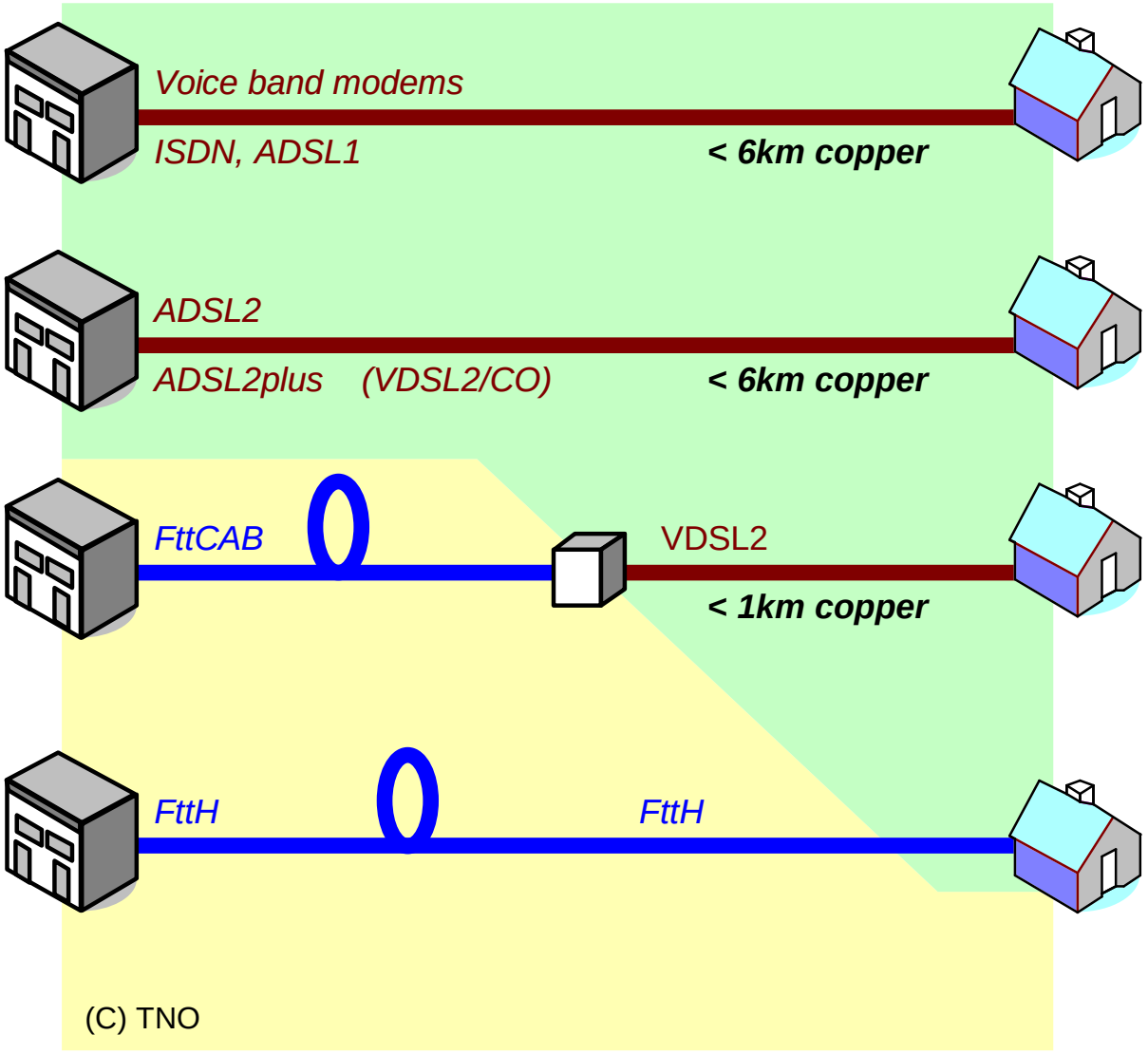
DSL Migrations towards Hybrid FttH, and associated regulation issues

Rob F.M. van den Brink - TNO

1. Network migration from Copper to Fiber

Evolution of telco solutions in offering Broadband



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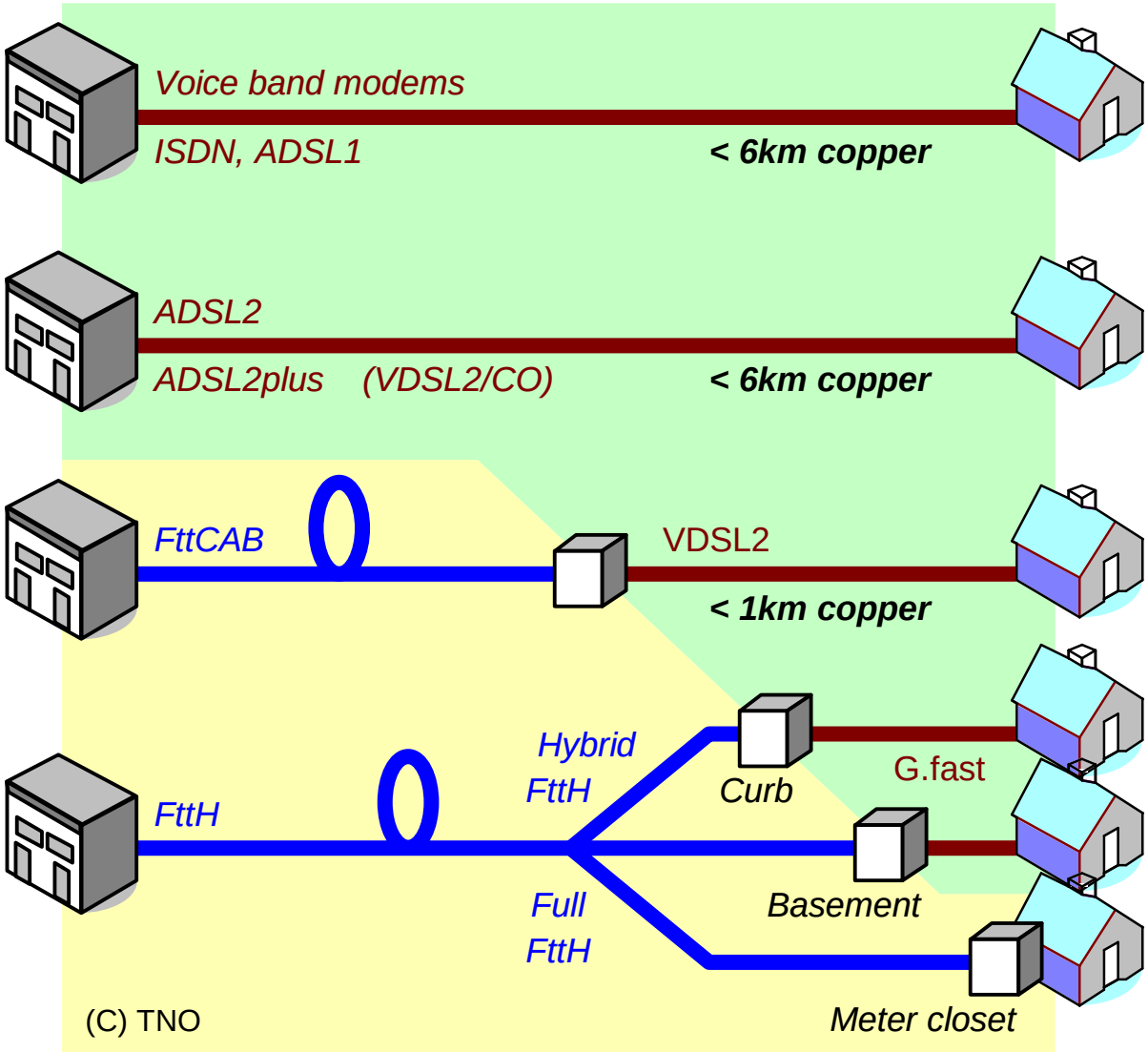


1. Network migration from Copper to Fiber

… in small steps

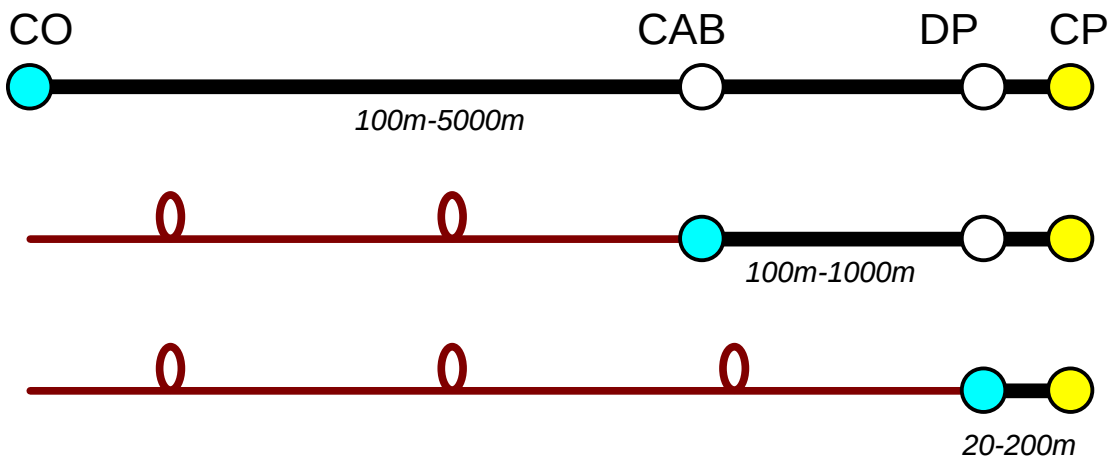
Fiber = expensive investments (digging, installation, ..)
Extending copper life (higher bitrates) = saving investment
Smart deployments (Dynamic line management) increases efficiency

- How to increase the bitrate even further
  - 1. Shortening copper loops **à** step into next generation FttX
  - 2. Widening spectra
  - 3. Bonding DSL wire pairs
  - 4. Vectoring DSL wire pairs

- Restrictions: regulation about unbundling
  - Unbundling sometimes stimulates progress (competition)
  - Unbundling sometimes blocks progress (prevents solutions)

2. Boosting bandwidth via “shortening loops”

Basic principles



Full copper:
ADSL2, ADSL2+, VDSL2/CO

Hybrid FttCab + copper:
VDSL2/CAB

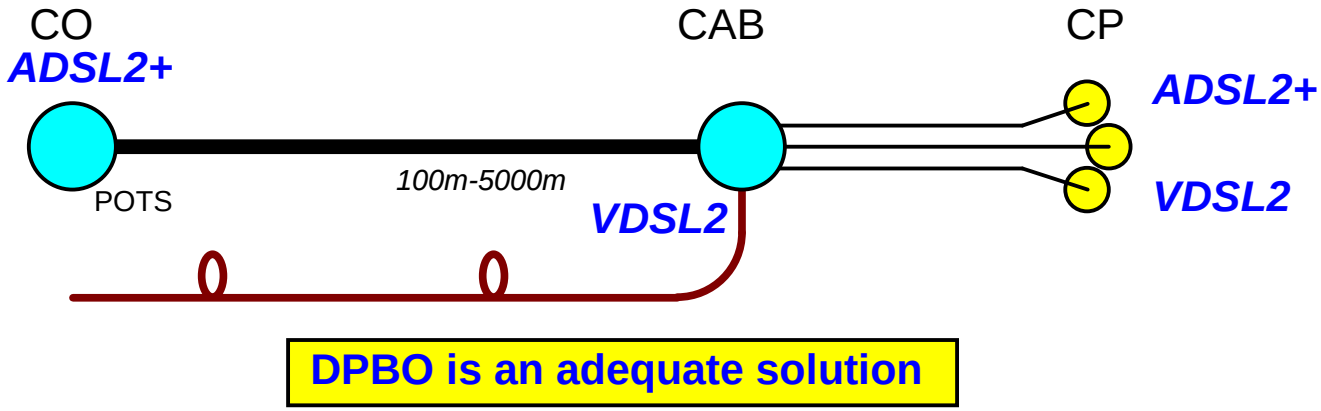
Hybrid FttH +copper:
G.fast

Shortening loops = investments in Fiber, (expensive)

so attractive only when limits of other DSL methods are reached

2. Boosting bandwidth via “shortening loops”

Consequences for unbundling à multi node deployments



ADSL2/CO + VDSL2/CAB can coexist

with adequate Downstream Power BackOff (DPBO)

2. Boosting bandwidth via “shortening loops”

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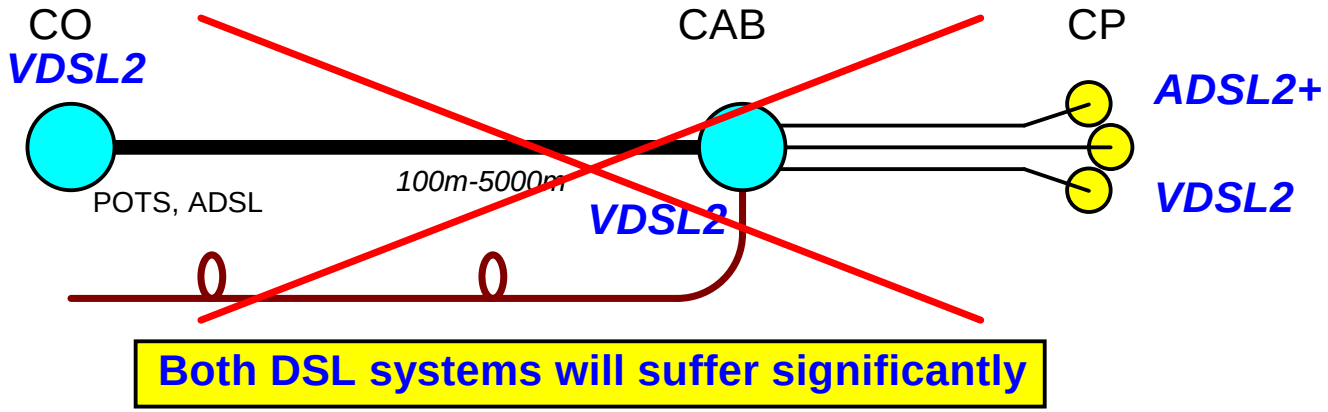

VDSL2/CO + VDSL2/CAB cannot coexist

performance will degrade from both

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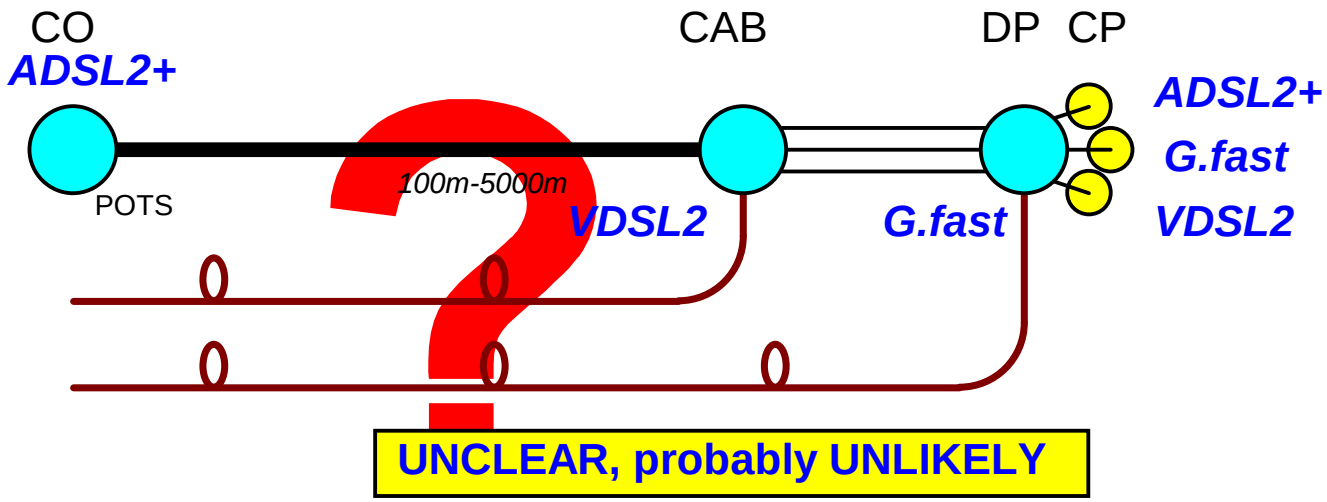
Consequences for unbundling à multi node deployments



ADSL2/CO + VDSL2/CAB + G.fast/DP **à** coexistant?

unclear if G.fast/DP should account for VDSL2/CAB

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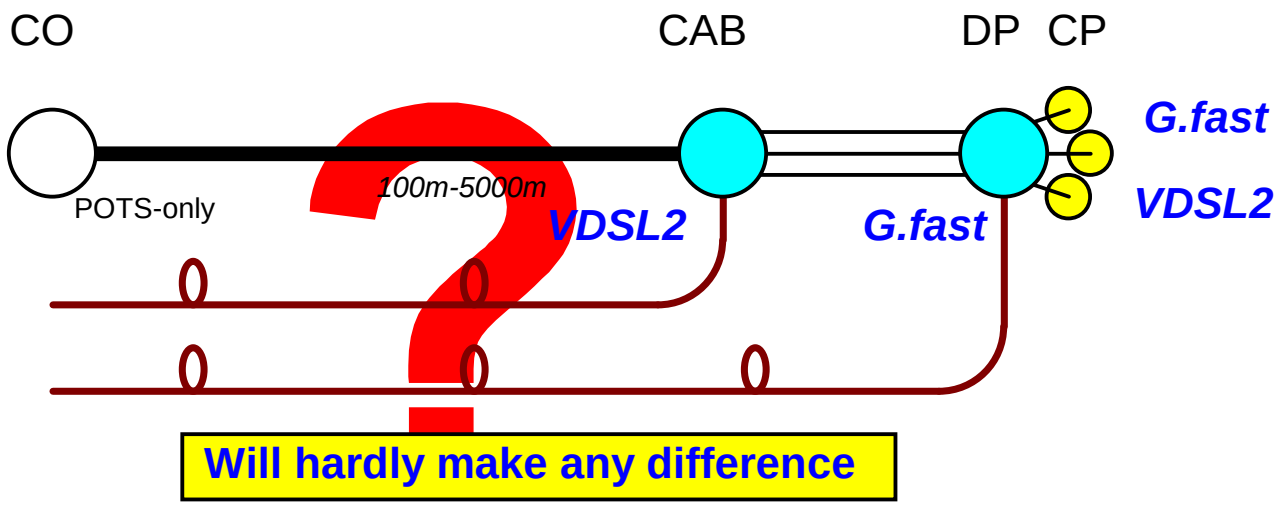

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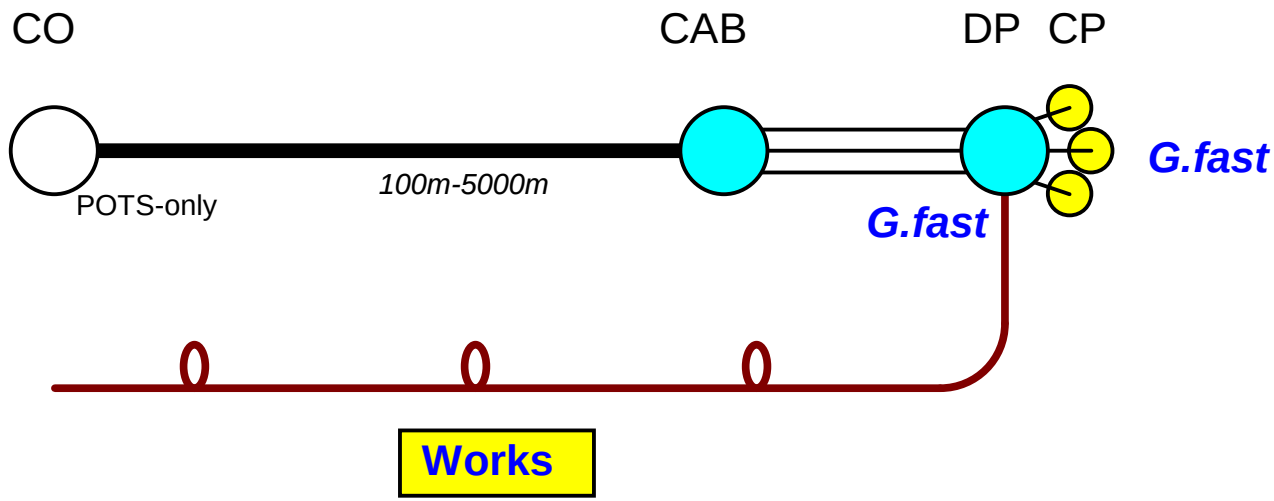
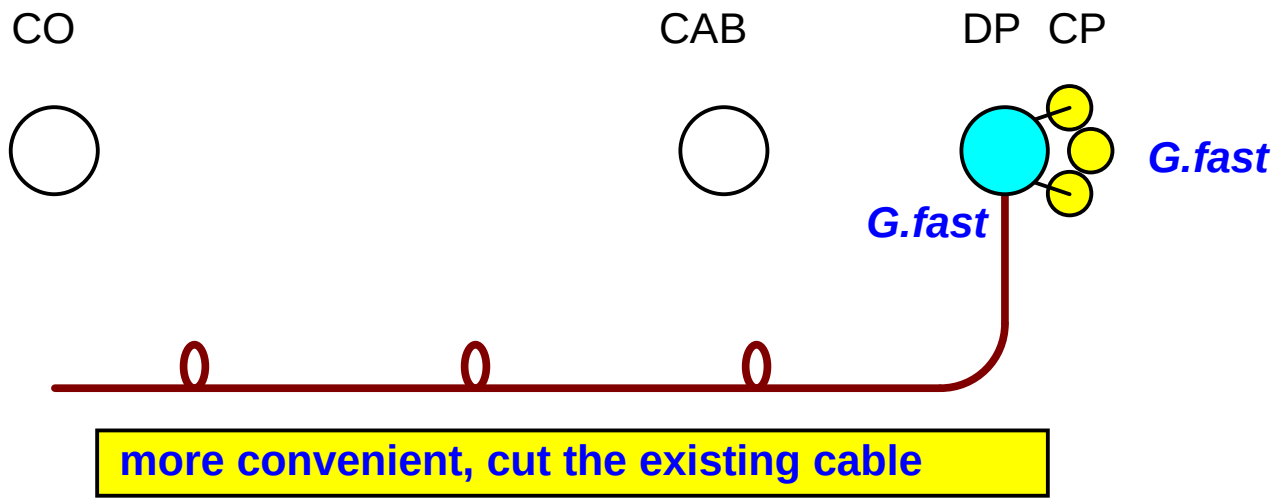


POTS/CO + G.fast/DP **à** will coexistist but is this realistic?

2. Boosting bandwidth via “shortening loops”

Consequences for unbundling à multi node deployments

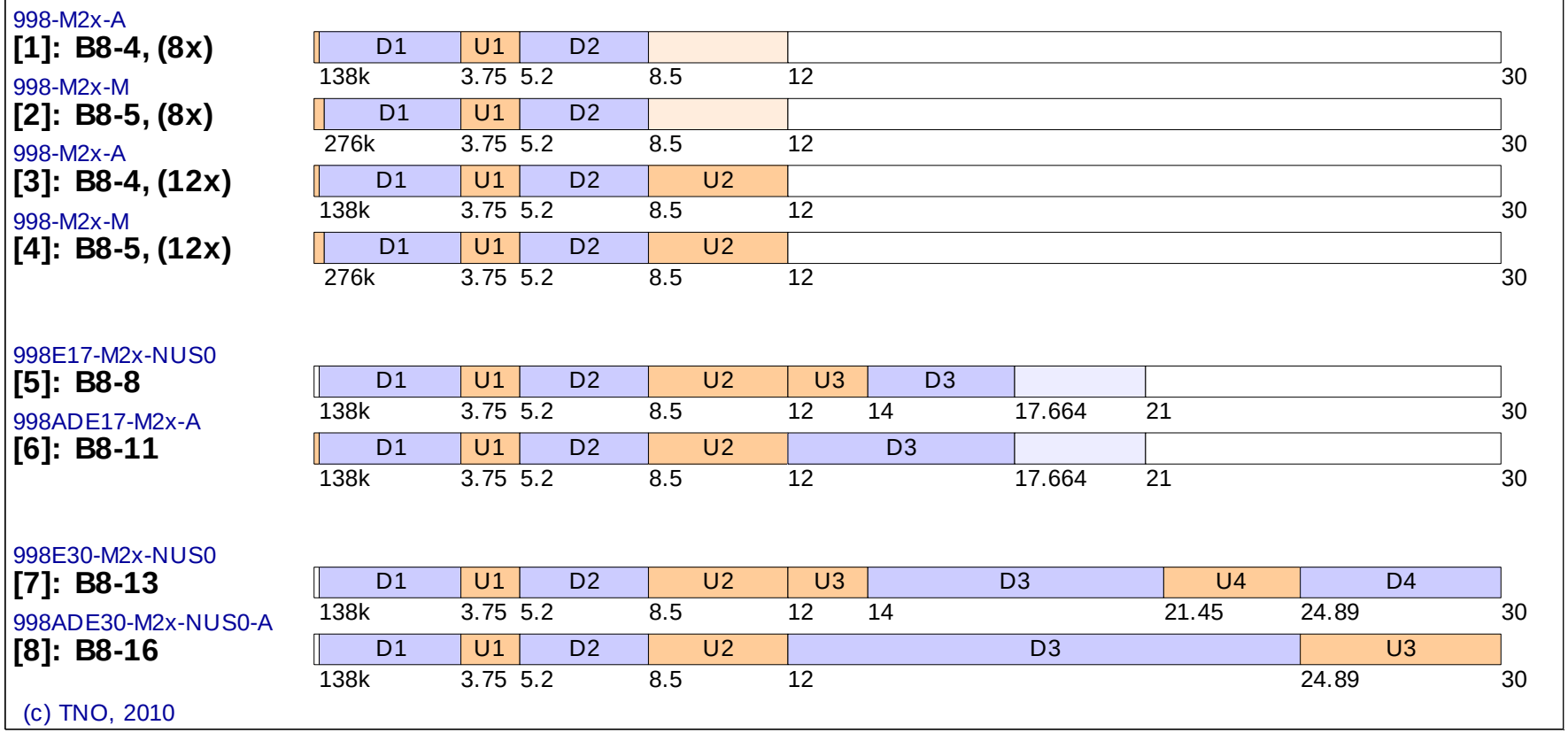


without any multi-node deployment one can cut the cable

3. Boosting bandwidth via “widening spectra”

Basic principles, up to 30 MHz

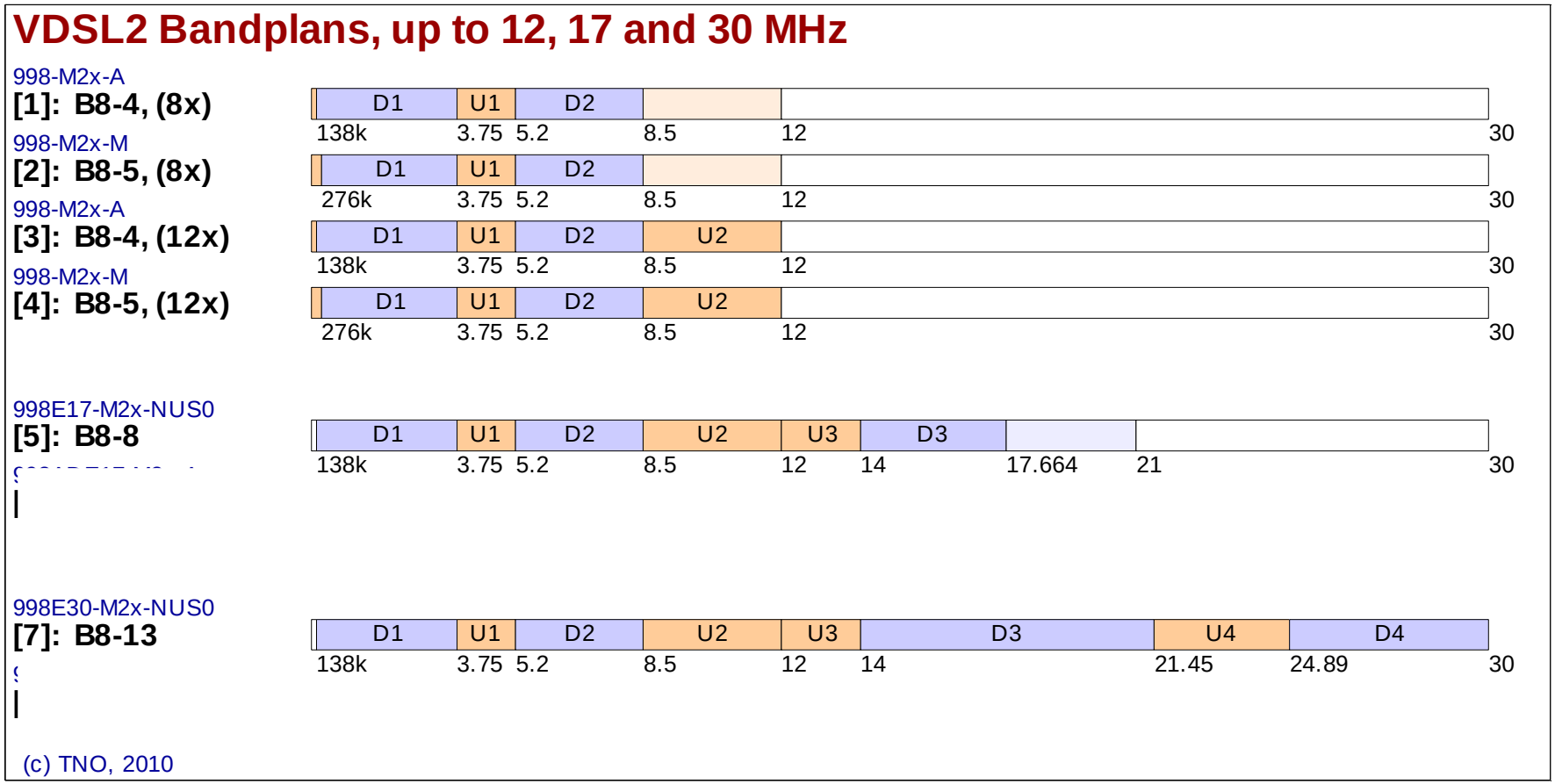
VDSL2 Bandplans, up to 12, 17 and 30 MHz



widening gives some improvement in bitrate (only for very short loops), several possibilities, but you cannot combine all bandplans

3. Boosting bandwidth via “widening spectra”

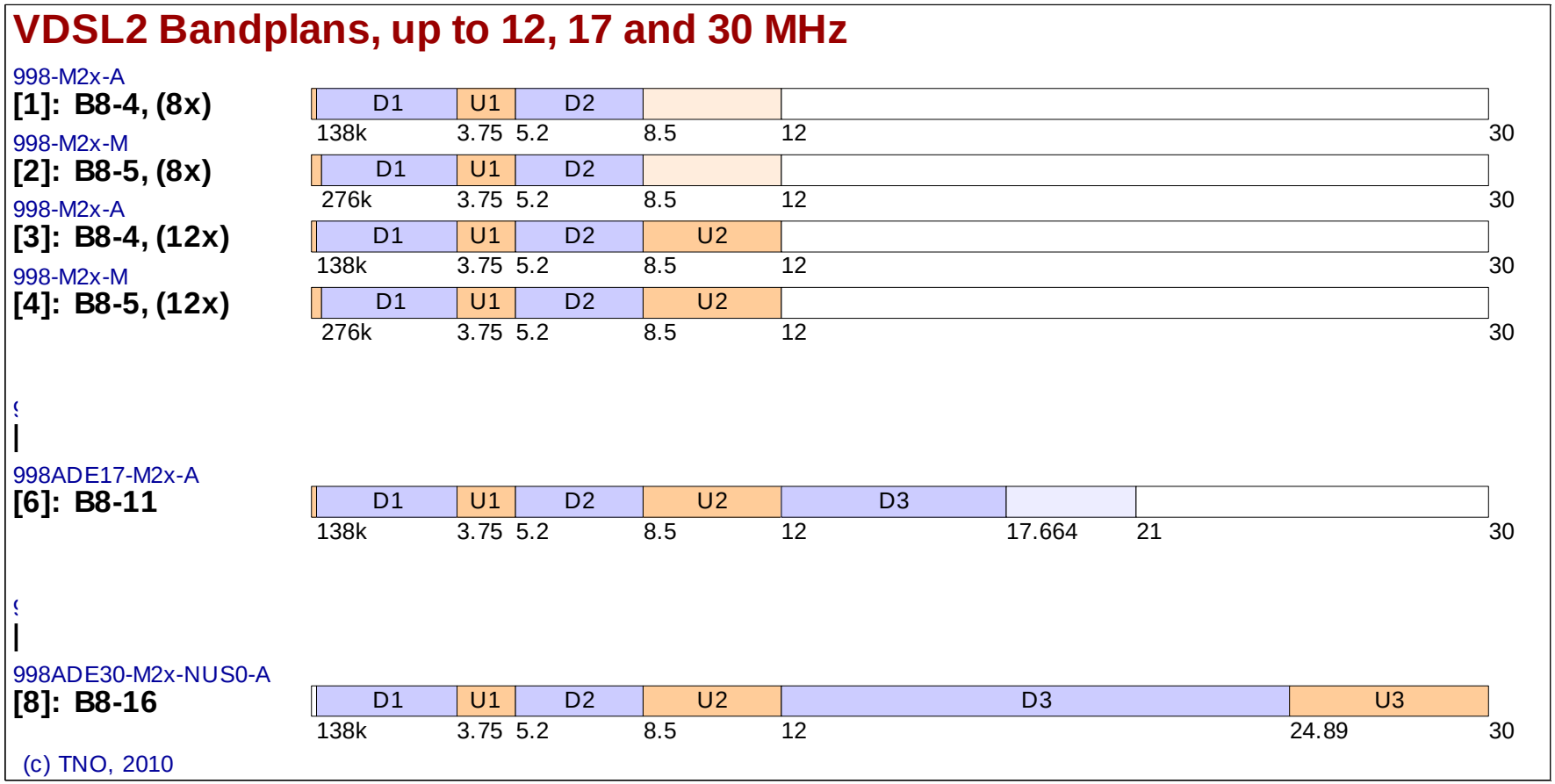
Consequences for unbundling à compatible bandplans



Option #1, select only bandplans that are spectrally compatible.
Unbundling works well, just extending existing access rules

3. Boosting bandwidth via “widening spectra”

Consequences for unbundling à compatible bandplans

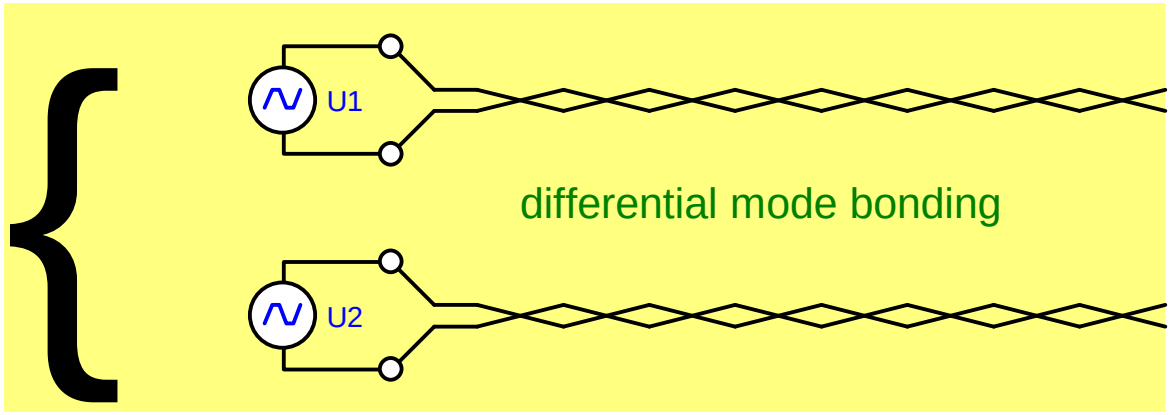


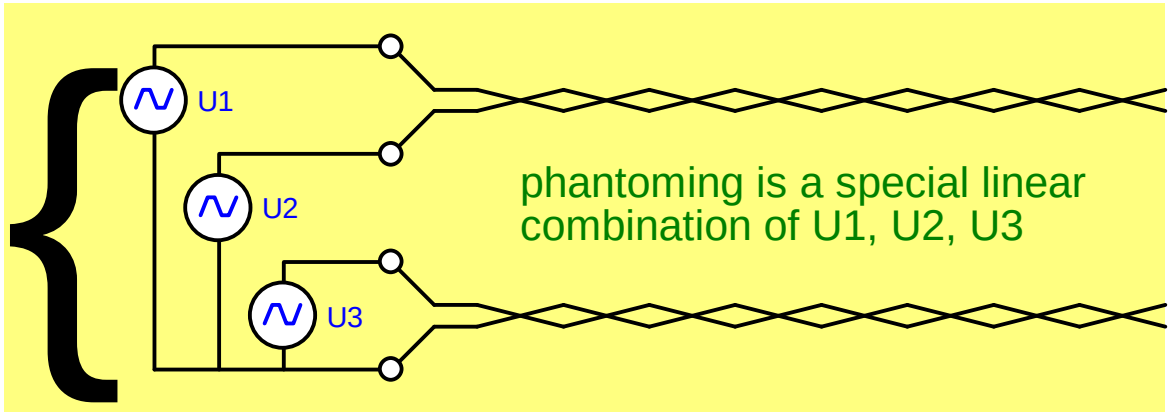
Option #2, select only bandplans that are spectrally compatible.
Unbundling works well, just extending existing access rules

4. Boosting bandwidth via “bonding”

Basic principles

diverting and combining bits via multiple transmission paths

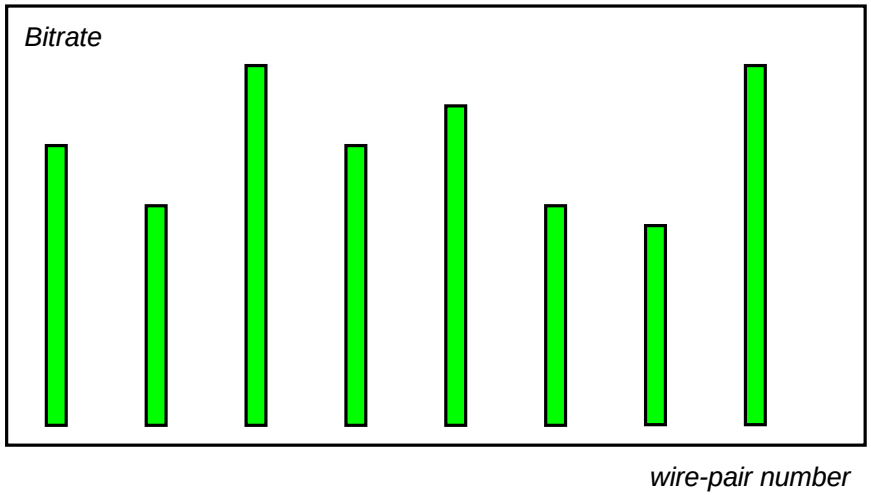




4. Boosting bandwidth via “bonding”

Basic principle

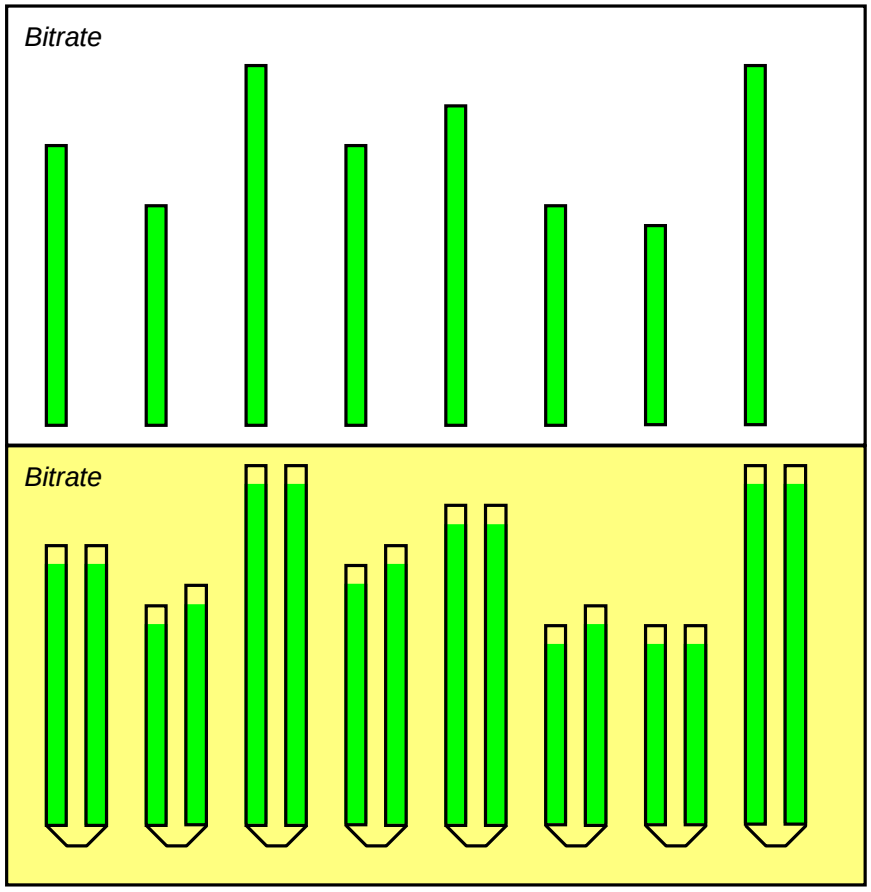
N lines,
without bonding



4. Boosting bandwidth via “bonding”

Basic principle – bonding them all

N lines,
without bonding



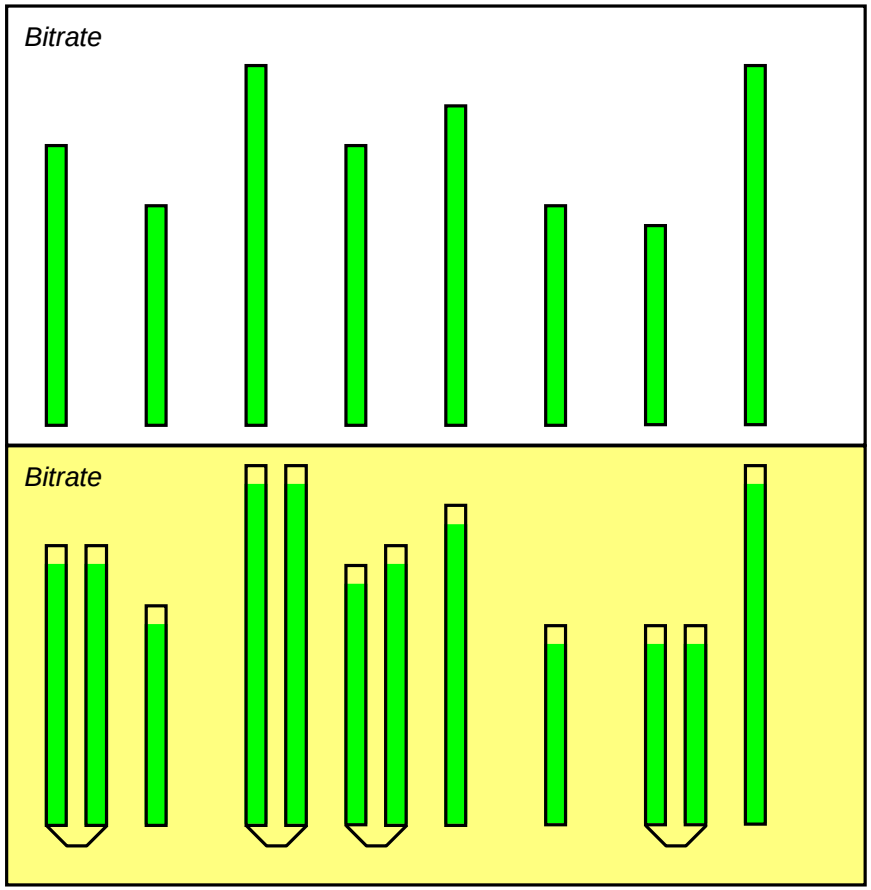
2N lines,
all bonded,

just a doubling of transceivers

4. Boosting bandwidth via “bonding”

Basic principle – bonding them partially

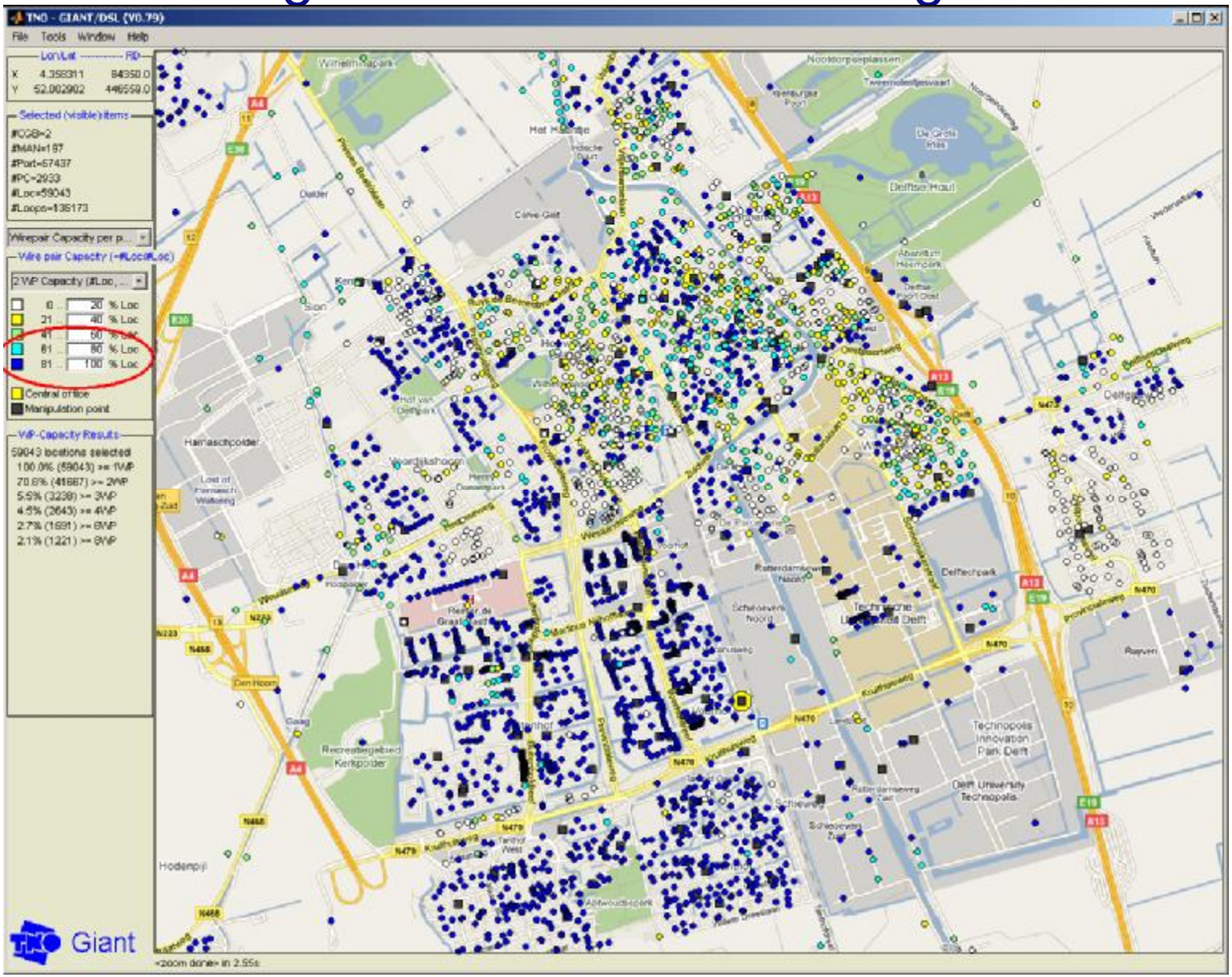
N lines,
without bonding



>N lines,
several bonded,

just an increase
of transceivers

4. Boosting bandwidth via “bonding”



A typical Dutch city

Bold markers denote 80-100% has a double wire pair

>70% in this city (example)

4. Boosting bandwidth via “bonding”

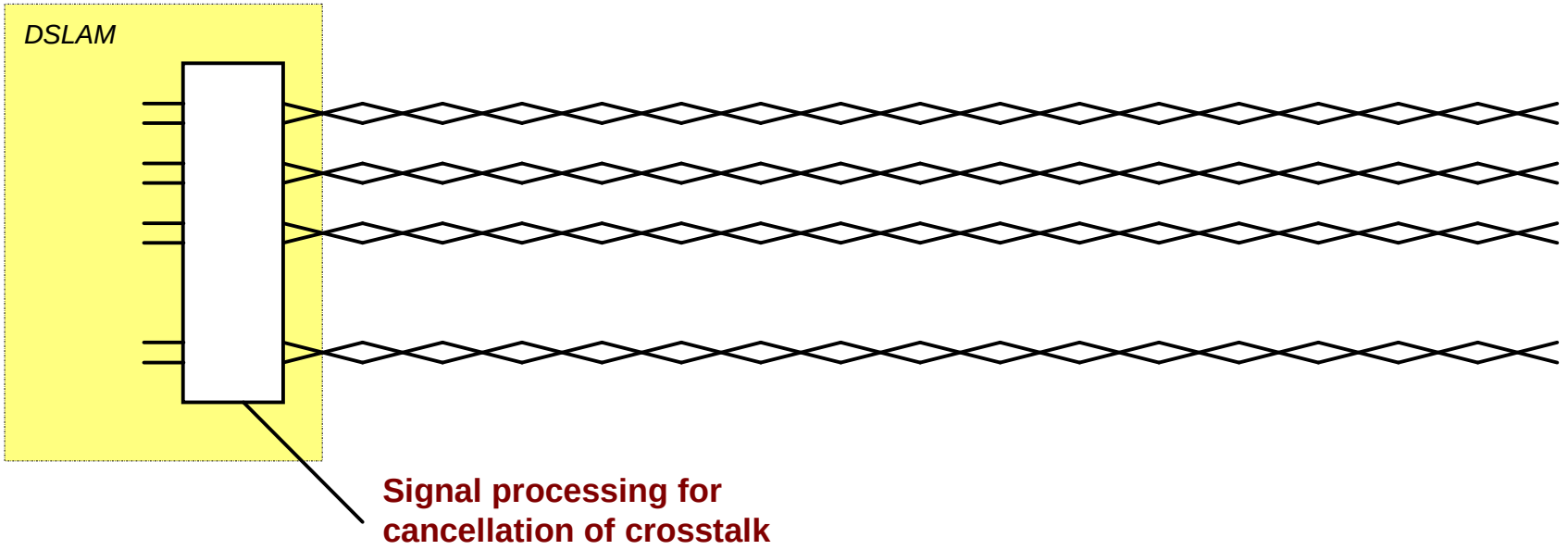
Consequences for unbundling - None

Bonding = just an increase of transceivers
(*multiple independent systems*)

Can be applied without changing access rules

5. Boosting bandwidth via “vectoring”

Basic principle

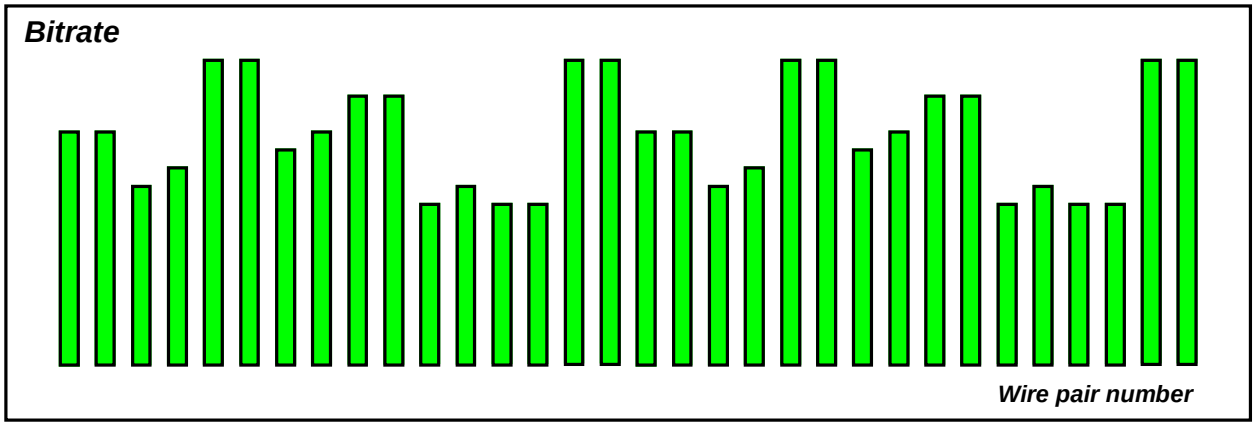


Vector group:

- Coordinated approach of multiple systems
- Signal processing to cancel crosstalk
- Transmission paths remain “independend”

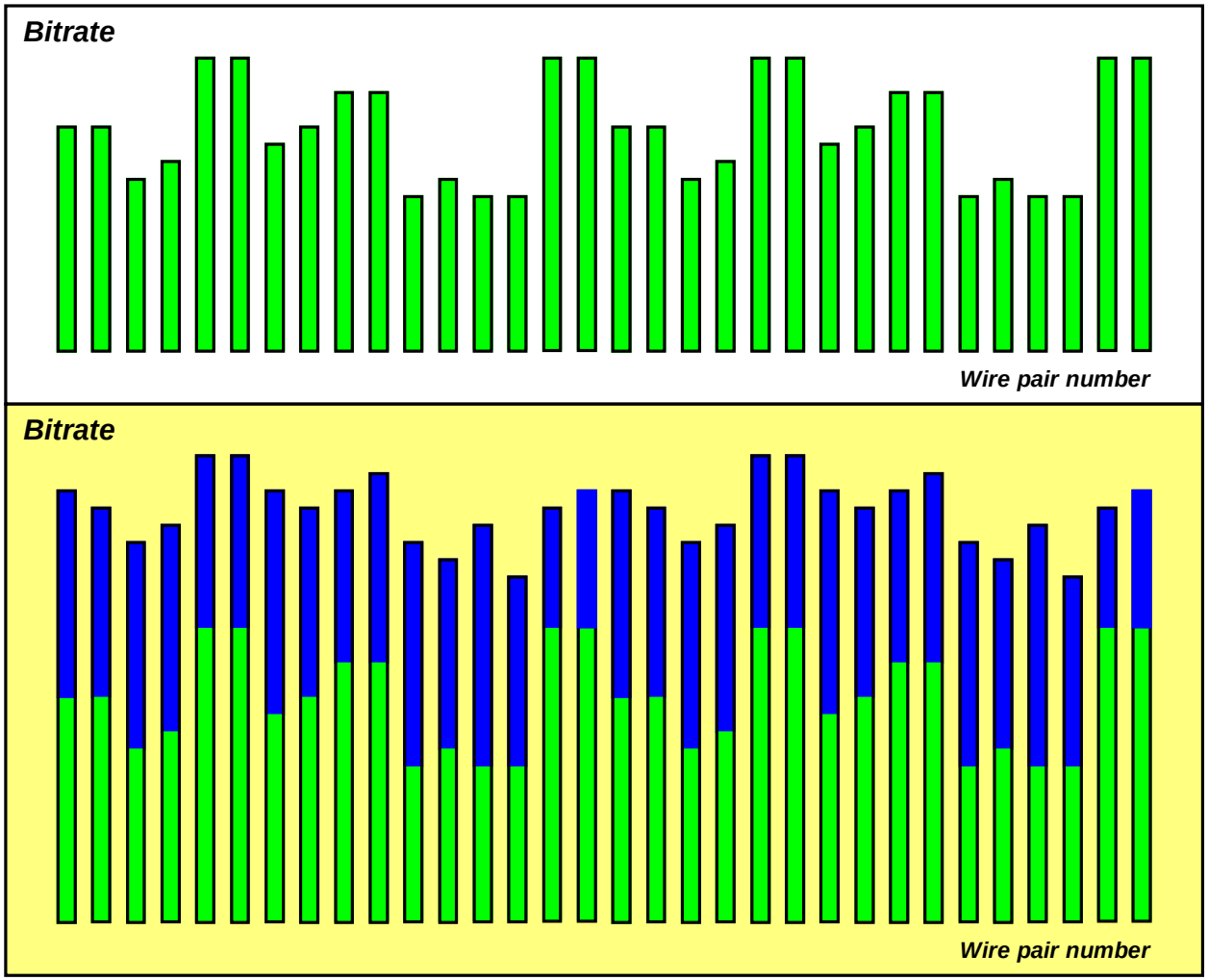
5. Boosting bandwidth via “vectoring”

Basic principle – all DSL systems in a vector group



5. Boosting bandwidth via “vectoring”

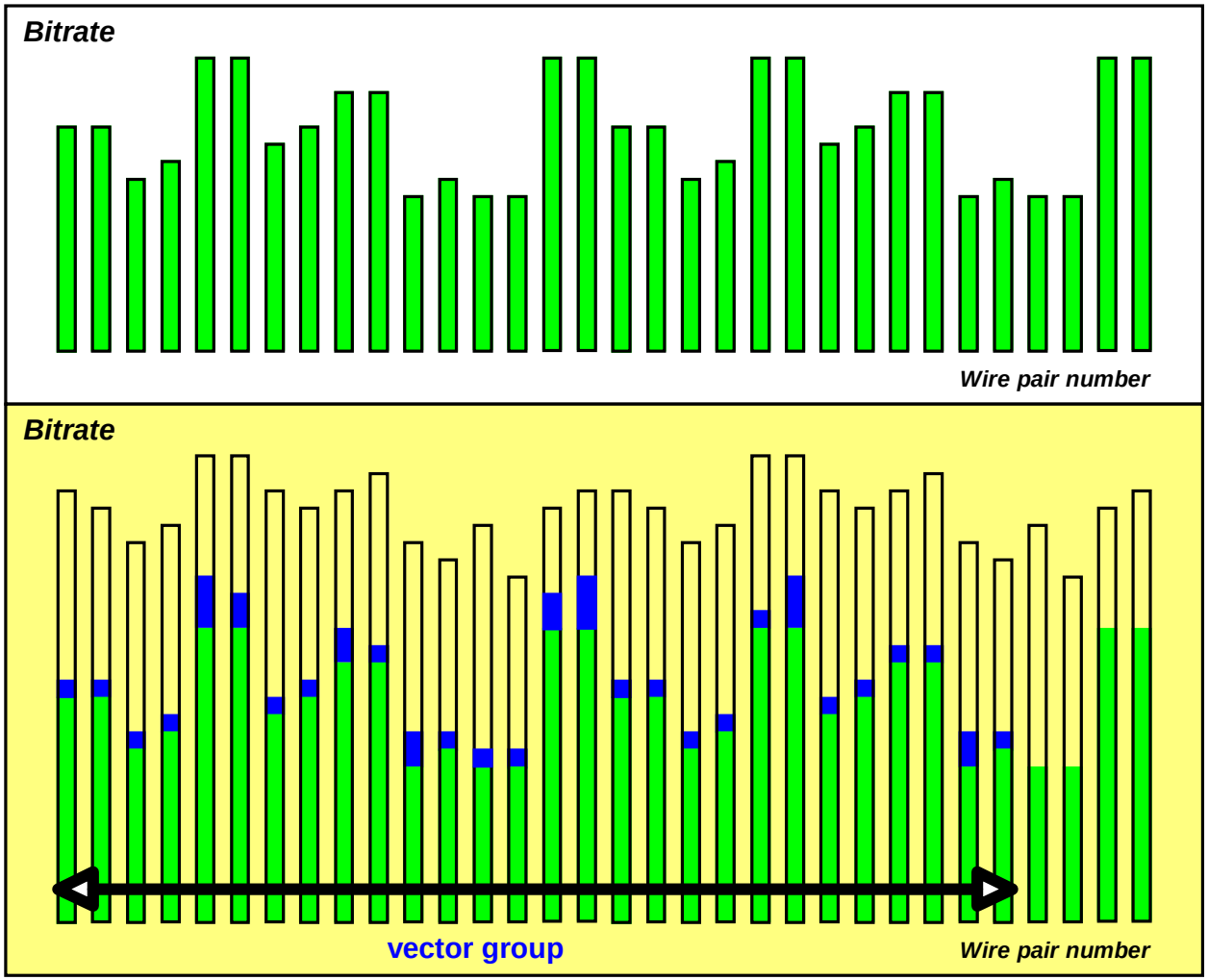
Basic principle – all DSL systems in one vector group



Significant increase of bitrates

5. Boosting bandwidth via “vectoring”

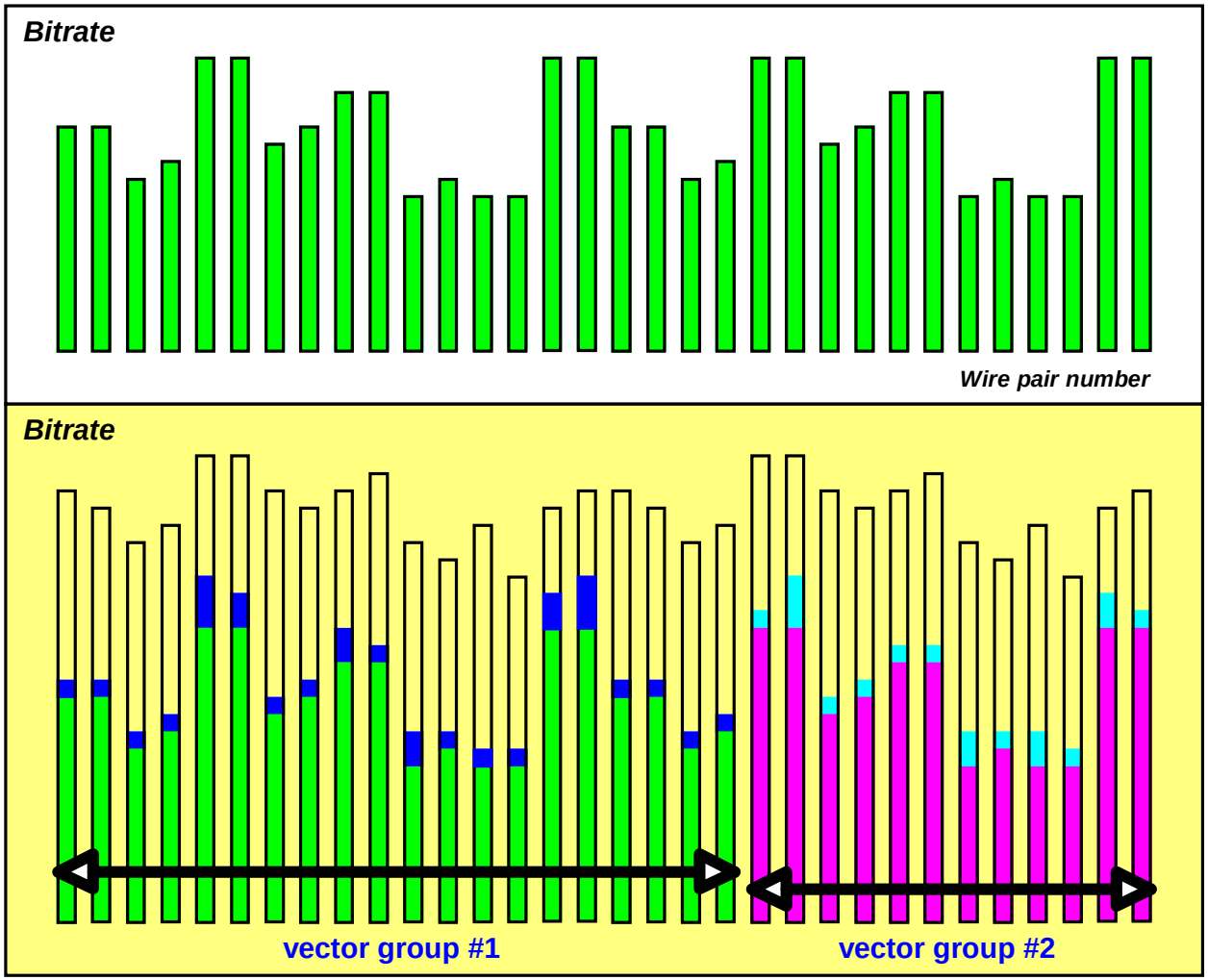
Basic principle – most DSL systems in one vector group



Small / minor increase of bitrates

5. Boosting bandwidth via “vectoring”

Basic principle – DSL systems in multiple vector groups



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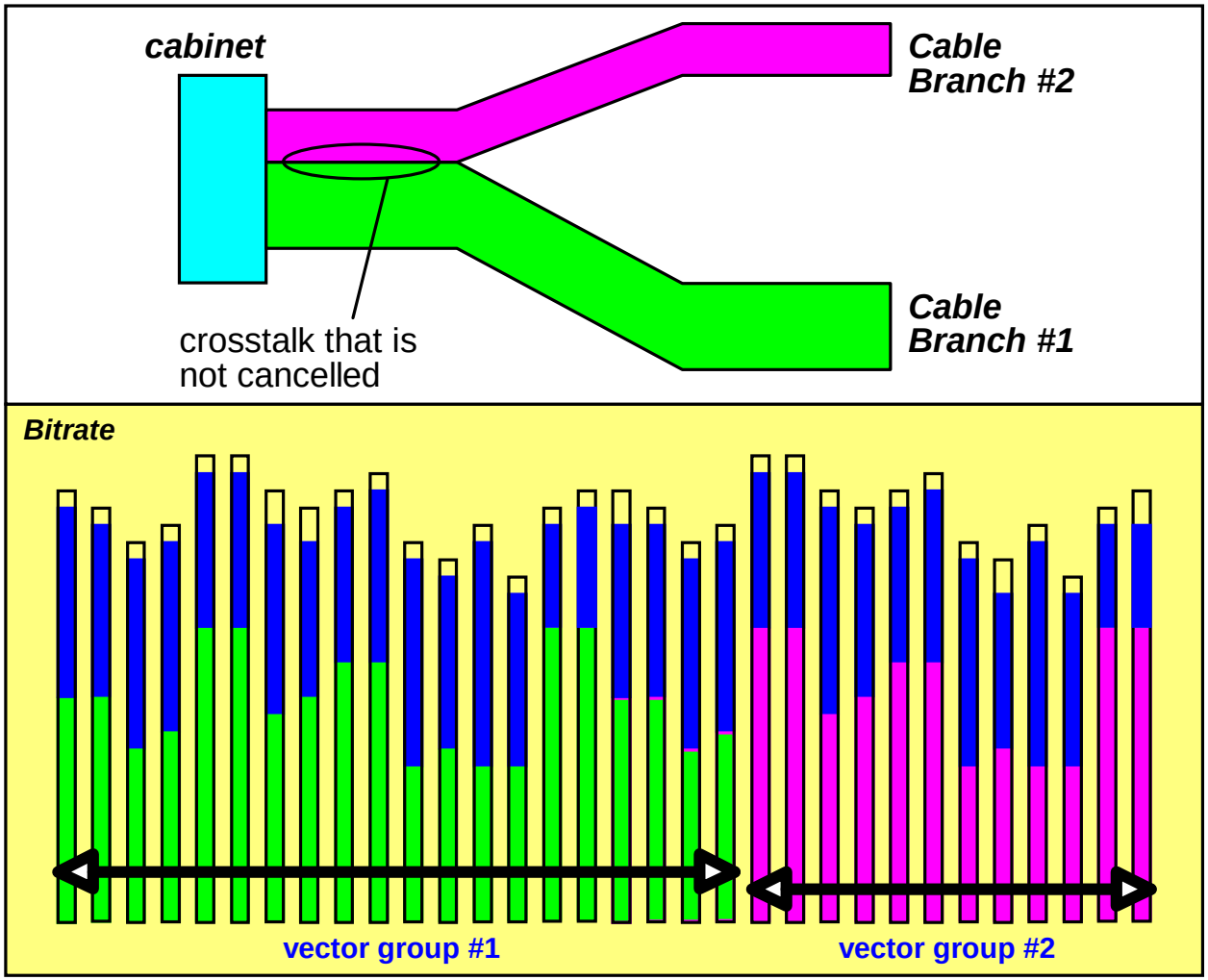


Unless vector groups are separated via branches …..

…significant increase of bitrates

Separation is a way to cope with system limitations

5. Boosting bandwidth via “vectoring”

Consequences for unbundling – Significant!

If vectoring is used:

- full coordination of all DSL modems from a common system
- or nobody can gain from vectoring

Consequence:

- in practice: all vector equipment from the same vendor
- in practice: a single “transmission” operator to operate them
- cannot offer unbundling via physical layer

à use another type of unbundling!

6. Different possibilities for unbundling

Aims for all unbundling principles:

- fair access for multiple operators
- enable efficient use of available copper capacity

Two different approaches:

- Physical unbundling
  - line sharing (spectrum separation), loop unbundling (wire separation), layer 1 unbundling, …
- Virtual unbundling / VULA
  - link unbundling (Ethernet VLAN's), "above layer 1" unbundling, bitsream access, …

6. Different possibilities for unbundling

Current status:

- Physical unbundling = commonly used
- Virtual unbundling = incidently allowed as temporary measure

  Mid 2010: EC allowed it for UK and Austria, as temporary measure, but not as a long term alternative to physical unbundling

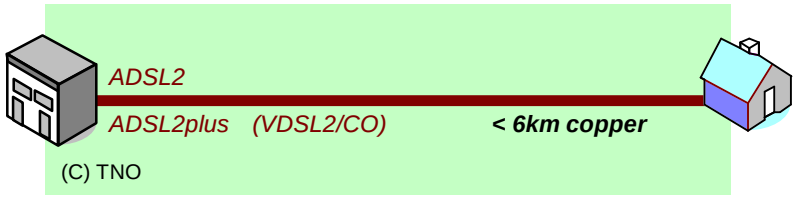
Vitual unbundling requires:

- Single DSL operator controls all lines
- Agreements to ensure fair access for other operators

This is a big challenge!

If fora of regulator+operators cannot agree on this, nobody can take advantage of any vectoring

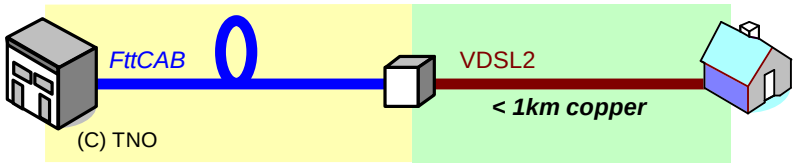
6. Different possibilities for unbundling



Full copper + (ADSL/CO, VDSL2/CO)

Physical unbundling **à** adequate

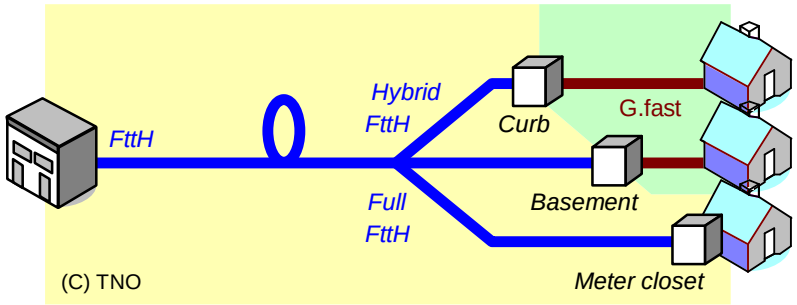
Virtual unbundling **à** not needed



Hybrid FttCab + VDSL2/Cab:

Physical unbundling **à** fair, but restrictive

Virtual unbundling **à** desired for vectoring



Hybrid FttH + G.fast/DP:

Physical unbundling **à** too restrictive

Virtual unbundling **à** essential

7. Summary

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- Extending copper life is very attractive (postpones fiber investements)
  - Essential to compete with cable operators
  - FttCab was enabled by VDSL2
  - Hybrid FttH will be enabled by G.fast
  - Various new DSL techniques can boost bitrates via copper

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- Bonding + Vectoring attractive bandwidth boosters
  - Bonding of quads will double bitrates
  - Vectoring increases bitrate significantly
  - **Problem**: vectoring is blocked by physical unbundling

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If extending copper life is essential, then
start regulating virtual unbundling for G.fast and VDSL2/Cab