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World Quantum Day

4/14/2023

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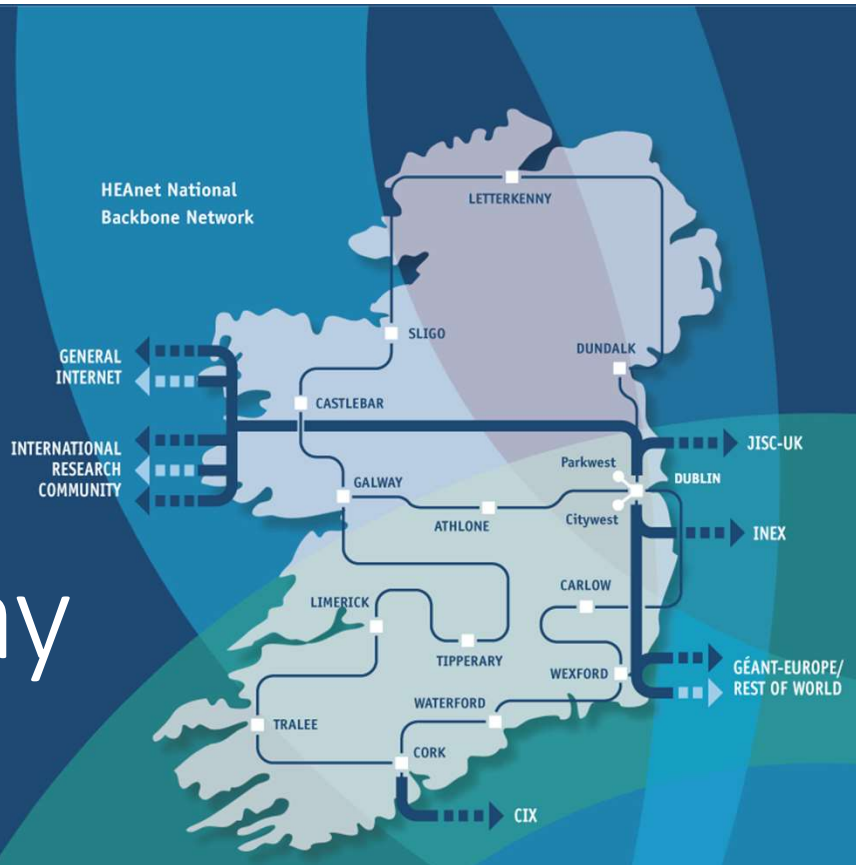
Update on EuroQCI Progress in Ireland

Eoin.Kenny@heanet.ie



IrelandQCI: Building a National Quantum Network for Ireland

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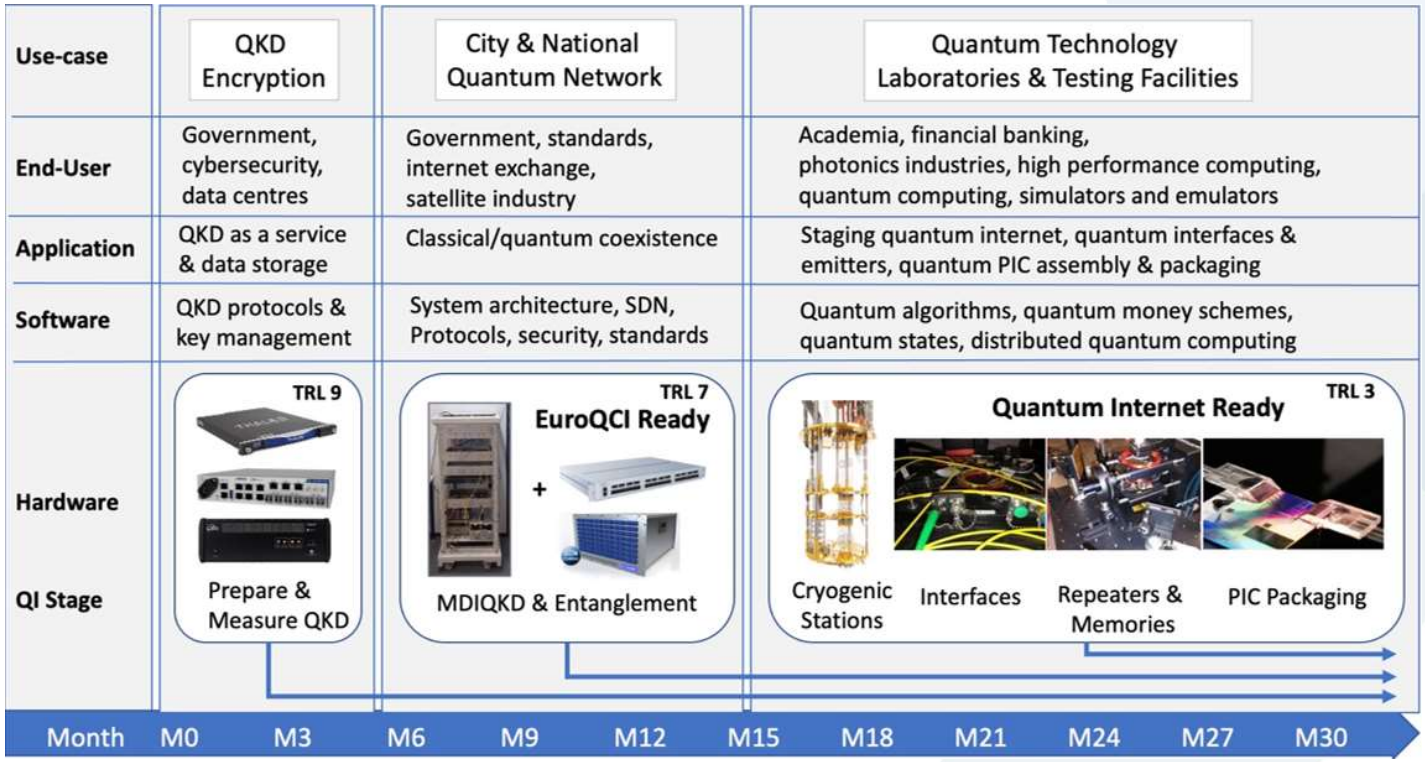
IrelandQCI Team & Partners

This project has received funding from the European Union's DIGITAL Europe Programme under grant agreement No. 101091520.

IrelandQCI Roadmap towards EuroQCI



National Backbone Network

- M12: PM QKD
  - 3 End Nodes
  - 1 Trusted Node
- M18: PM + SNSPDs QKD
  - 3 End Nodes
  - 2 Bypass Nodes
- M20: MDI QKD
  - 4 End Nodes
  - 2 Core Nodes

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Quantum Network Evolution

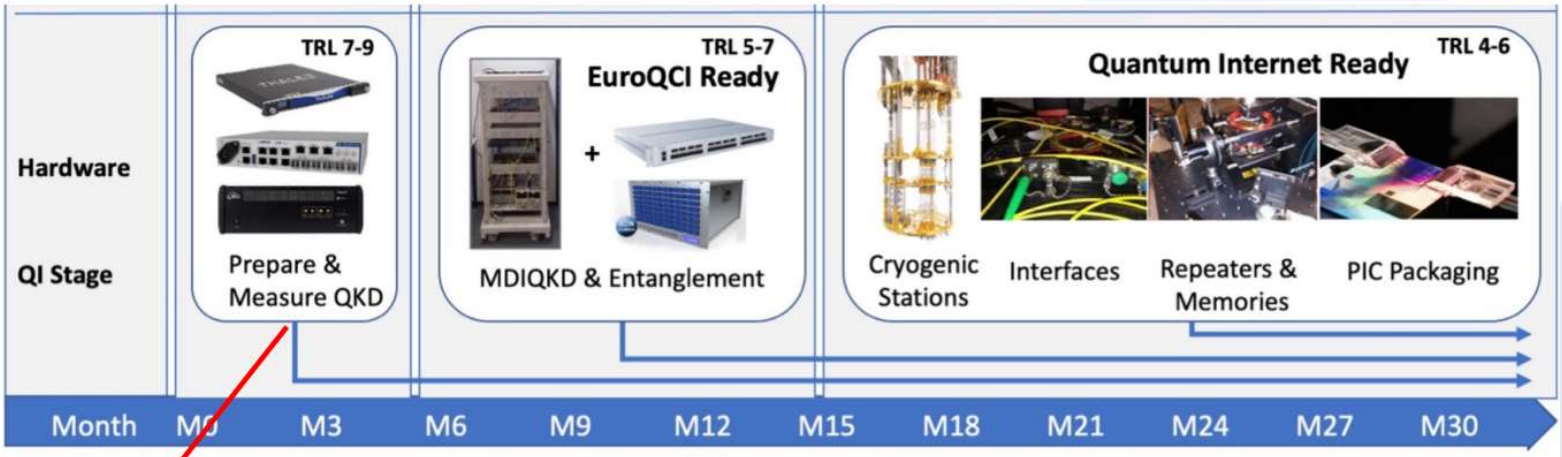

Fig. 2 *IrelandQCI* roadmap towards EuroQCI and the quantum internet

- Point-2-Point (P2P) QKD Links
- Off The Shelf (OTS) QKD devices at different DWDM wavelengths
- Create multiple topologies (P2P, Loop, Star)
- Integrate with OTS Encryption (transmission, IPsec, MACsec) and Key Management Devices

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QKD with existing solutions

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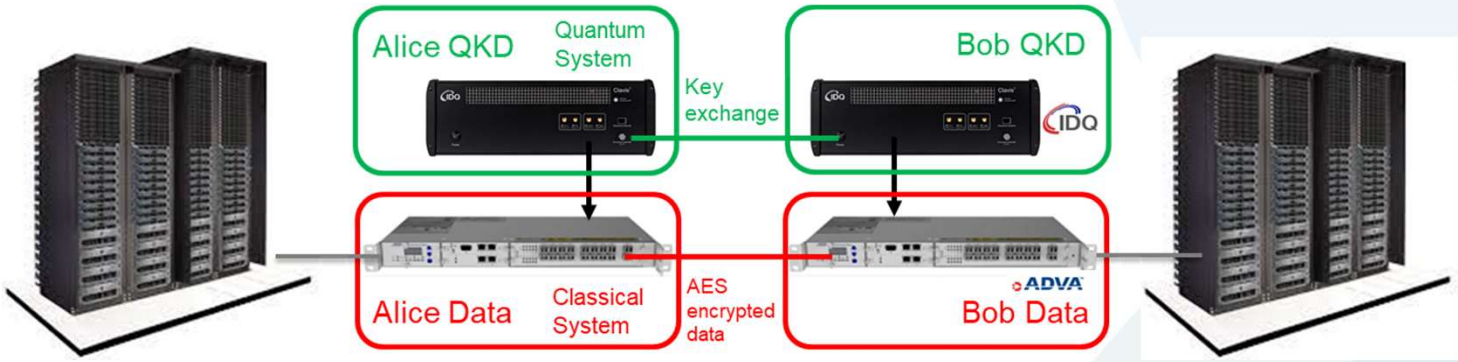
QKD – Data Centre Interconnect



Quantum Encryption

- IDQuantique Clavis^3 QKD system:
  1.4 kbps, 12 dB loss ~100 km over standard telecoms
- ADVA FSP3000:
  100 Gbps, QKD-enabled WDM AES256 encryptors
- Compatible via the ETSI-QKD API

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Quantum Network Evolution

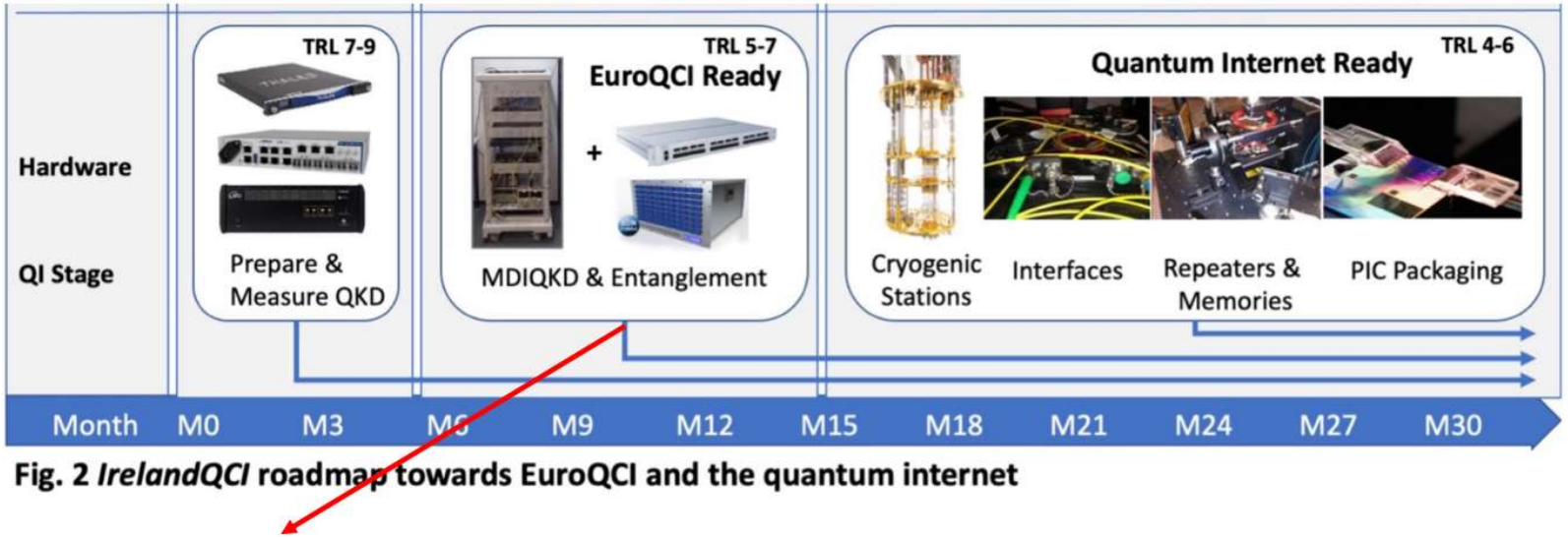

Fig. 2 *IrelandQCI* roadmap towards EuroQCI and the quantum internet

- External detectors added to extend practical range
- Prepare and Measure and superconducting nanowire single-photon detectors (SNSPD) QKD
- Multipoint-2-Multipoint (MP2MP) QKD Links
- Using Measurement Device Independent (MDI) QKD – with Core Nodes and End Nodes
- Bi-directional star topologies, with star to star connectivity
- Integrate with OTS Encryption (transmission, IPsec, MACsec) and Key Management Devices

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Quantum Network Evolution

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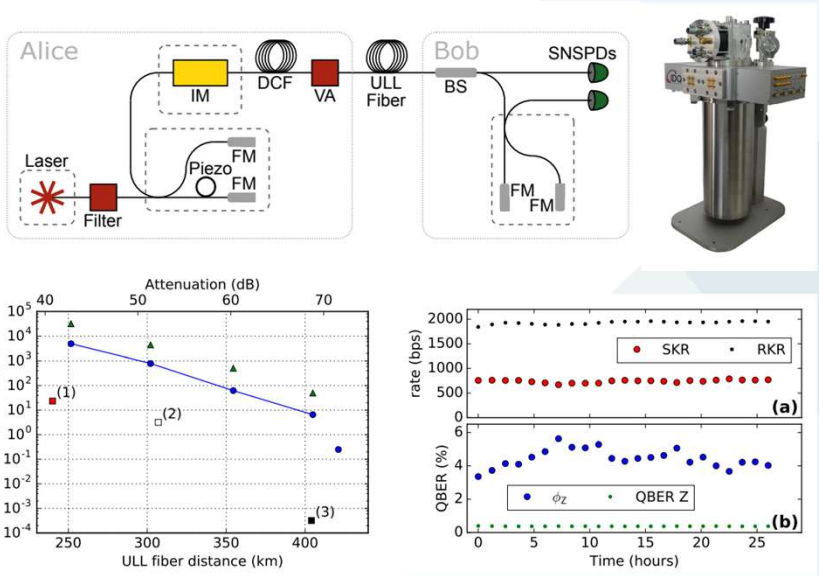
Prepare and Measure SNSPD

Geneva (Laboratory)

- Phase-randomised pulsed laser diode 2.5 GHz
- 3 state time-bin, one decoy
- Modulating optical phase & intensity
- IDQuantique Quantis QRNG
- ULL single-mode fibre 0.16 dB/km loss
- SNSPDs @ 0.8 K
- Secure key rate 6.5 b/s over 405 km



Boaron, A. *et al. Phys. Rev. Lett.* (2018)
[1807.03222.pdf (arxiv.org)]

Quantum Network Evolution

National Backbone Network

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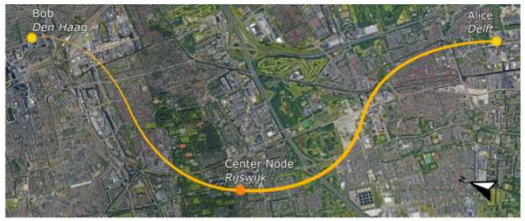
Measurement Device Independent

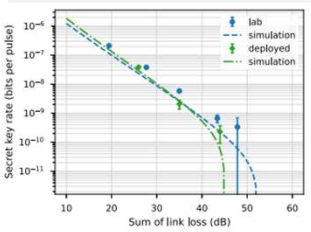
Netherlands

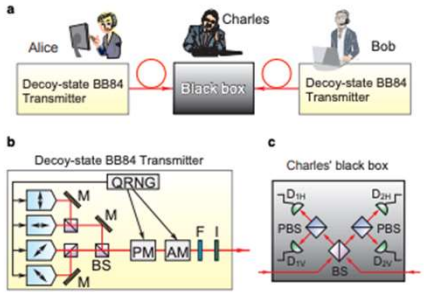
- End nodes (Alice, Bob)
- Centre node SNSPDs
- Decoy state BB84
- 10 Gb/s traffic over all links
- 50 dB attenuation,
- ~250 km spooled fiber

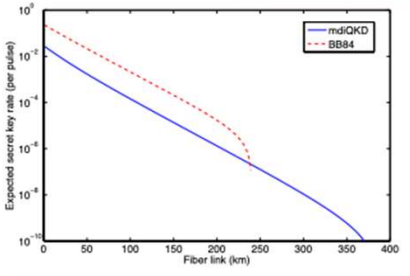
Network Performance

Number of nodes	3
Longest link (loss)	14.7 km (13 dB)
Operation Period	14 days
Data multiplexing	yes
Data bandwidth	10 Gbps









Lo, H. *et al. Nat. Photonics* (2014)
Berrevoets, R. C. *et al. Commun. Phys.* (2022)

QuTech OPEN QKD

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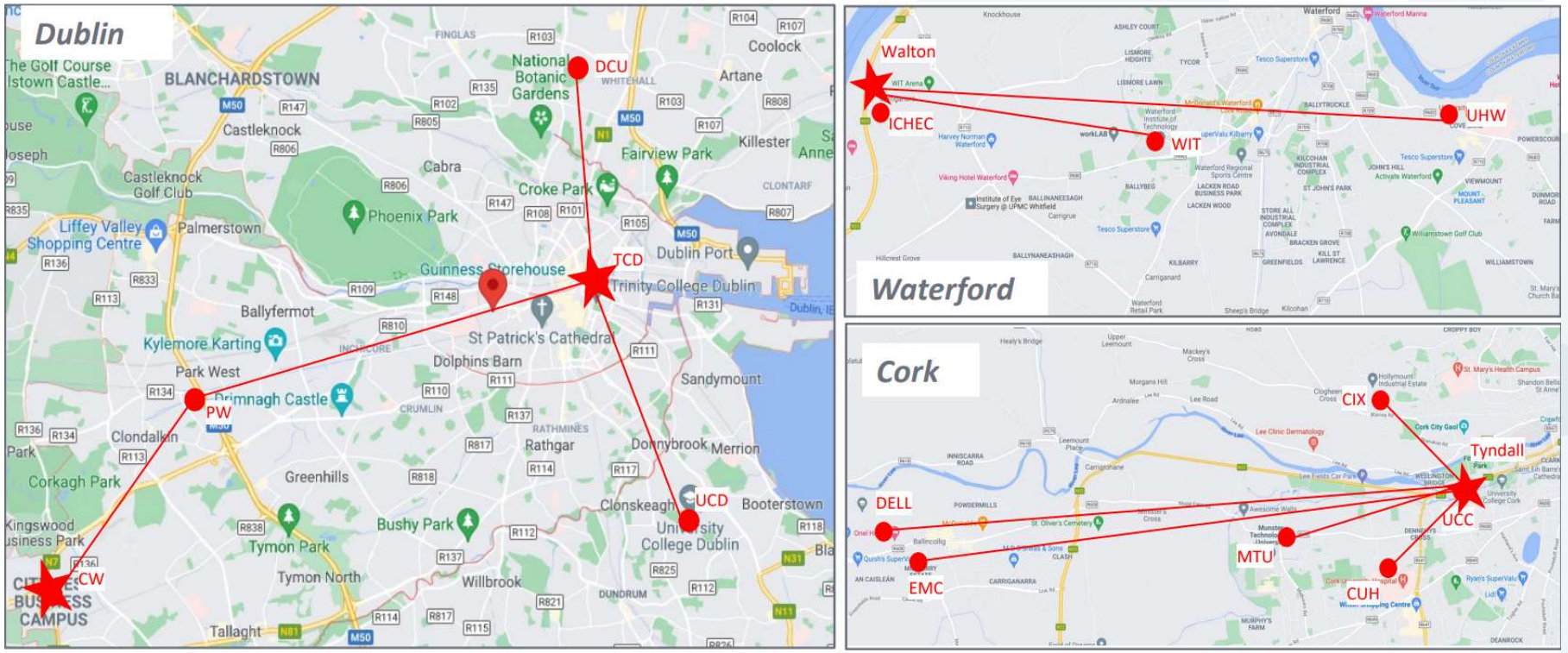
Metro MDI-QKD Pilots



MDI-QKD Star topology

Centre Node – Complex/Expensive hardware

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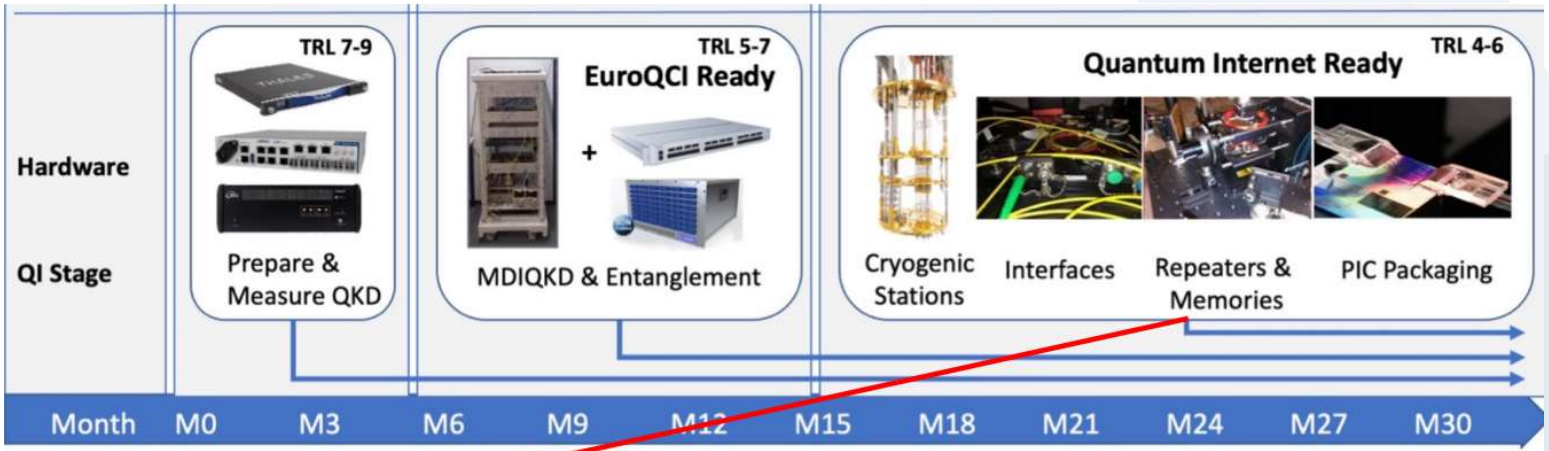

Fig. 2 *IrelandQCI* roadmap towards EuroQCI and the quantum internet

- Quantum Memories & Quantum Repeaters
- Interface with entanglement pair sources (EPS) and detectors in dilution refrigerators
- EPS to replace MDI End-Nodes
- MDI-QKD Core Nodes upgrade
- Quantum Packaging
- Create integrated quantum photonics that will be tested within the dilution refrigerators operated on the EuroQCI network

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Thank you

Any questions?