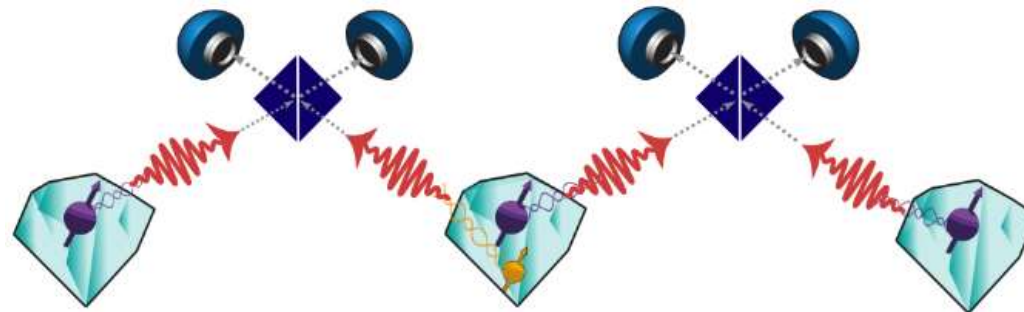
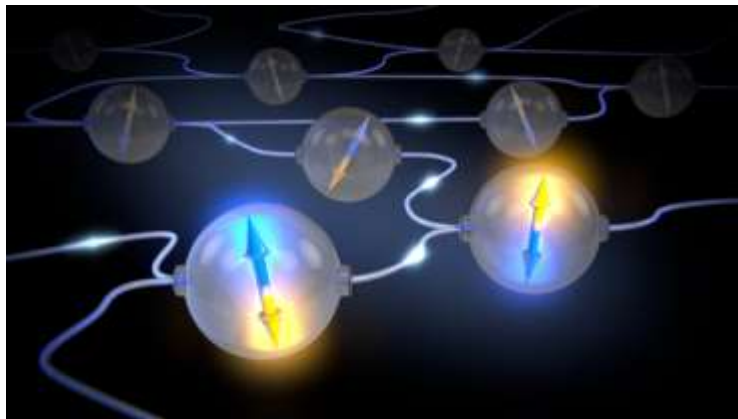
CAT-2 | The Setup of an NL Quantum Network





CAT-2 | Milestones

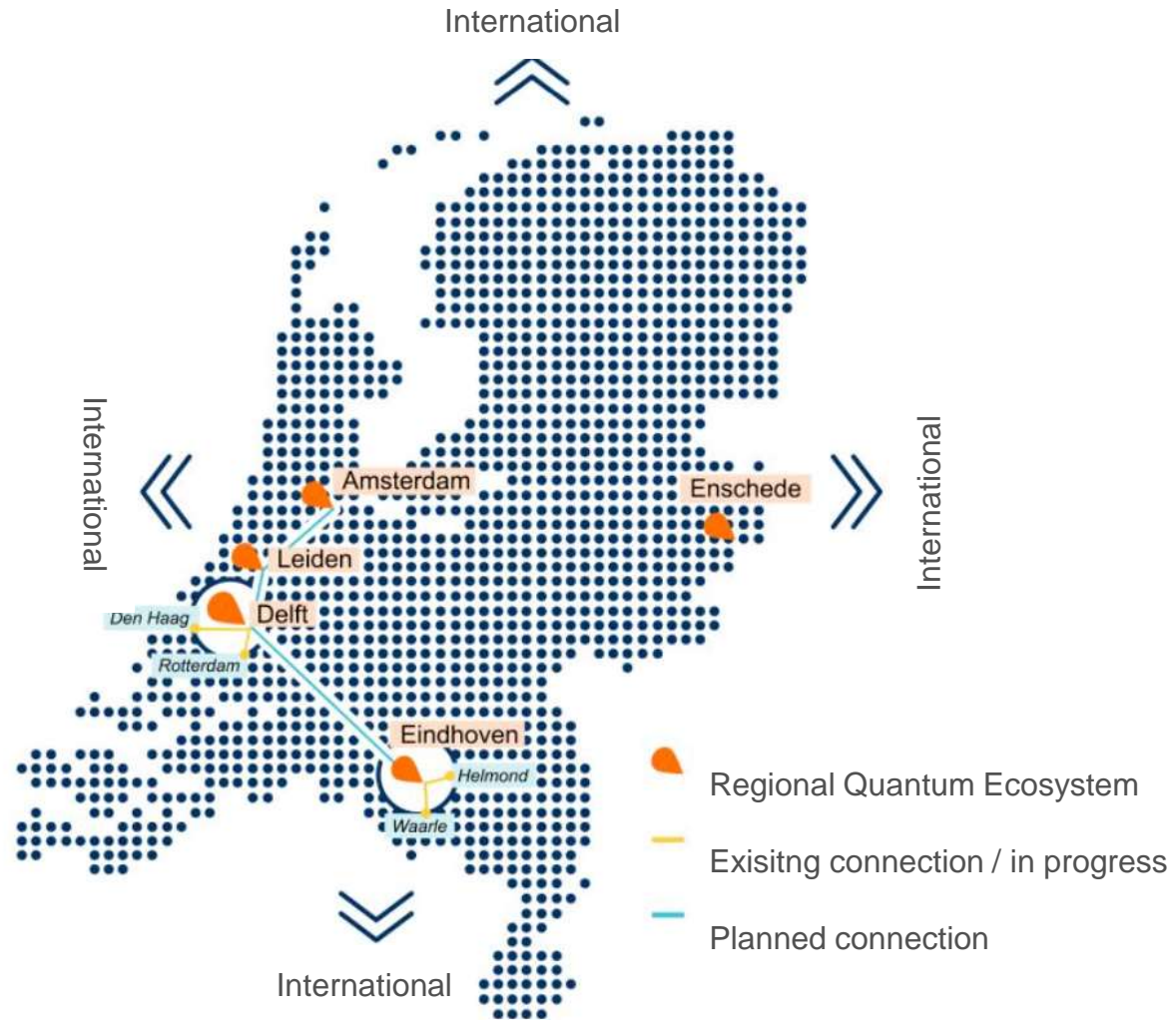
- 1 Quantum NL R&D network with three quantum processors realized | 2023
- 2 Online remote access to the NL Q-Staging network | 2023
- 3 Quantum NL Staging Network with ≥ 5 Quantum nodes (incl. embedding cloud) | 2026



Rozpędek et al. arXiv:1809.00364

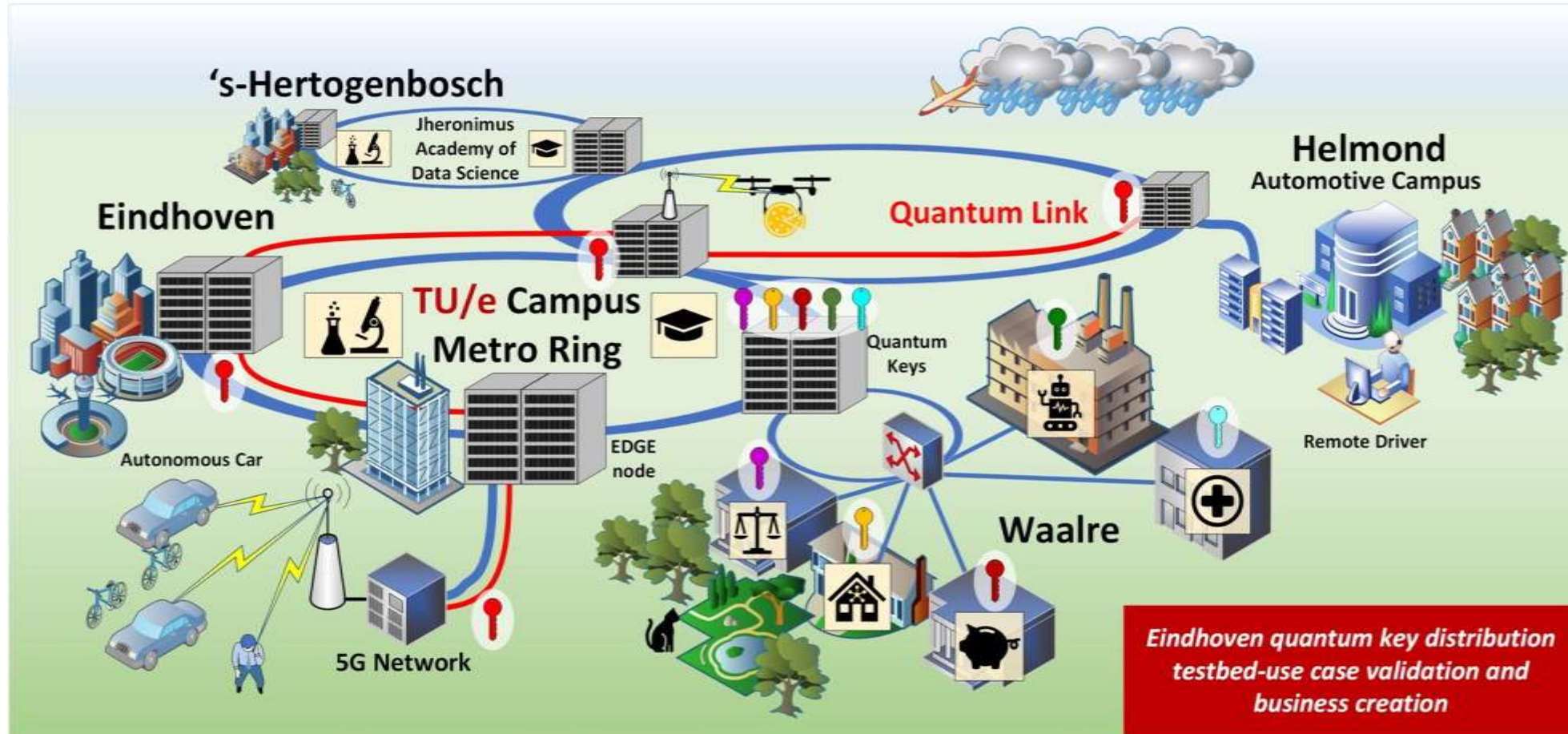


CAT-2 | National Quantum Network



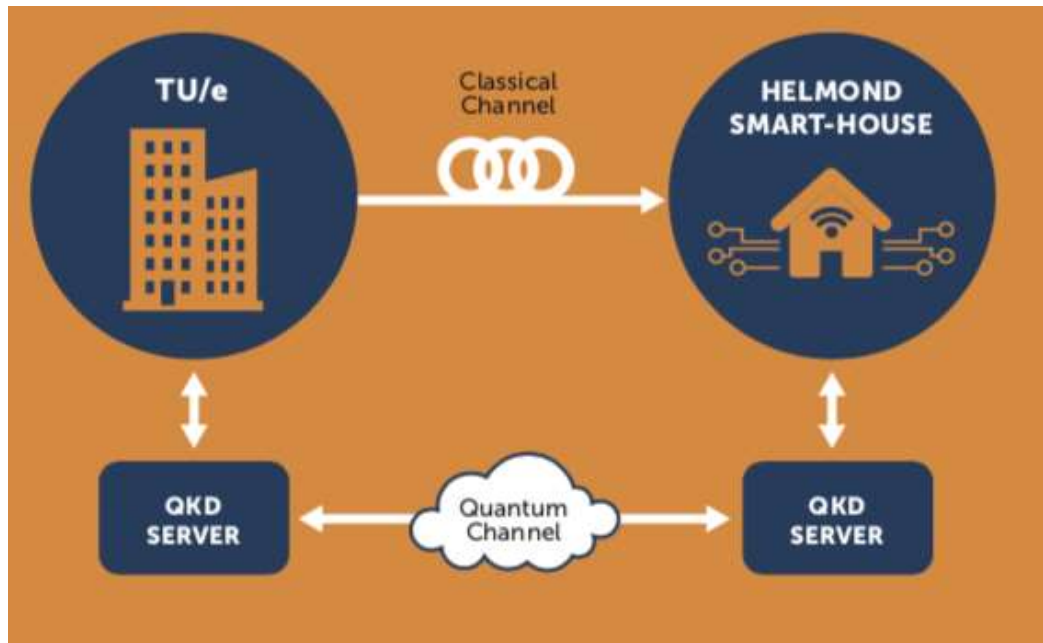


CAT-2 | Testbed for Quantum Internet





CAT-2 | QKD Network North-Brabant



QKD infrastructure to test solutions in relation with:

- Encryption
- Authentication
- Integration with classical networks

Third parties involved:



CAT-2 | 5G & Self-driving cars

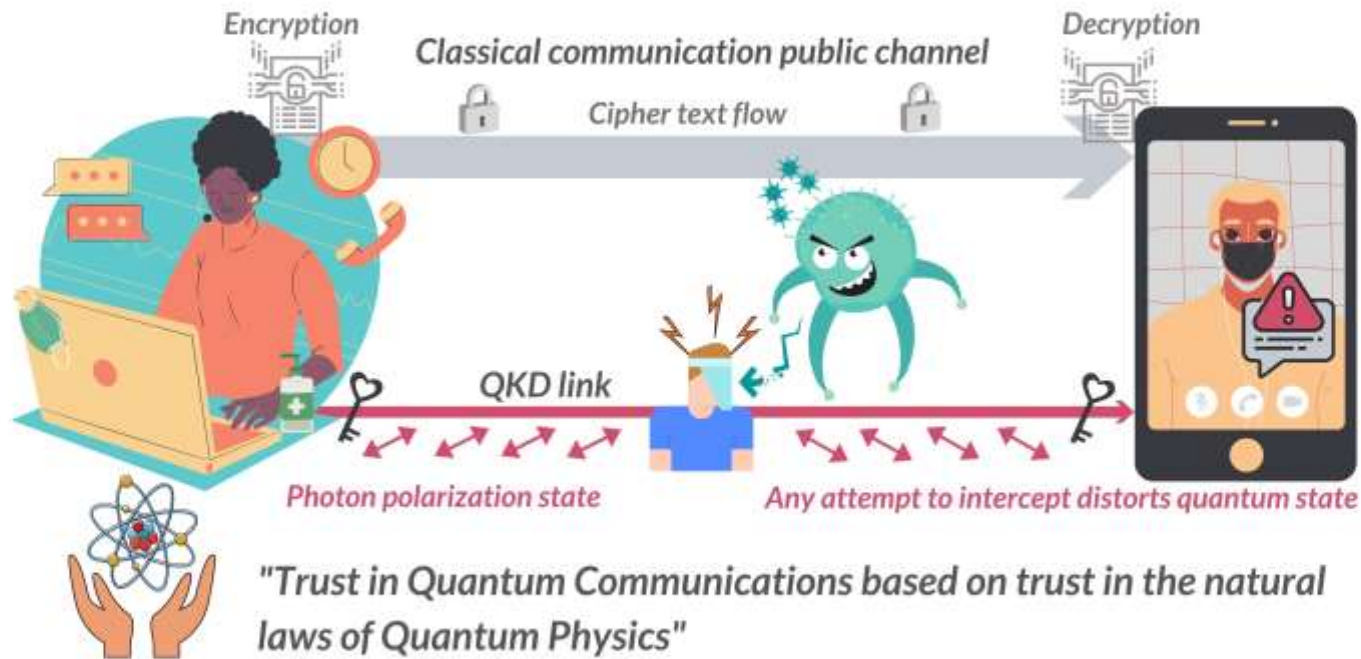


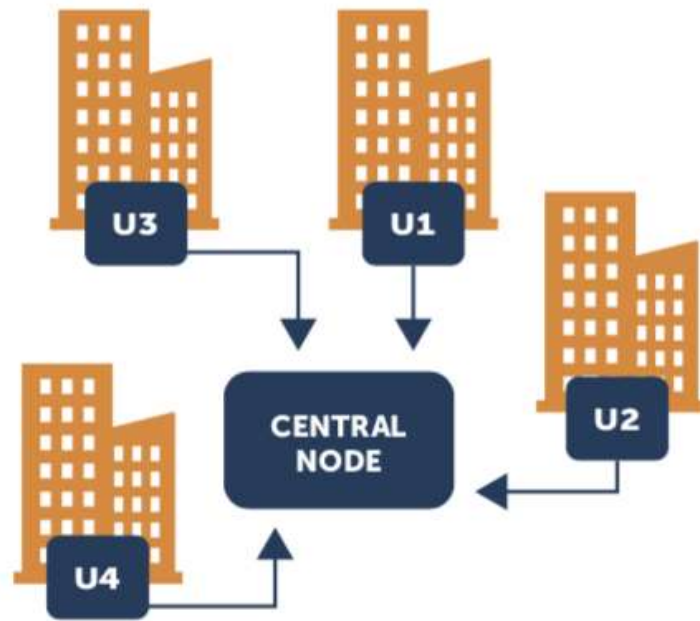
Foto: Bart van Overbeeke



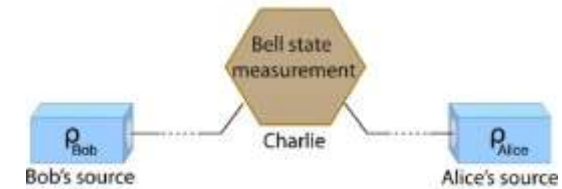
CAT-2 | MDI-QKD Network Delft - the Hague metro area

MDI-QKD infrastructure for governmental users to test their solutions in relation with:

- Encryption
- Authentication
- Integrity



MDI-QKD Network



Preferential users:



Government of the Netherlands

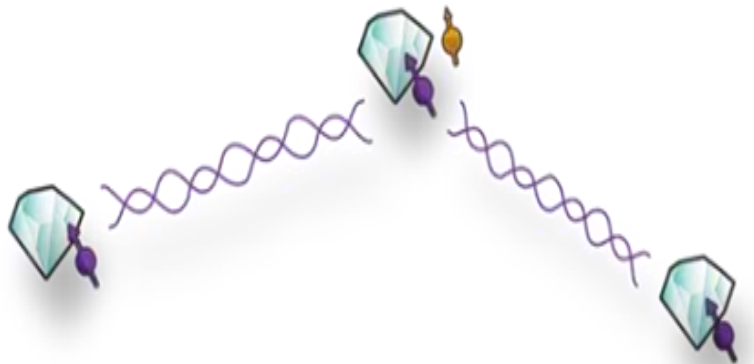




CAT-2 | 3-nodes Quantum Entanglement Link

Entanglement based quantum network

- Connecting three quantum processors through entangled Qubits
- New functionality exceeds what is currently possible
- The 3rd quantum node open to the public as “showcase”
- Existing close collaboration with industrial partners

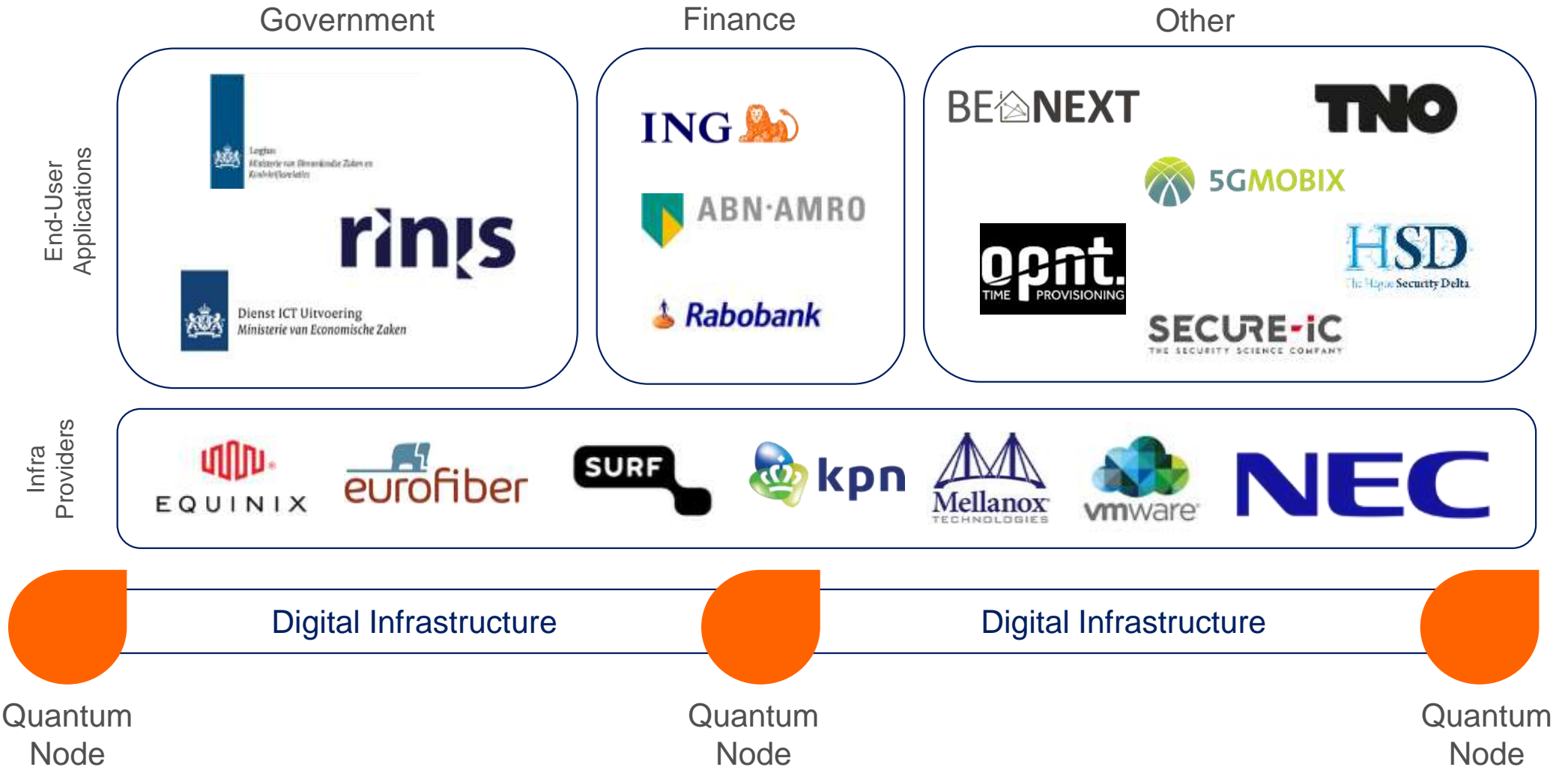


- Open to further consortium building and connecting new partners.





CAT-2 | NL Quantum Staging Network Ecosystem



CAT-2 | Taskforce

CAT-2 | Core

Jesse Robbers (QDNL)
Ingrid Romijn (QuTech)
Chigo Okonkwo (QT/e)

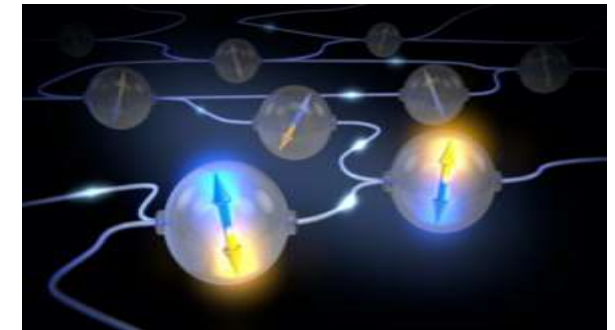
Lead: Jesse Robbers (QDNL)
Program Manager: Ingrid Romijn (QuTech)

Eindhoven: Chigo Okonkwo (QT/e)

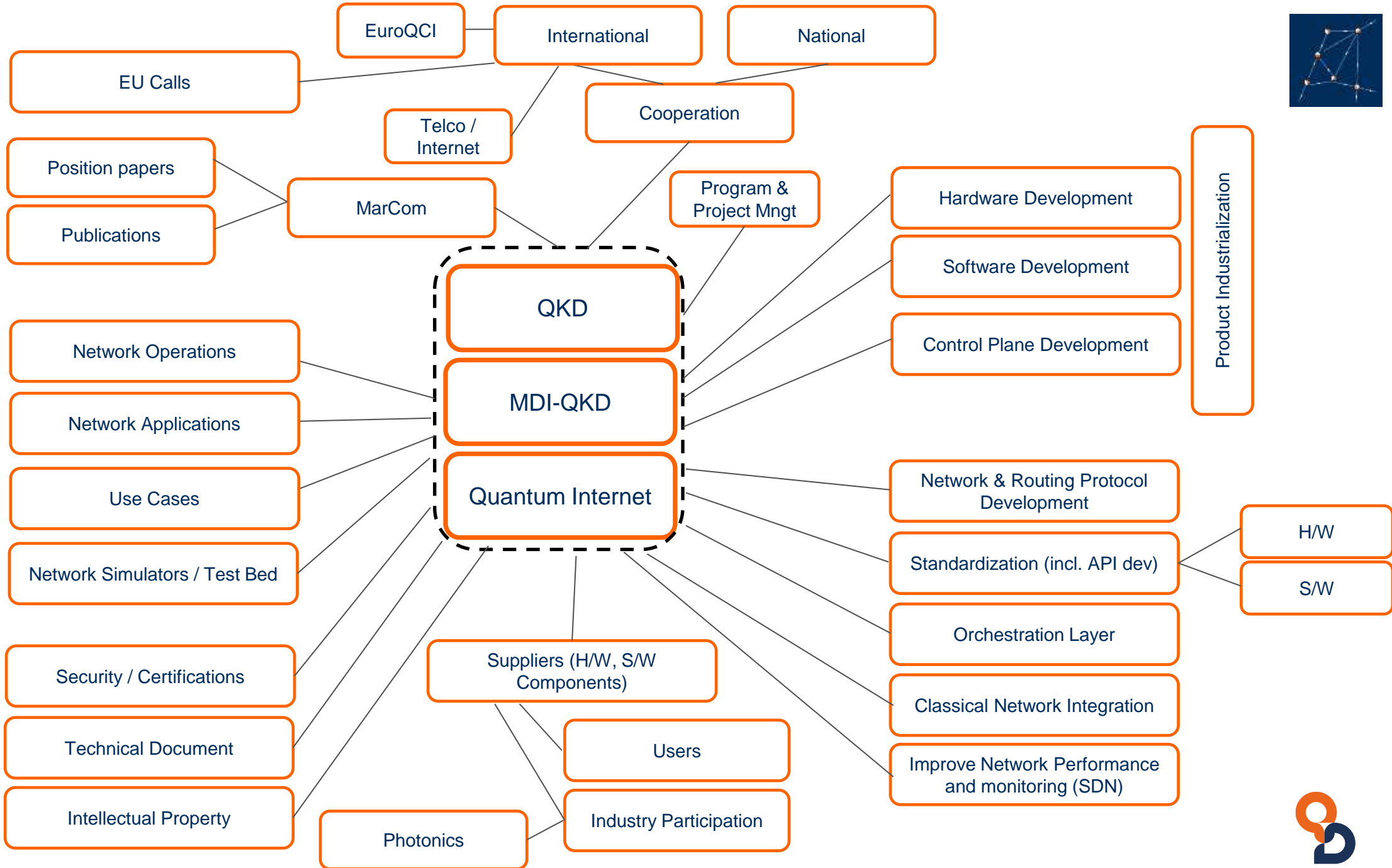
Amsterdam: Florian Speelman (QuSoft)

Delft: Erwin van Zwet (QuTech)
Wojciech Kozlowski (QuTech)

Leiden: Wolfgang Löffler (Uni. Leiden)



CAT-2 | Program Eco-System



What's Next | NL Quantum Staging Network

Short Term

Quantum Networks (QKD)



Long Term

Quantum Internet



- Continue the projects which started with the StartImpuls
- Extend the CAT-2 program based on the granted Growth Fund (NAQT) proposal
- Translate targets and guidelines of the Growth Fund to next phase of the CAT-2 program
- Define more detailed projects / goals / KPI's May-**June**-Sept+
- Act on International level (EU & Global)
- Realize the NL Quantum Staging Network & Build the ecosystem, with:
 - Researchers & Engineers
 - Startups & tech innovation
 - Industry: H/W, S/W, Applications & Infra suppliers/partners
 - Build use cases



QDNL | Important Starting points

- The Dutch Growthfund (groeifonds) award is based on the **submitted plan** by QDNL, from what the “National Agenda Quantum Technology” the fundament is.
- So after the award we **don’t start from scratch**, but we start with the implementation, which has already started (limited) with the earlier award of the StartImpuls funding.
- The QDNL plan is **bigger** then the awarded funding by the Dutch Growthfund. EU co-financing, industry participation and other research funding are crucial to realize the Dutch Quantum ambitions.
- All projects and activities needs to be in line of the main goals of the different CATs and Action lines. **Open calls** are available in A: “Actionline 1 – Research & Innovation” B: “CAT 3 – Quantum Sensing Applications” and C: ”Actionline 2 – Quantum Ecosystem”
- After 3 year the overall program will be evaluated and adjusted where necessary.





Jesse Robbers

[QuantumDelta.nl](https://www.quantumdelta.nl)

j.robbers@tudelft.nl or jesse.robbers@tno.nl

Ingrid Romijn

[QuantumDelta.nl](https://www.quantumdelta.nl) / [QuTech](https://www.qu.tech)

i.g.romijn@tudelft.nl

Chigo Okonkwo

[QuantumDelta.nl](https://www.quantumdelta.nl) / [QT/e](https://www.qt.eur.nl)

cokonkwo@tue.nl

Let's kick some QuBits!

Q&A