WDM-PON and 5G

Frank Effenberger

Futurewei Technologies, USA

Frank.effenberger@Futurewei.com

The idea of WDM-PON

- The concept of WDM-PON has been around for a long time
  - Stuart Wagner invented it at Bellcore in 1989 (called PPL at the time)
- The system has experienced several bursts of interest over the years, as new technologies and applications emerged
- The typical problem has always been its high cost, coupled with an excessive capacity that is not so easily shared between users
- 5G wireless sounds like it could use WDM-PON, as it needs
  - Very high capacity and low latency and jitter
  - Perhaps not as cost sensitive as residential
- So, we should consider the 5G use case, to see what fits

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Main issues to consider for access networks and 5G

- Layout of the combined 5G + fixed network
  - Where are the important equipment locations?
  - Where are the RoW's and facilities that can be used?
- Traffic profile of the 5G network
  - How much bandwidth and its latency tolerance?
  - Going between which points in the network?

- So far as I can see in the literature, people create fanciful pictures of every possibility, often including cloud-shaped objects
  - These are useless for our purpose. We need specifics

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Motivational example

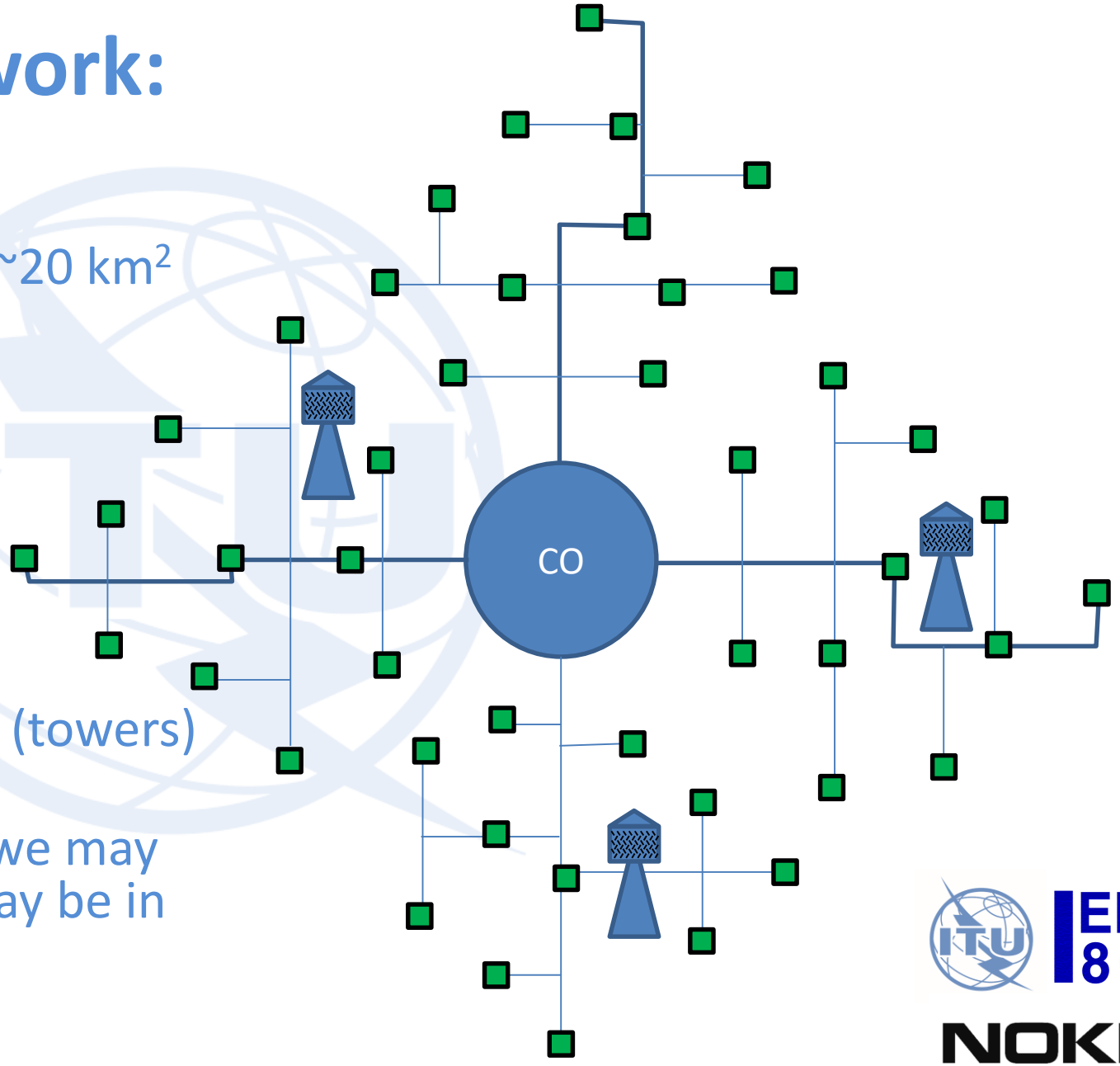
- Just as an example of what can be determined with simple information, consider the case of Orange France
- Recently at ECOC, Philippe Chanclou presented their findings on the network in a representative area of France
  - The number of cell sites was about the same as the number of Central Offices
  - This means that we don't need PON to serve those sites, P2P is a better fit, if we are assuming that all the wireless equipment remains at those sites

- Clearly this is not a universal answer, but suggests a way to analyze the wireless over fiber problem
- We see two different scenarios in the world: Western and Eastern

Typical western network: CO with feeder

- CO has feeder routes covering ~20 km^2
- Each feeder serves ~10 SAI's
- Each SAI hosts ~250 homes
- Thus CO serves 10k homes
- Splitters are located in the SAI

- On average there are 3 cell site (towers) distributed over the area
- Cell sites contain 4G BBU, and we may presume the 5G DU (The CU may be in the CO, or in the cloud)



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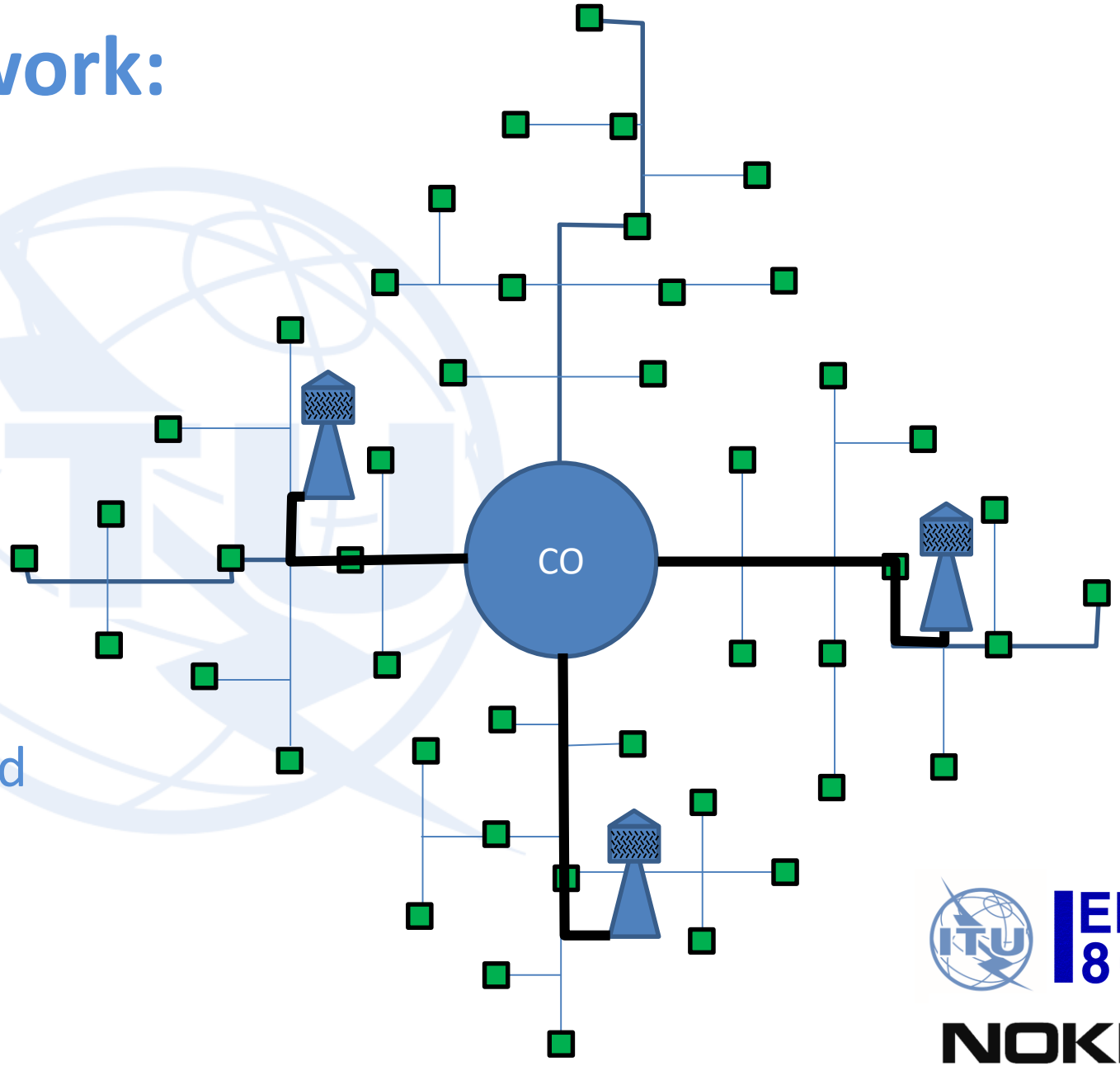
Typical western network: Cell site to CO traffic

- Cell site holds 4G and 5G
  - 4G BBU requires ~1Gb/s backhaul to CO
  - 5G DU-CU link requires 10~25G, normal latency
- Transport solution is 25G BiDi or dual fiber optics
- 4G might possibly be hosted on an XGS-PON, but 5G doesn't fit



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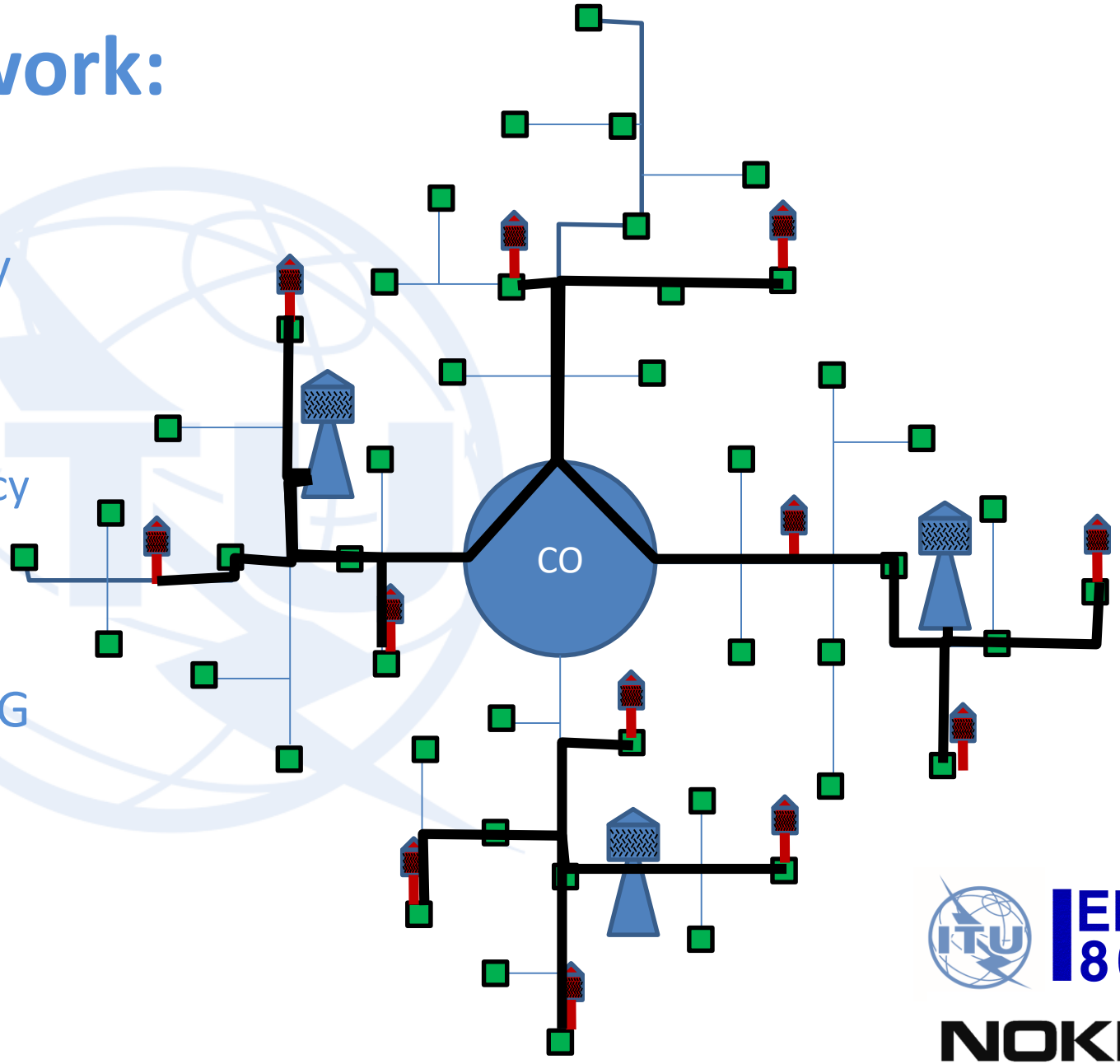
Typical western network: RU to DU traffic

- Each cell site is augmented by some satellite RU's
  - RU's and the hosting tower going to use CoMP
  - Fx-type traffic, very low latency and jitter
  - 25G per sector at least

- Transport solution is 25 or 50G bidi modules
  - Note some RU's need to take the long way around
  - In this scenario, WDM-PON doesn't really shine



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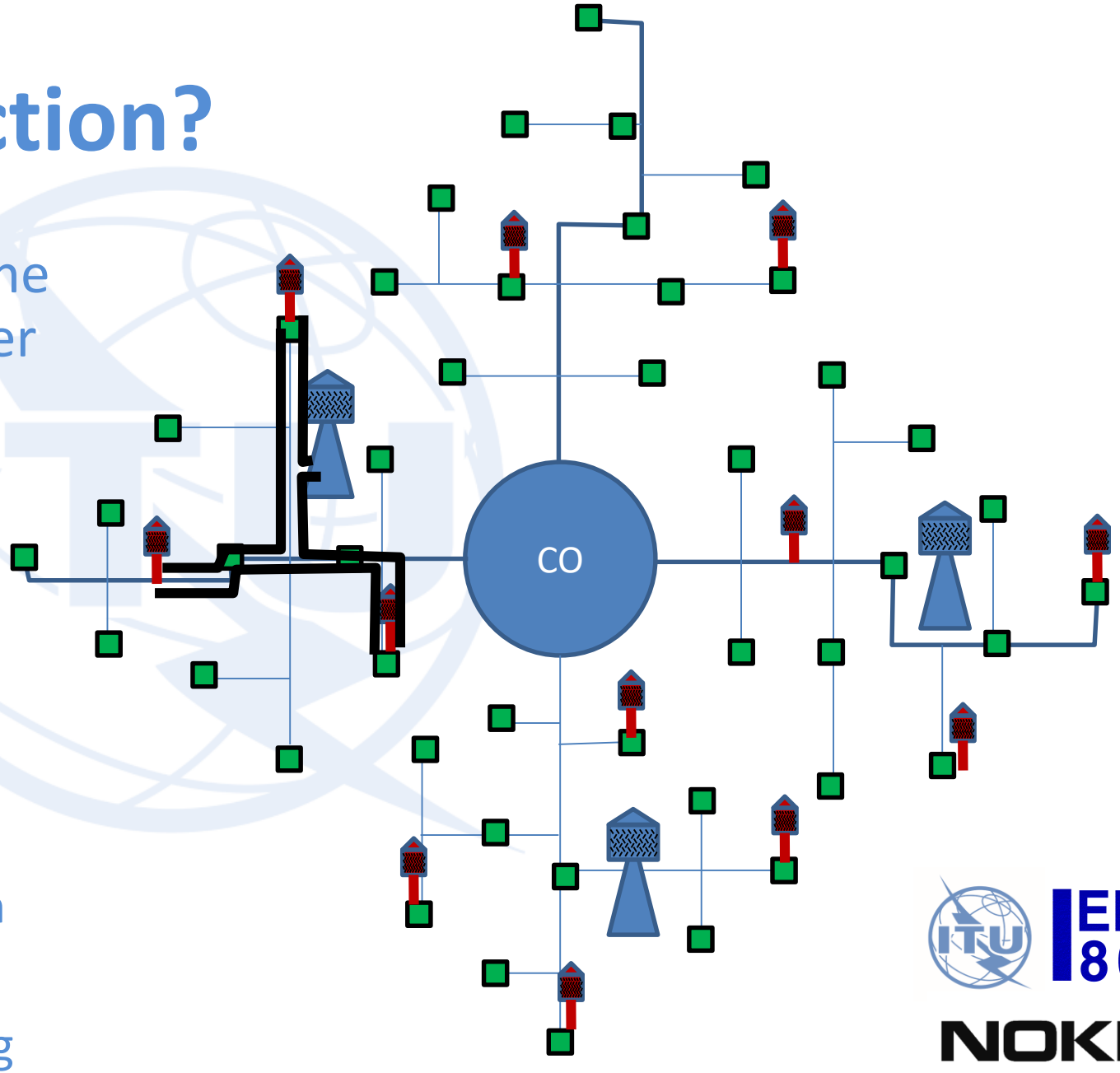
What about protection?

- One unique factor here is the RU's will have reliable power
  - A big difference from FTTH
- This enables us to consider ring or bus networks
  - This could be OTN, ring of switches, or other protocol

- Such a scheme features
  - Optical interface protection
  - Fiber sharing
  - Dynamic bandwidth sharing



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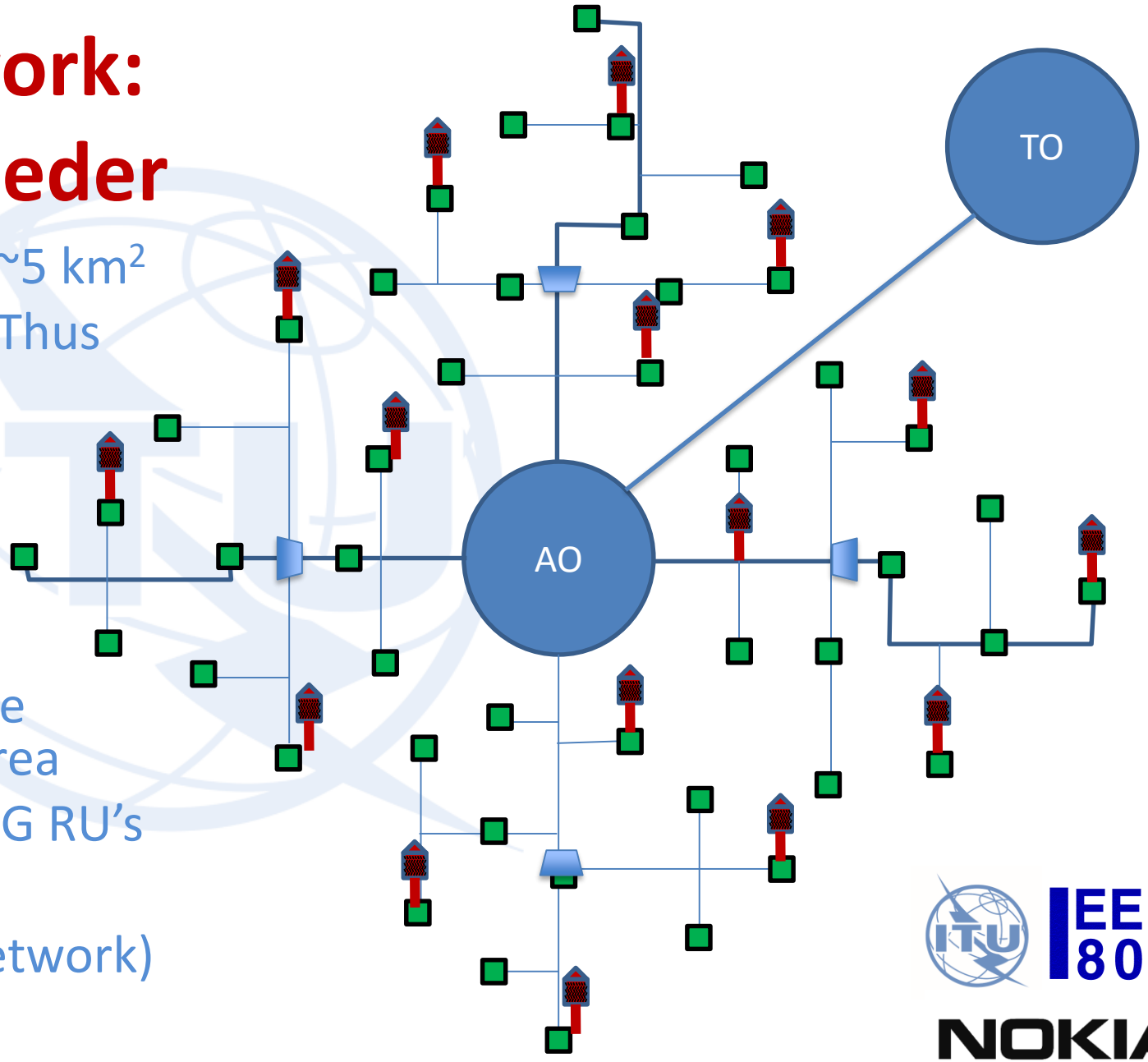
Typical eastern network: Access Office with feeder

- AO has feeder routes covering ~5 km^2
- Average density is 500 LU/km^2 Thus AO serves ~2500 homes
- Two stage splitting is used
  - 1:8 in the AO, 1:8 in the field
- Fiber is relatively scarce

- On average there are 16 cell site (towers) distributed over the area
- Cell sites contain 4G RRU and 5G RU's
- 5G DU's located in the AO
- 5G CU located in TO (or core network)



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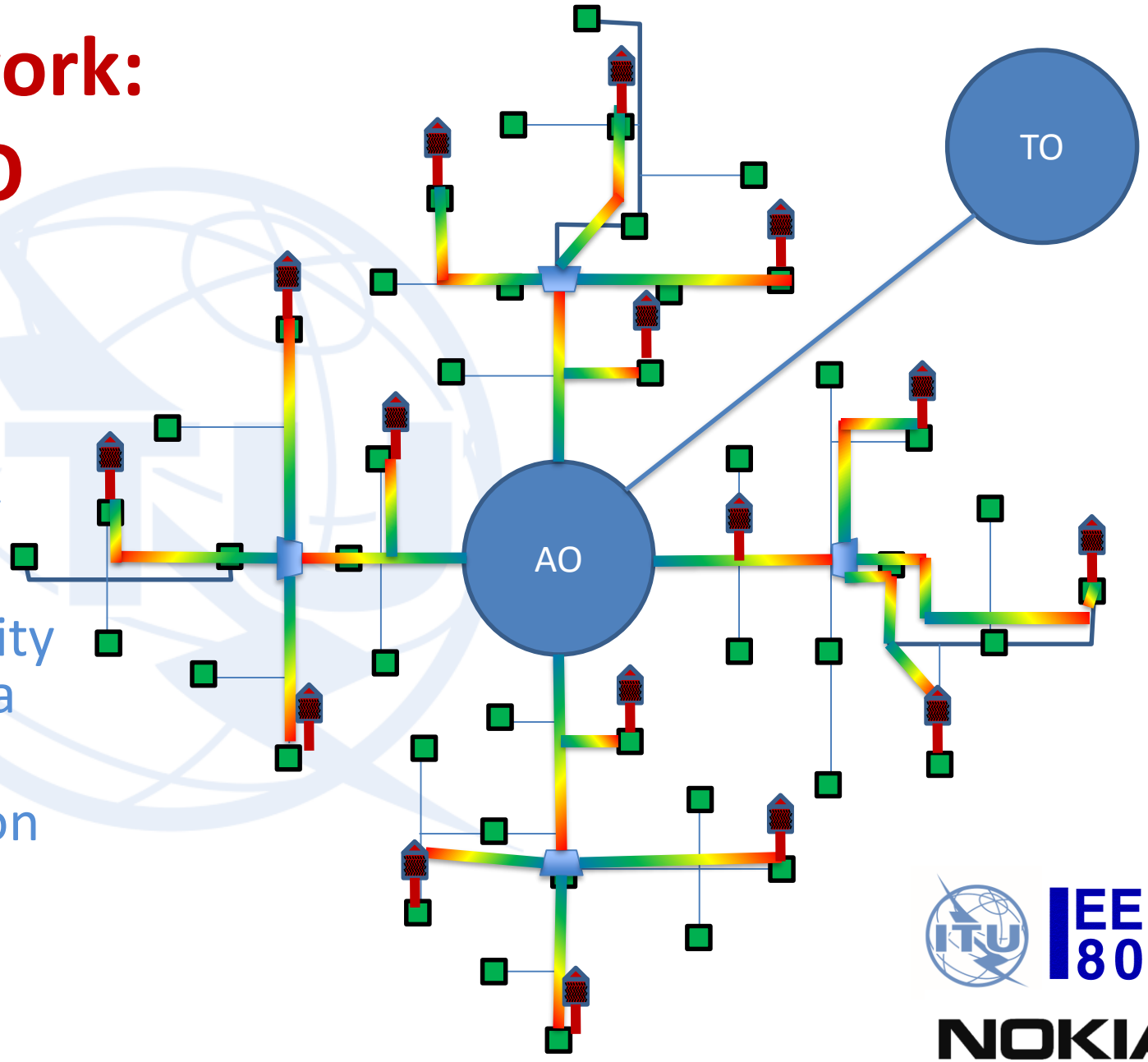
Typical eastern network: Traffic from RU to AO

- Each RU needs 3 * 25G links connecting it to the DU
  - This is Fx interface, requiring latency under 100 us
- Each feeder needs a capacity of 12 * 25G
- A WDM-PON with this capacity could serve each route with a single fiber
- This, basically, is the attraction of WDM-PON
  - Not a place for TDM-PON; simply not enough capacity



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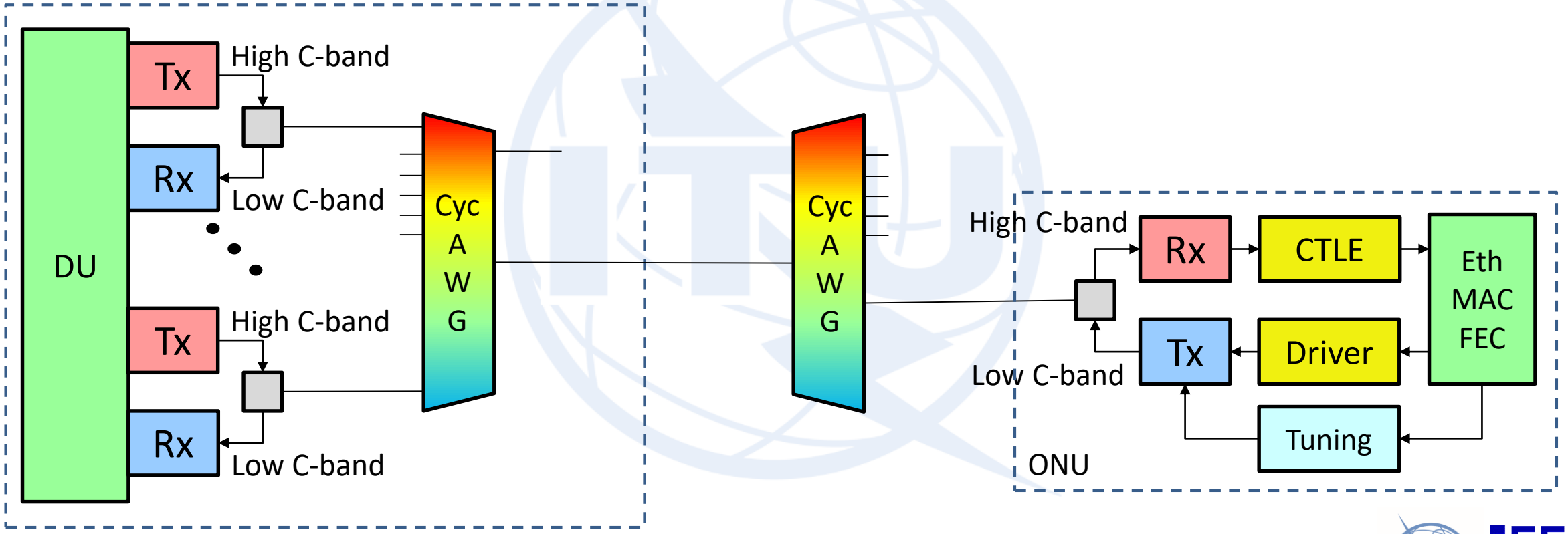
Generic architecture of WDM-PON



Conclusions

- The 5G use case is interesting, but it needs more careful study
  - The physical realities of the network, both now and in the future, need to be accounted for
  - The choice of 5G architecture also plays a big role
- Considering the standardization activity in the past year, it seems that operators from the East and West cannot agree on the 5G transport solution
- This is most likely due to differing network situations and design choices: these are largely ‘hidden assumptions’
- All operators should more fully describe their use cases, to gain better understanding for all the parties

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