

Origins of G.fast and its Role in future FTTH deployments

Rob F.M. van den Brink - TNO

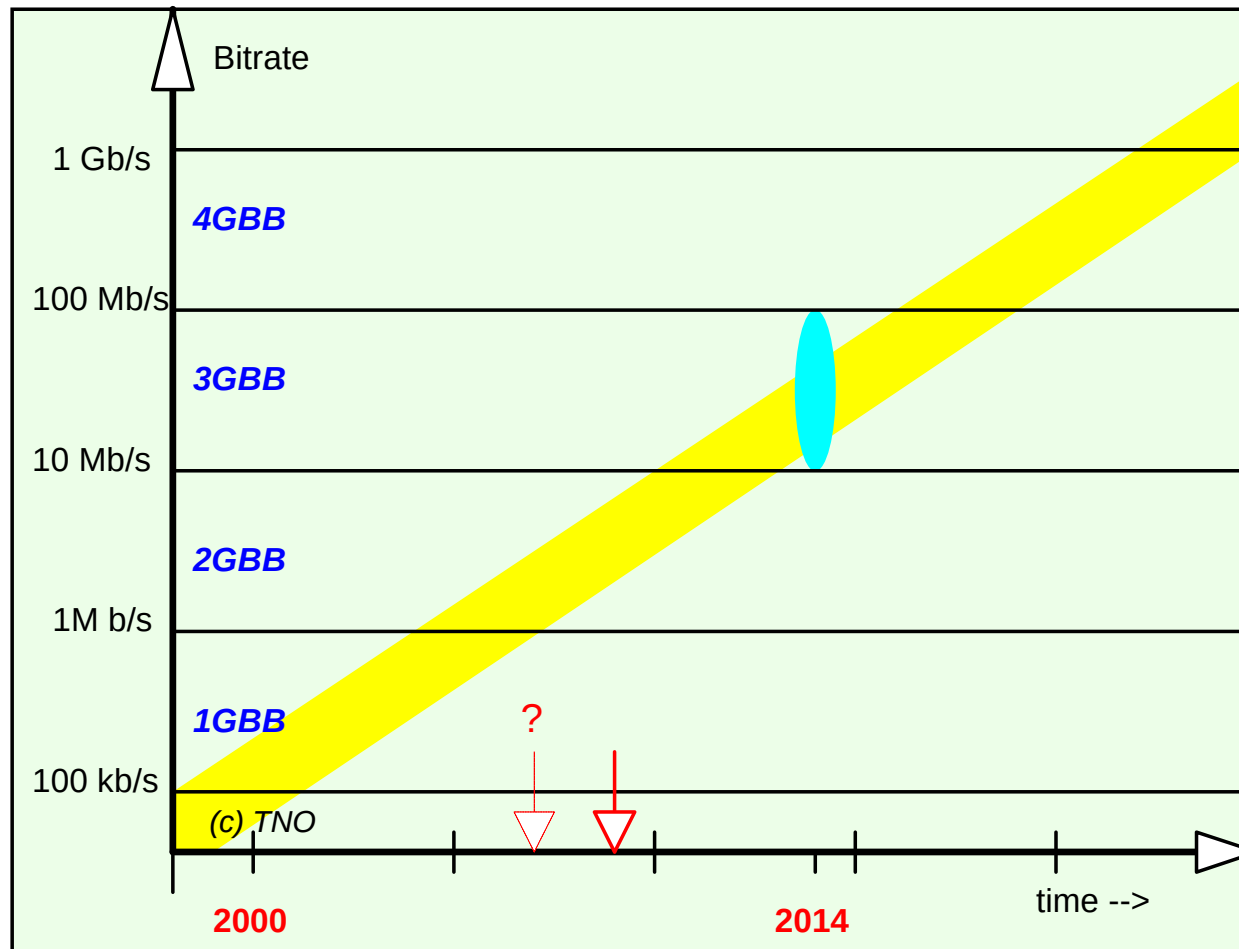


Origins of G.fast and its Role in future FTTH deployments

Rob F.M. van den Brink - TNO



1. And suddenly there was G.fast ????



Higher bitrates?

à The demand for it keeps growing

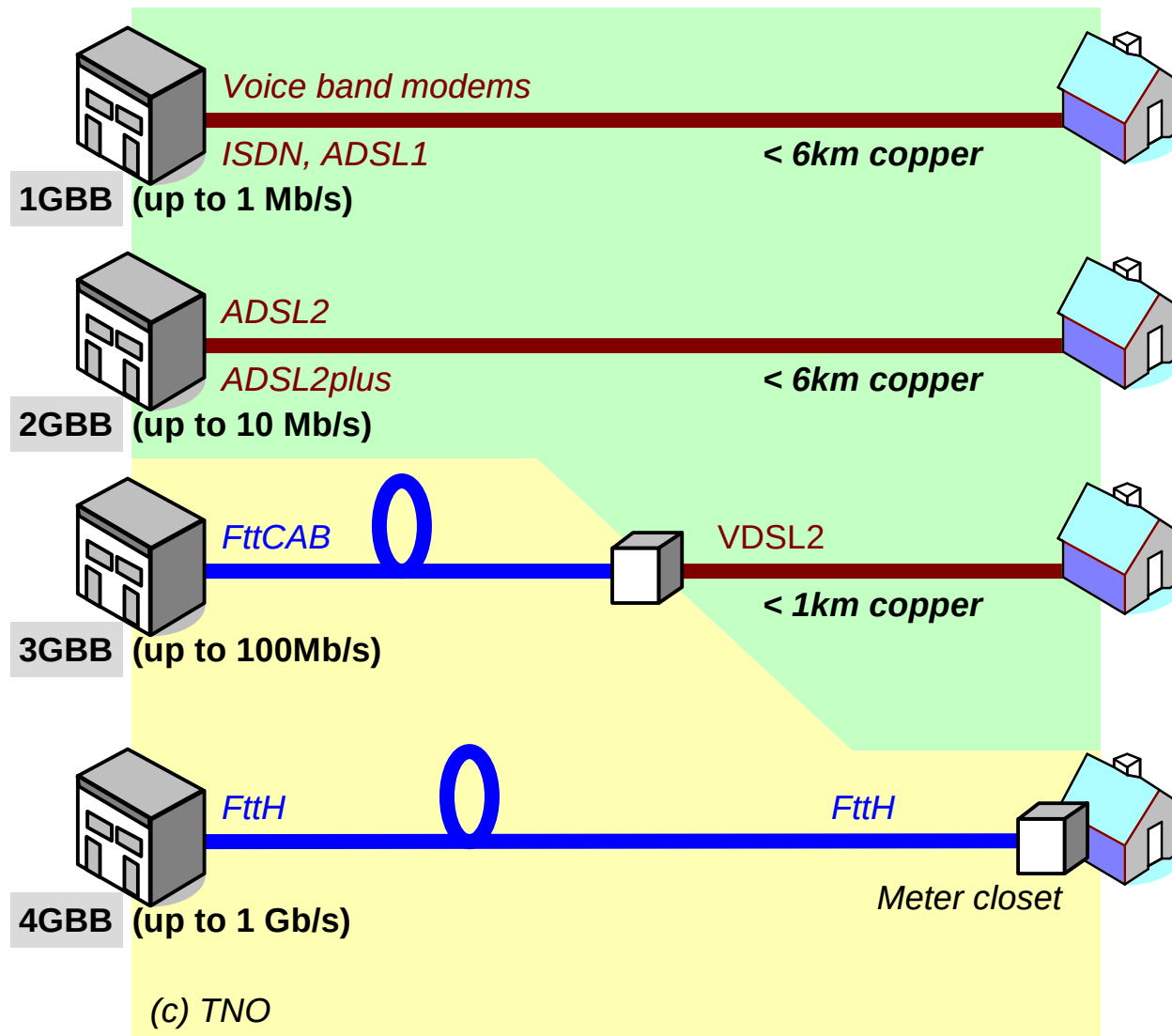
1. And suddenly there was G.fast ?

2007: FP6 project MUSE, Task Force 2:

- BT, TNO, Ericsson, ULUND, ...
- Discussion: What comes after VDSL?
 - VDSL: 35 Mb/s up to 800m (with vectoring!)
 - VDSL: 80 Mb/s up to 400m (with vectoring!)
 - VDSL: 125Mb/s at zero meter
 - VDSL with vectoring & Bonding: increase to 190%
- Discussion: will it be (full) Fiber to the Home?

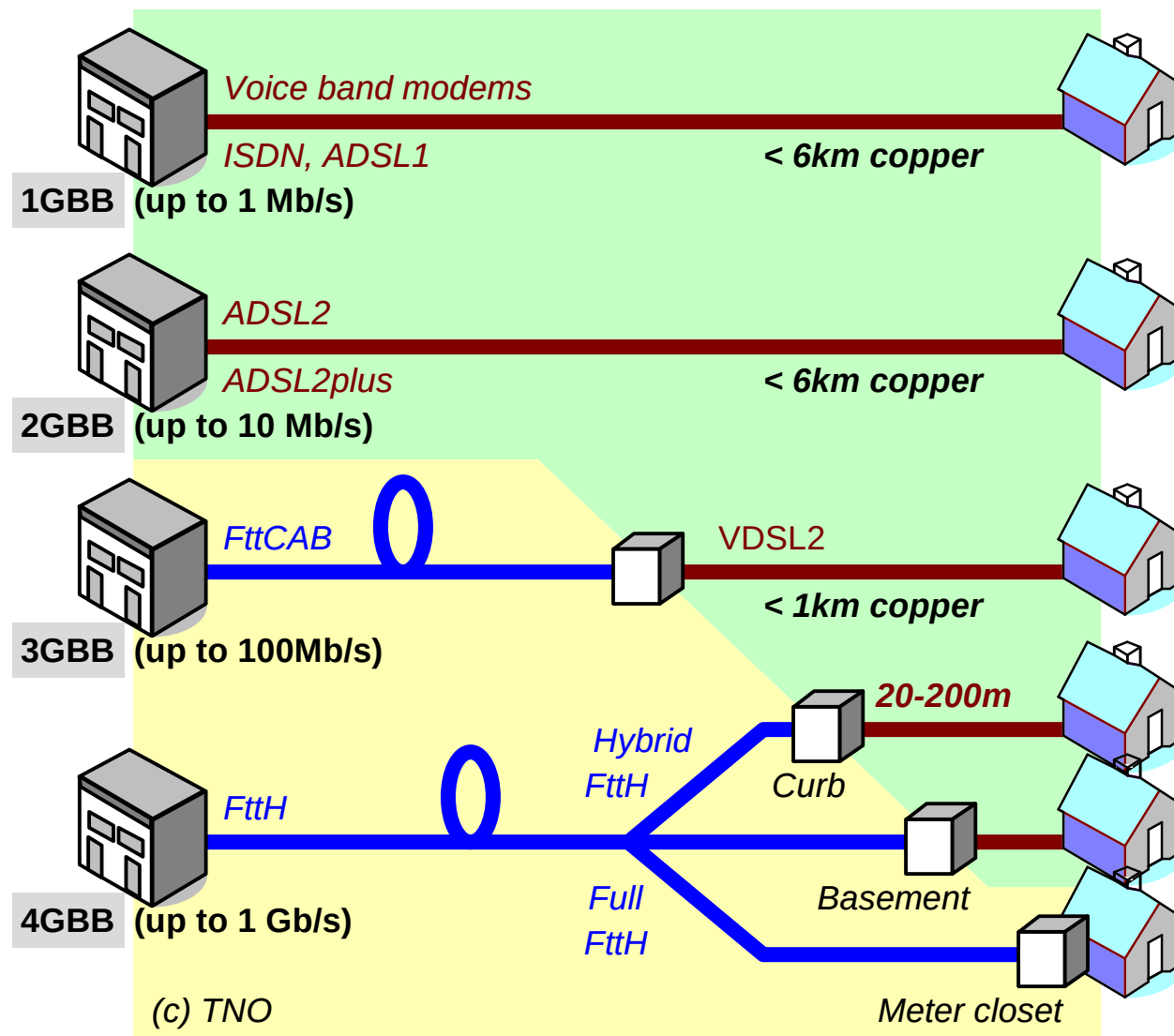
1. And suddenly there was G.fast

Evolution of telco solutions in offering Broadband



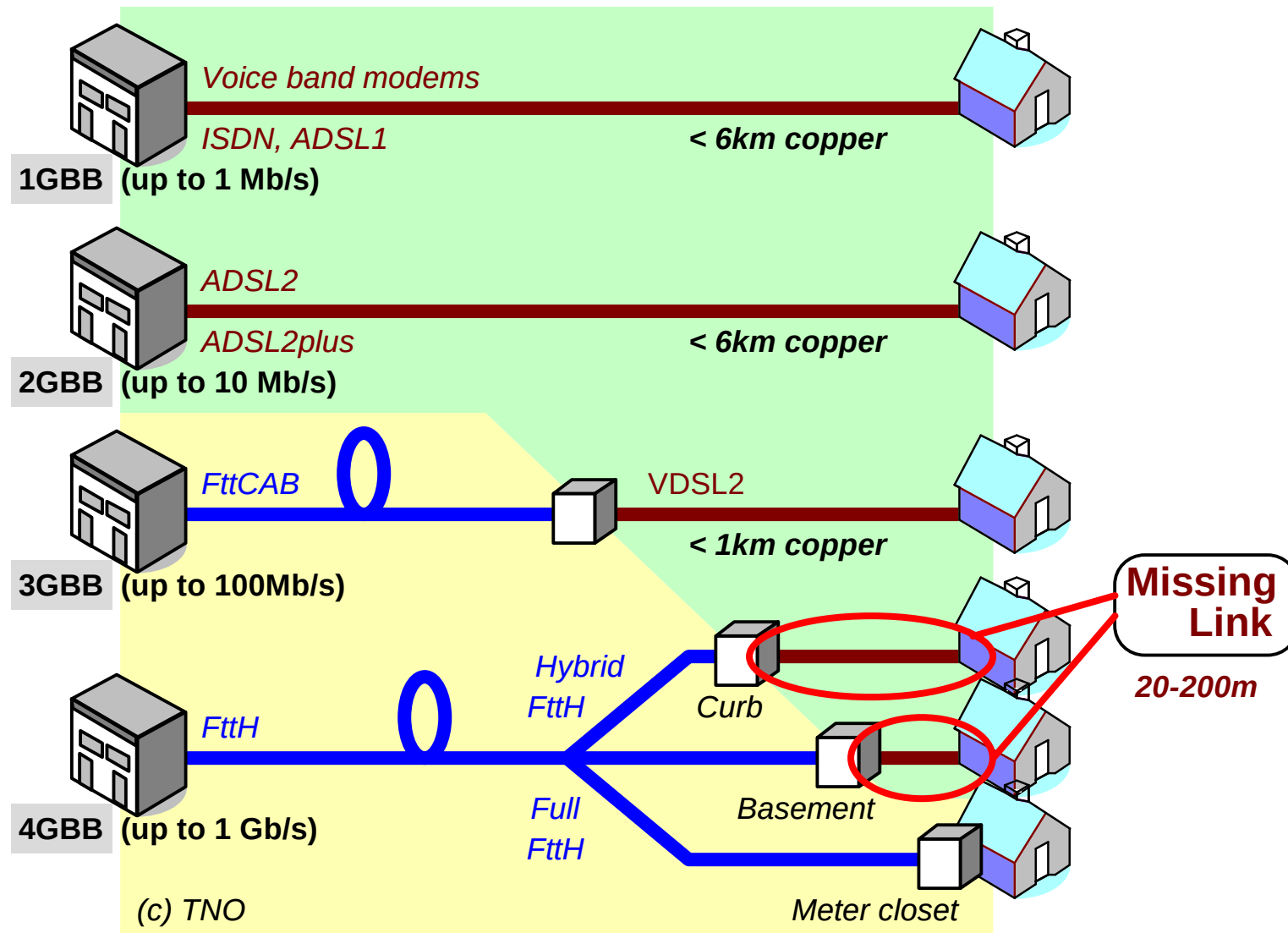
1. And suddenly there was G.fast

Evolution of telco solutions in offering Broadband



1. And suddenly there was G.fast

Evolution of telco solutions in offering Broadband



1. And suddenly there was G.fast ?

2008: FP7 project proposal “Omega DSL”:

- BT, TNO, Ericsson, ULUND, ...
- Discussion: up to 1 Gb/s via 20-200m telephony cabling?
 - What are the techno-economic drivers for it?
 - Is it technically feasible via copper?
 - Can we transmit >100MHz via telephony wiring?
 - Can we initiate a world-wide standard for it?
 - Can we bring the industry into motion?
 - Aren't we not too late for that?
- The next generation BroadBand requires up to 1 Gb/s !!

1. And suddenly there was G.fast ?

2009-2012: Celtic project “Enabling 4G BB”



4G BB Consortium members:



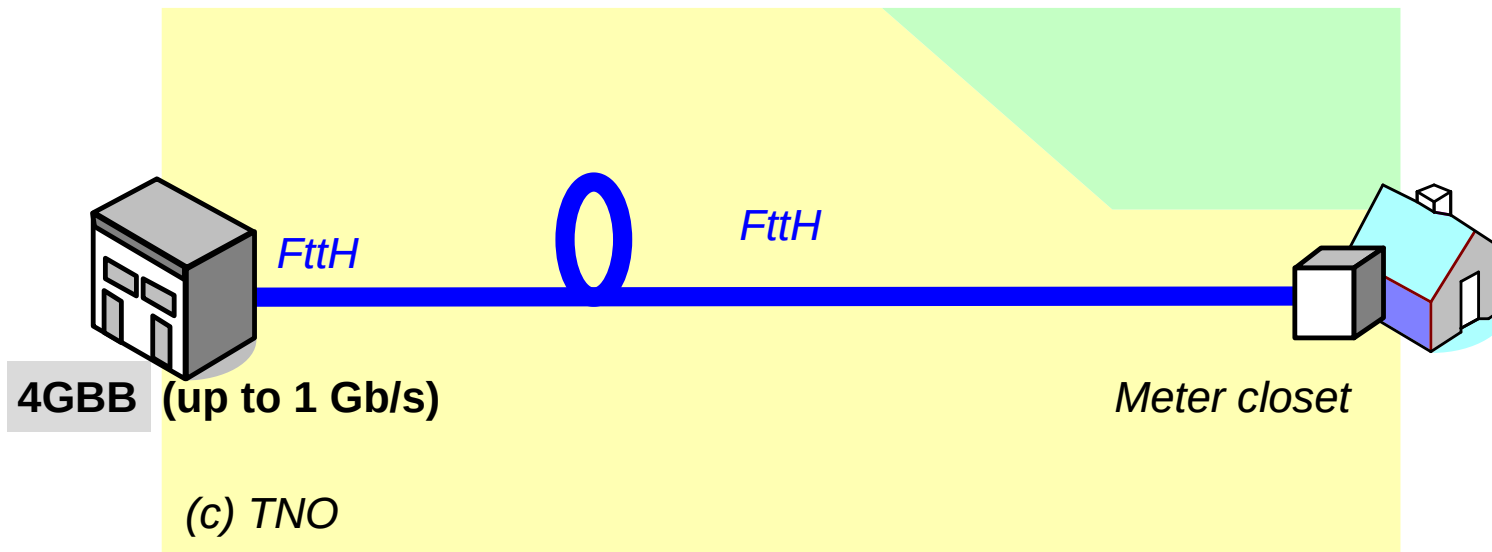
Partners participating part of the project



Question in 2009

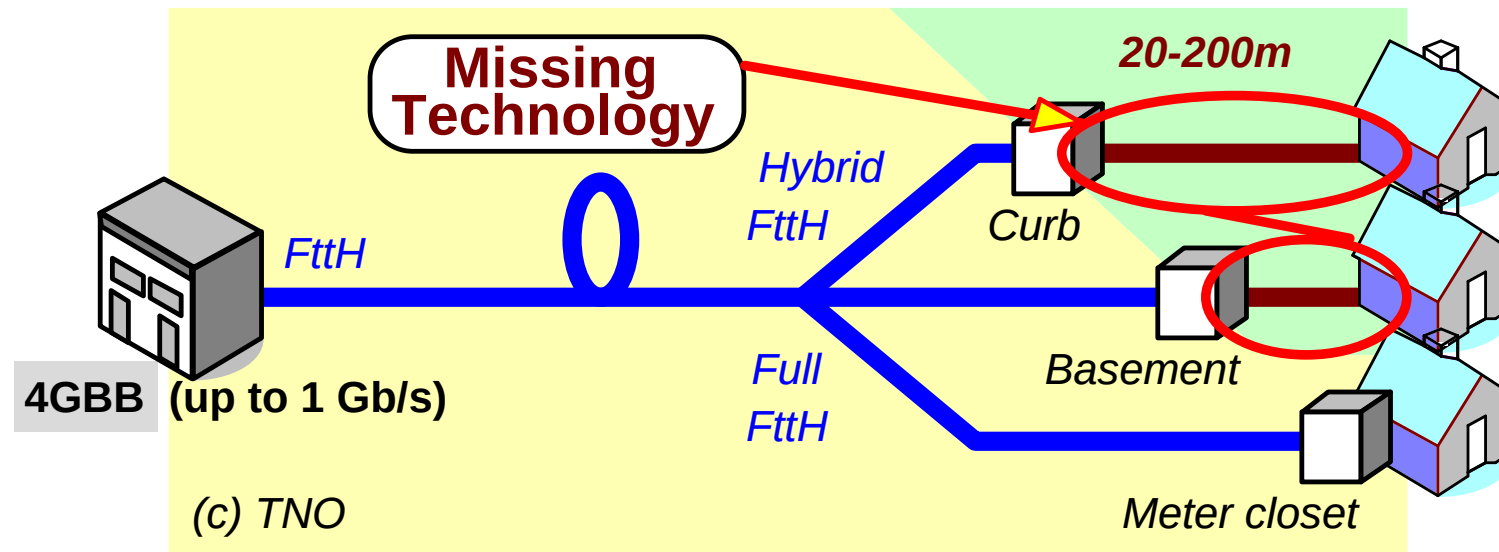
**Why copper
if you can bring
1 Gb/s via fiber as well?**

2. Techno-economic drivers for DSL beyond VDSL



**2009: Only one flavor of FTTH available
à “into the Home”**

2. Techno-economic drivers for DSL beyond VDSL



Multiple flavors of FTTH needed

- à into the Home à “Full” FTTH
- à upto the Home à “Hybrid” FTTH

2. Techno-economic drivers for Hybrid FTTH

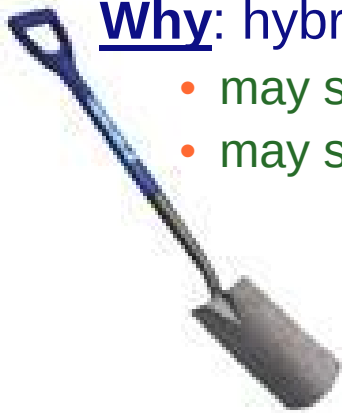
Hybrid FTTH is complementary to Full FTTH

à into the Home à “Full” FTTH

à upto the Home à “Hybrid” FTTH

Why: hybrid has possible techno-economic advantages

- may save costs for digging/installation when copper can be reused
- may save installation time, so faster roll-out



2. Techno-economic drivers for Hybrid FTTH



Digging and drilling:

- Too expensive
- Not allowed in historical areas
- Inconvenient in shopping area



2. Techno-economic drivers for Hybrid FTTH



Digging and drilling:

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2. Techno-economic drivers for Hybrid FTTH



Digging and drilling:

- Too expensive
- Not allowed in historical areas
- Inconvenient in shopping area



Hybrid FTTH (with G.Fast) brings opportunities

- Less digging and drilling
- Shortens installation time
- Does not disturb customers
- Allows for self-install in premises (No appointment needed)
- Postpones huge investment

Cost effective compared to Full FTTH!

2. Techno-economic drivers for Hybrid FTTH

Example use case #1 – Dense areas



Quick-win

Hybrid FTTH reduces the amount of digging / drilling



- Digging in historic city centers is a problem
- Digging in busy shopping streets is a problem

2. Techno-economic drivers for Hybrid FTTH

Example use case #1 – Dense areas



Quick-win

Hybrid FTTH reduces the amount of digging / drilling



Tomorrow: TNO presentation on
Amsterdam case study !

- Digging in historic city centers is a problem
- Digging in busy shopping streets is a problem

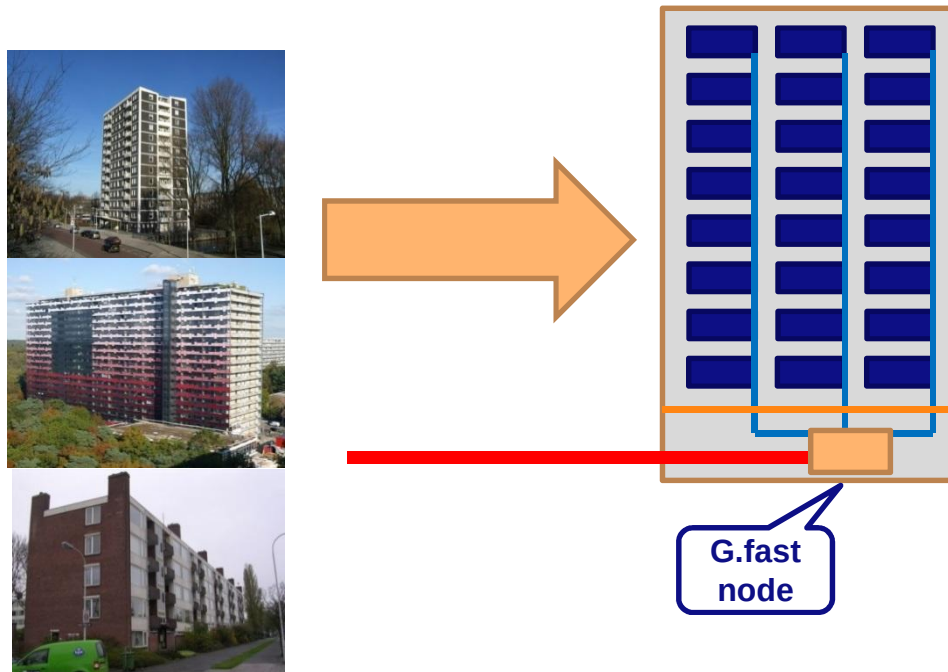
2. Techno-economic drivers for Hybrid FTTH

Example use case #2 – High rise buildings



Quick-win

In the past considered as the ideal **Full** FTTH scenario



- Full FTTH in practice far more complicated then aimed
- Drilling in floors of all stacked meter closets, all in one day!
- “Not in my Home” and “Not at Home” problems

2. Techno-economic drivers for Hybrid FTTH

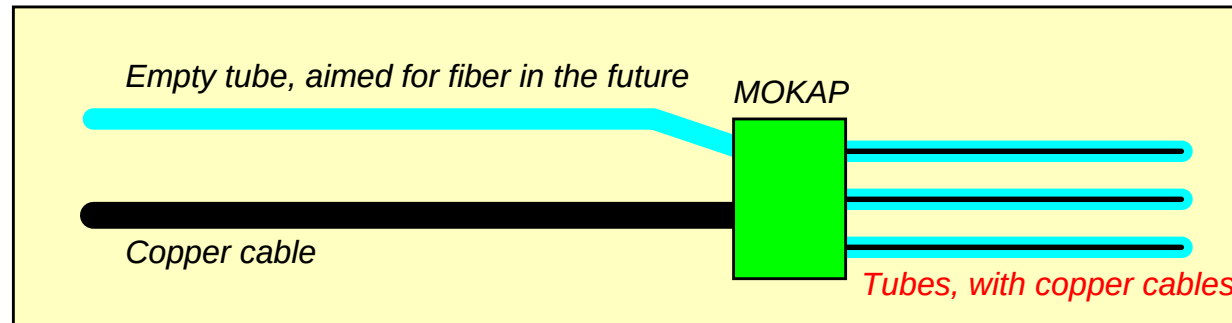
Example use case #3 – “Flashnet”



Quick-win

“Flashnet” was aimed at the ideal **Full** FTTH scenario

Roughly 300 000 connections scattered all over the Netherlands



- Aimed for replacing copper by fiber in the future
- But in practice it does not work that easy

2. Techno-economic drivers for Hybrid FTTH

Example use case ##– many others (country specific)

- From street poles (BT)
- Single Fiber extension (Orange)
- Mobile back hauling (Ericsson)
- etc

Expected deployment strategy:

- A mix between Hybrid and Full FTTH
- Use Hybrid FTTH where attractive
- Otherwise stay with VDSL, migrate to Full FTTH or skip



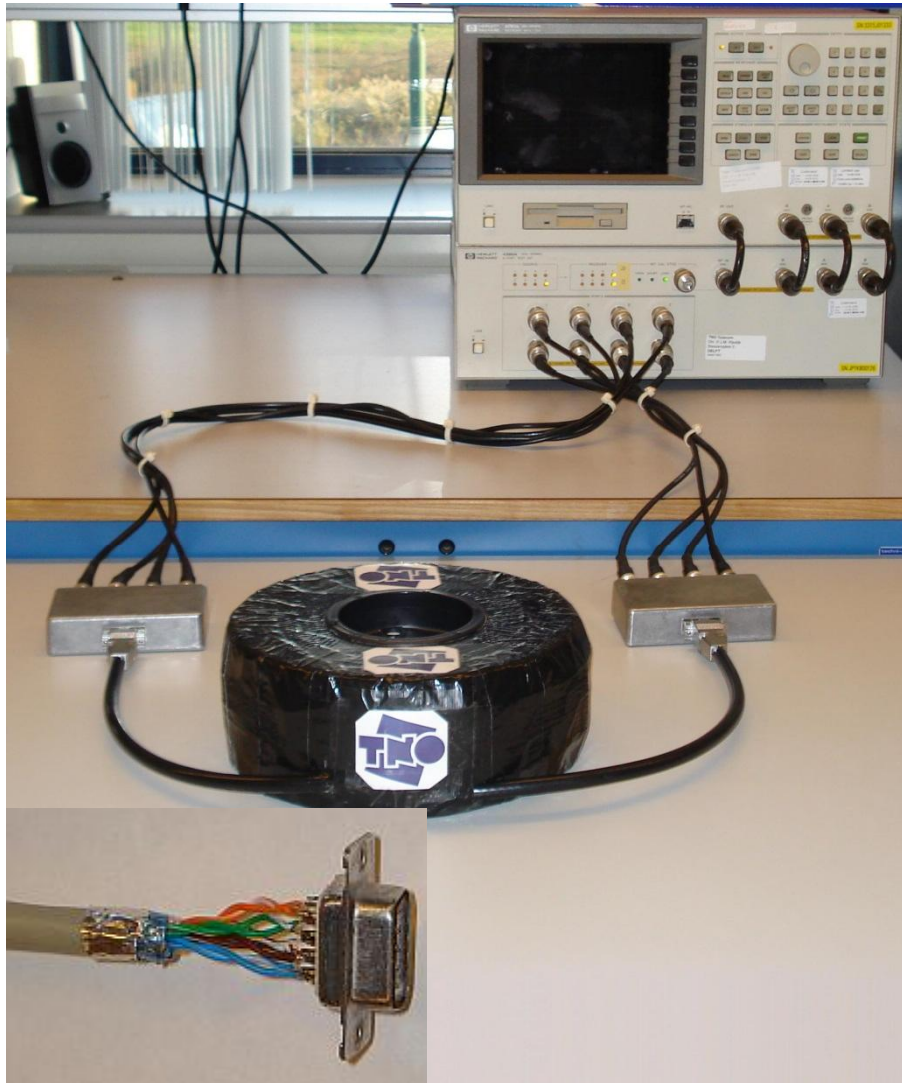
Various operators
communicated
their use-cases in
BBF



Question in 2009

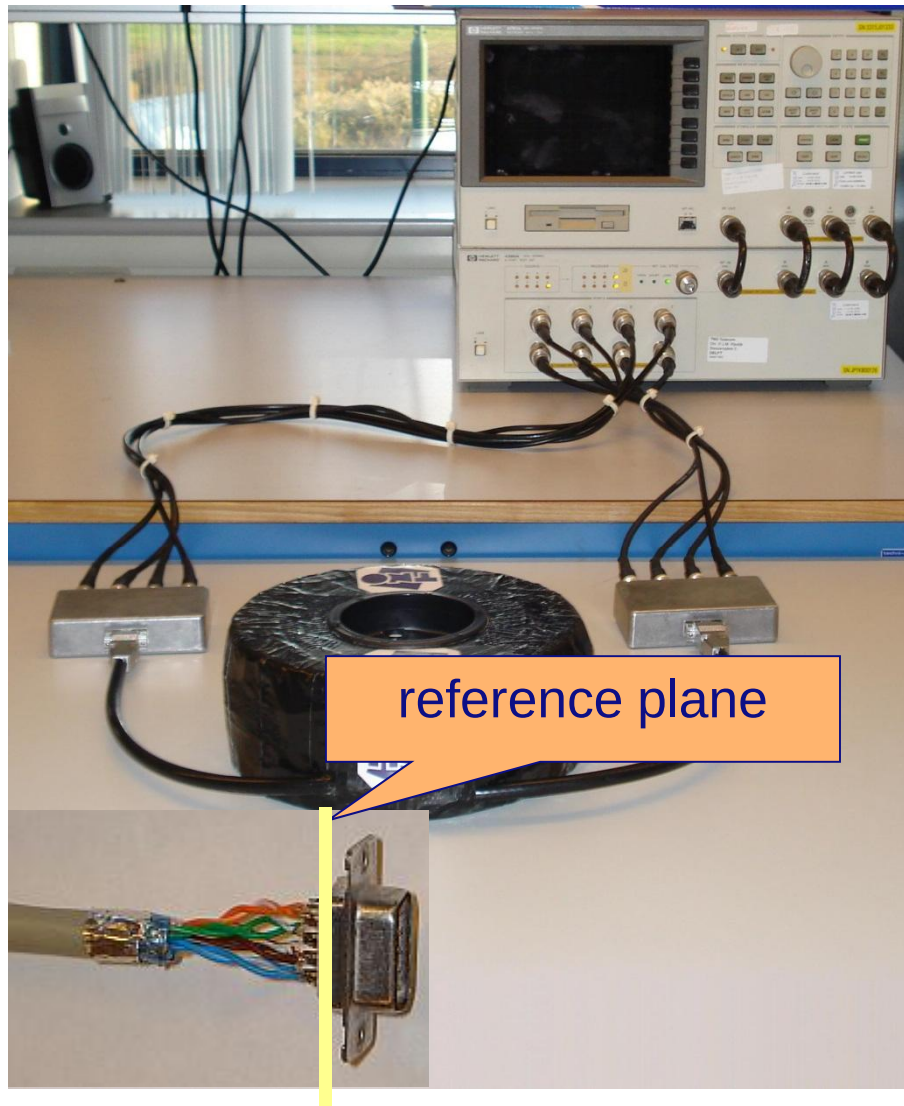
**Can we transport
up to 1 Gb/s
via telephony wiring?**

3. Multiport cable measurement setup, up to 500 MHz



Measurement setup

3. Multiport cable measurement setup, up to 500 MHz

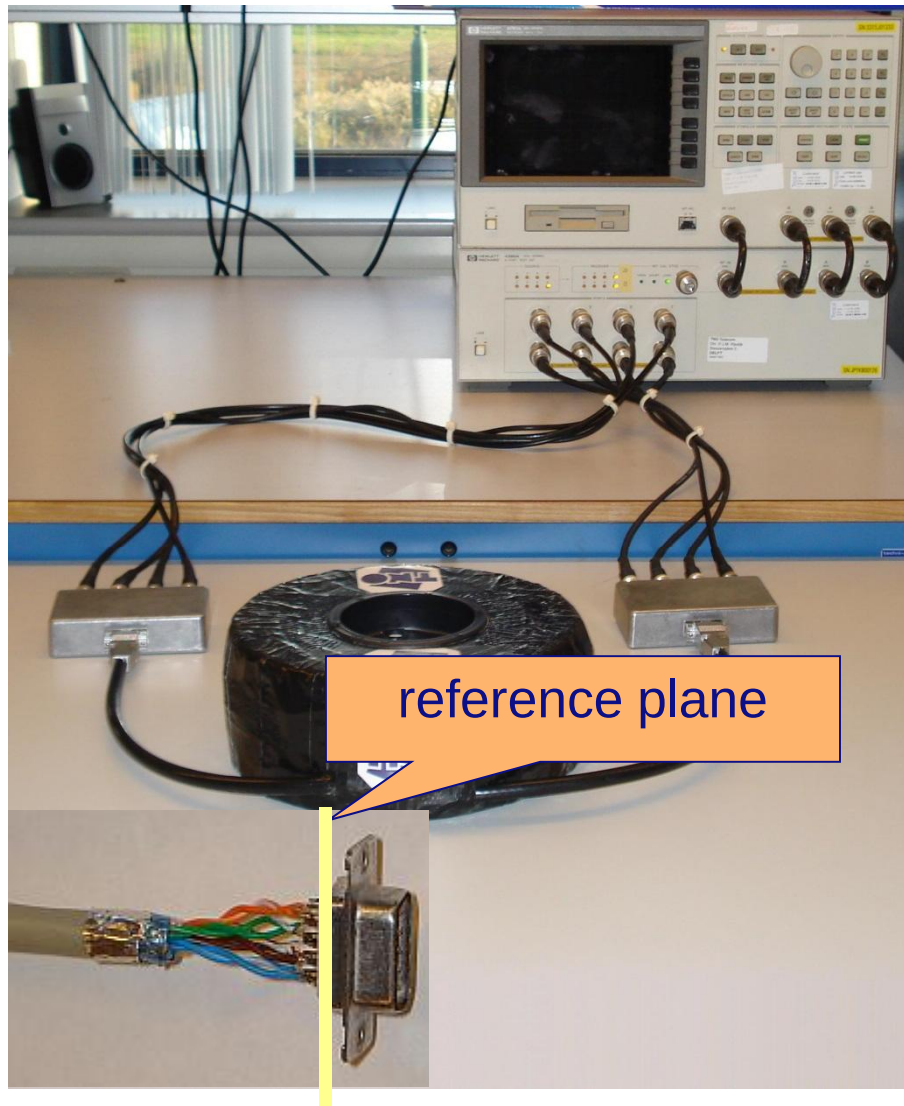


Key problem:

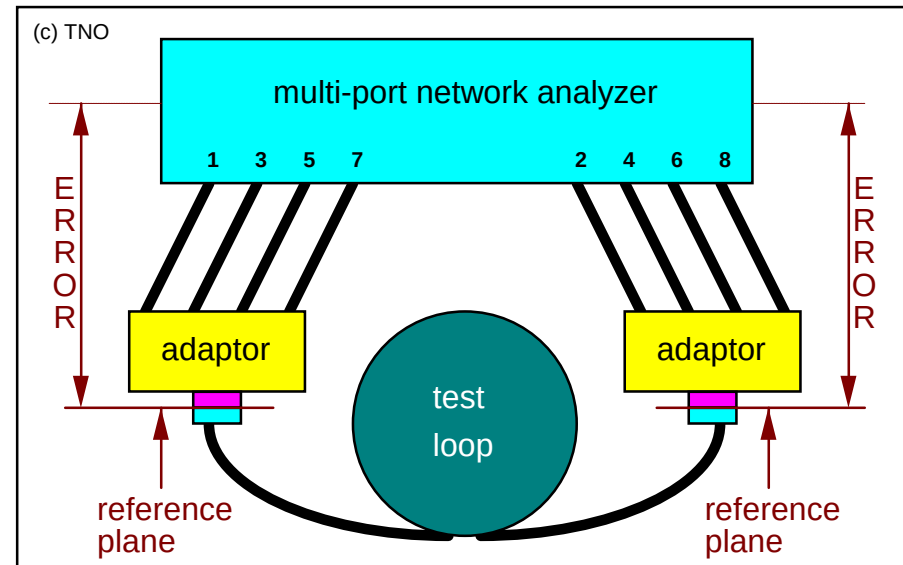
Instrument does not measure
what I would like to know!

Measurement setup

3. Multiport cable measurement setup, up to 500 MHz

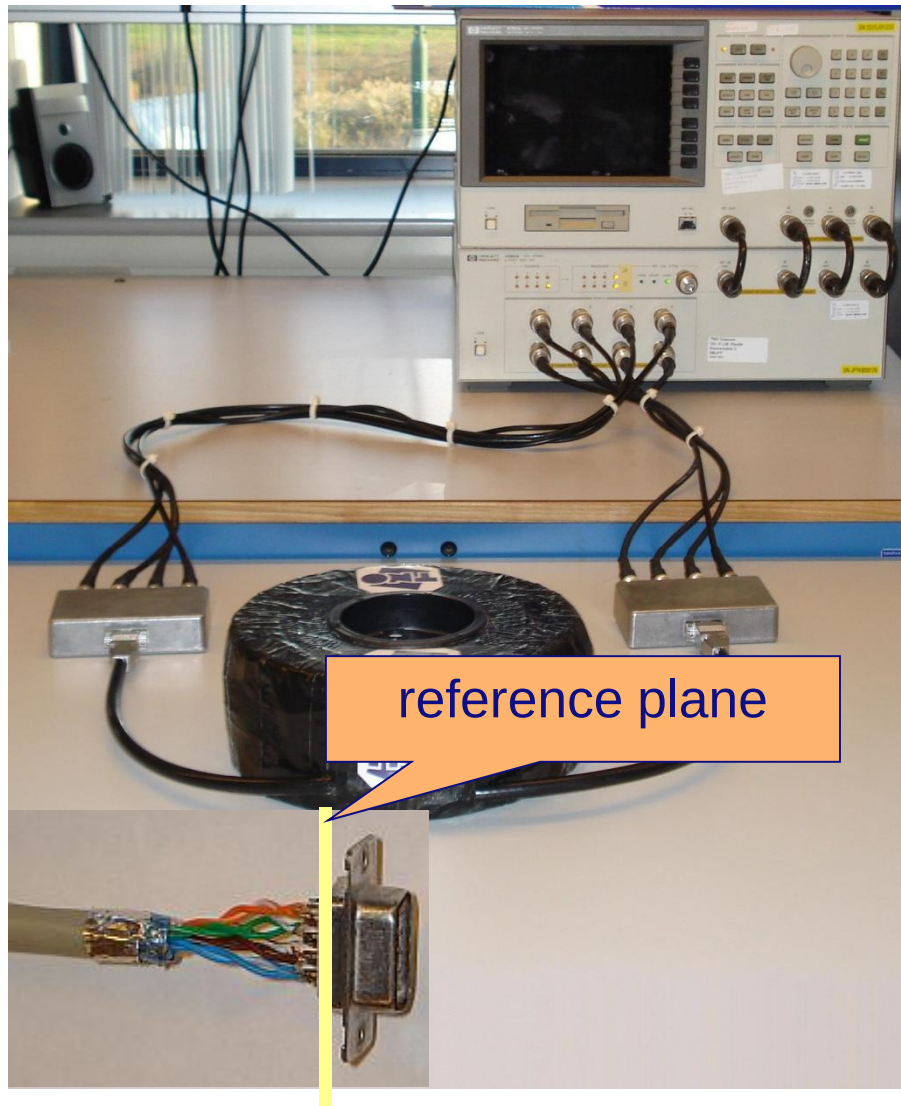


Measurement setup



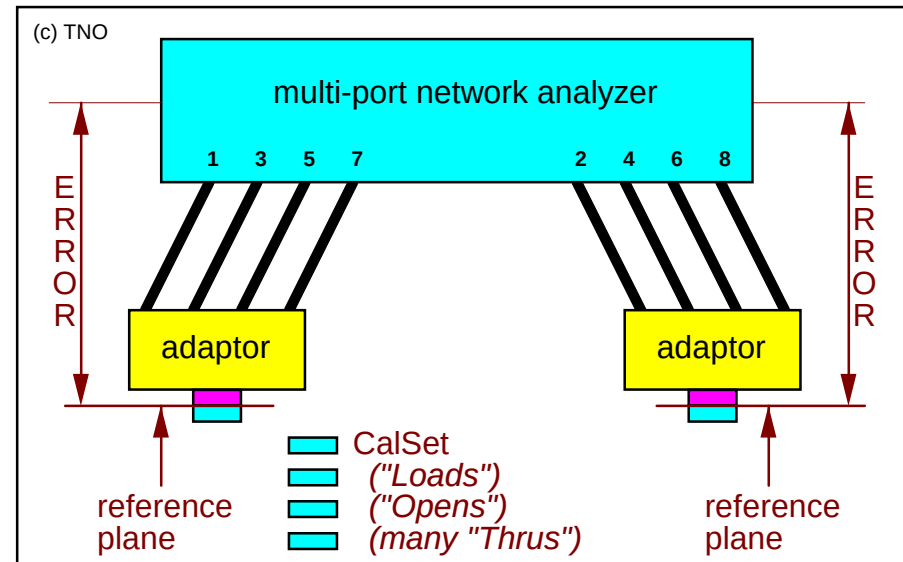
schematic diagram

3. Multiport cable measurement setup, up to 500 MHz



reference plane

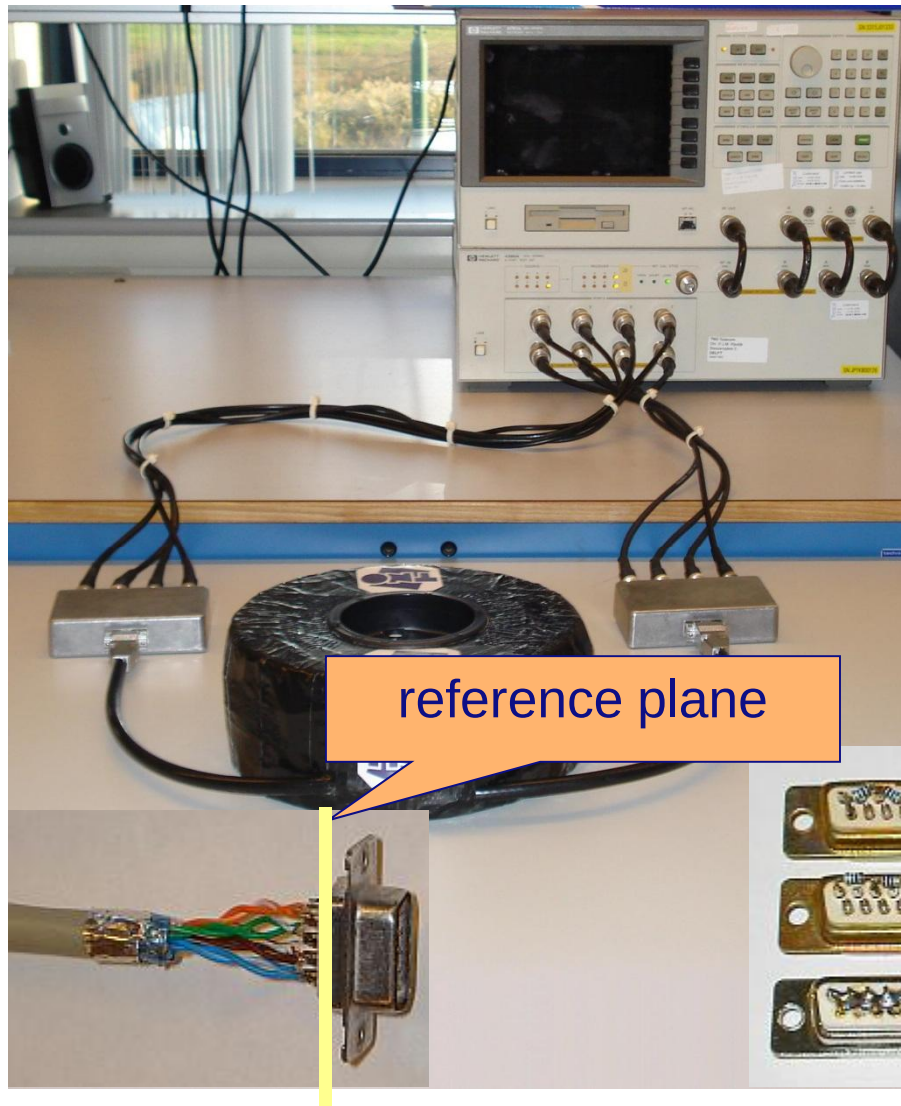
Measurement setup



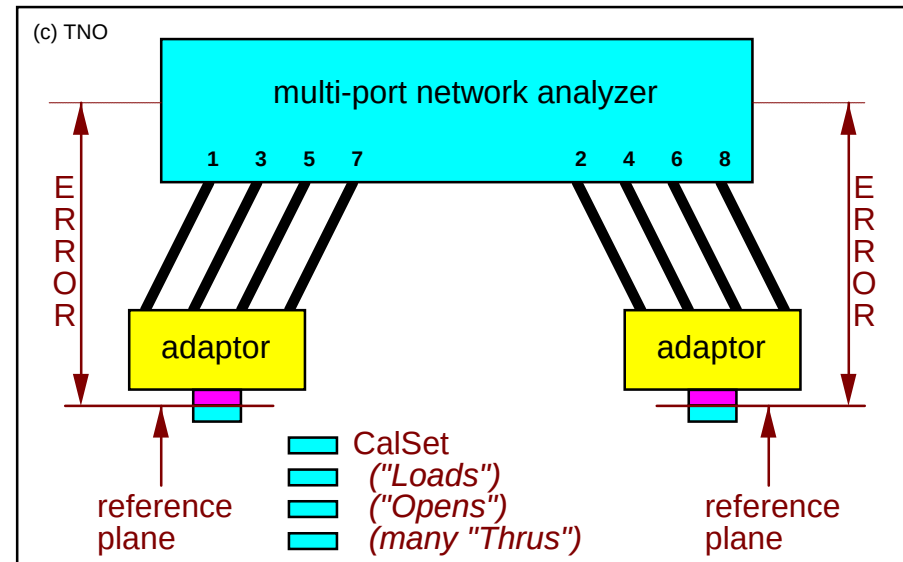
use known networks to measure the errors, and to correct for it via software post-processing ...

solve 140 equations to find 48 unknown (for each frequency)

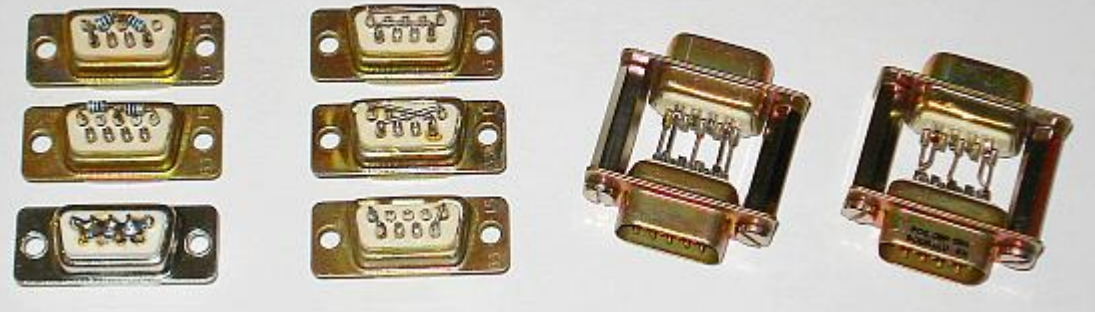
3. Multiport cable measurement setup, up to 500 MHz



Measurement setup



use known networks



calibration set, for error correction

3. Multiport cable measurement setup, up to 500 MHz

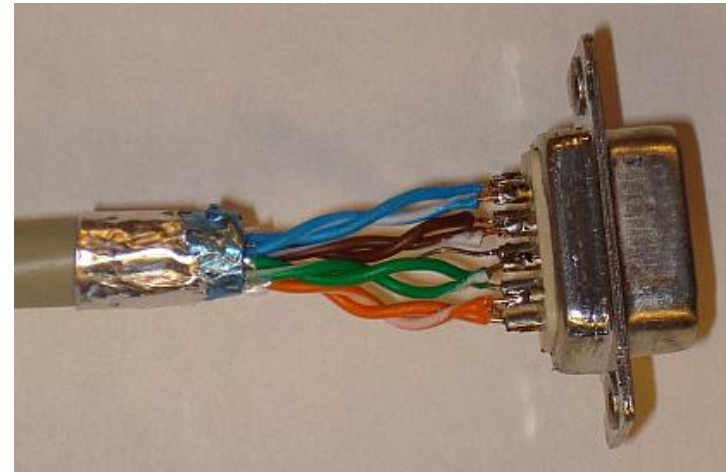


Measurement setup

calibration set, for error correction

4. Characterizing the copper environment

- CAT5-quality
- 4 twisted-pairs
- shielded
- intended for Gb Ethernet networks



232m, CAT5, 4 twisted-pairs

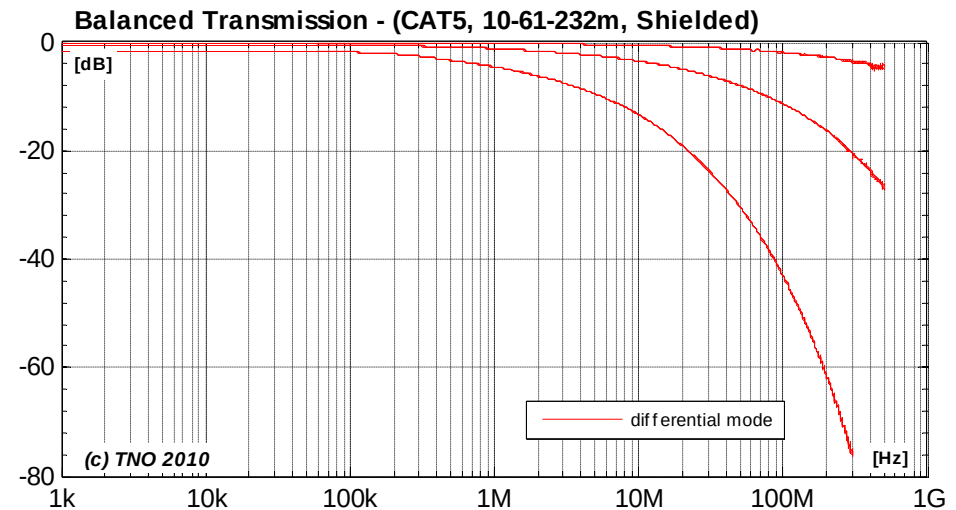
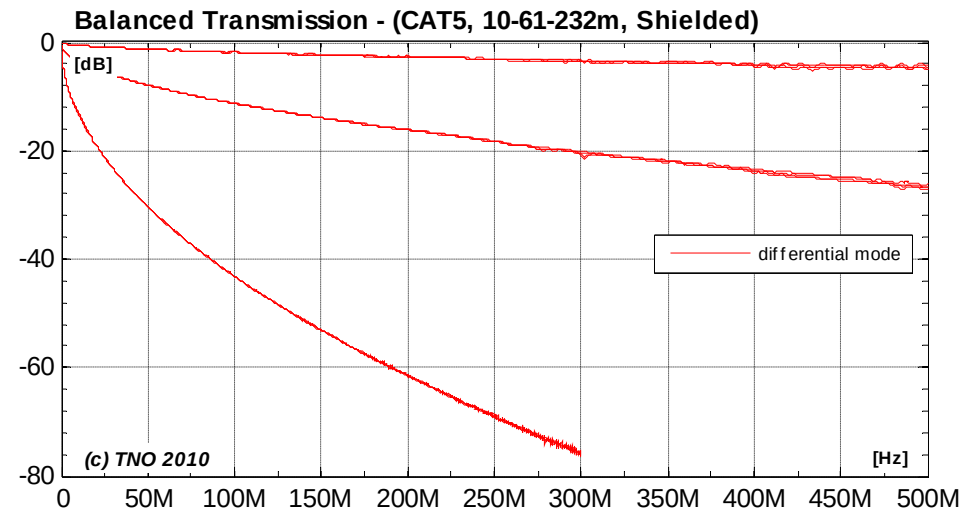


61m, CAT5, 4 twisted-pairs

4. Characterizing the copper environment

Balanced Transmission:

5.7 dB / 100m @ 10MHz
18.6 dB / 100m @ 100MHz



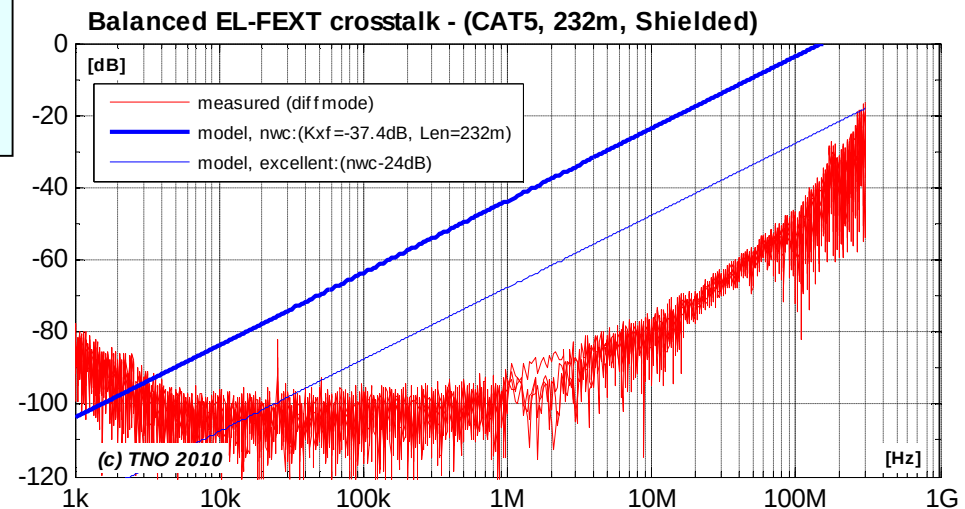
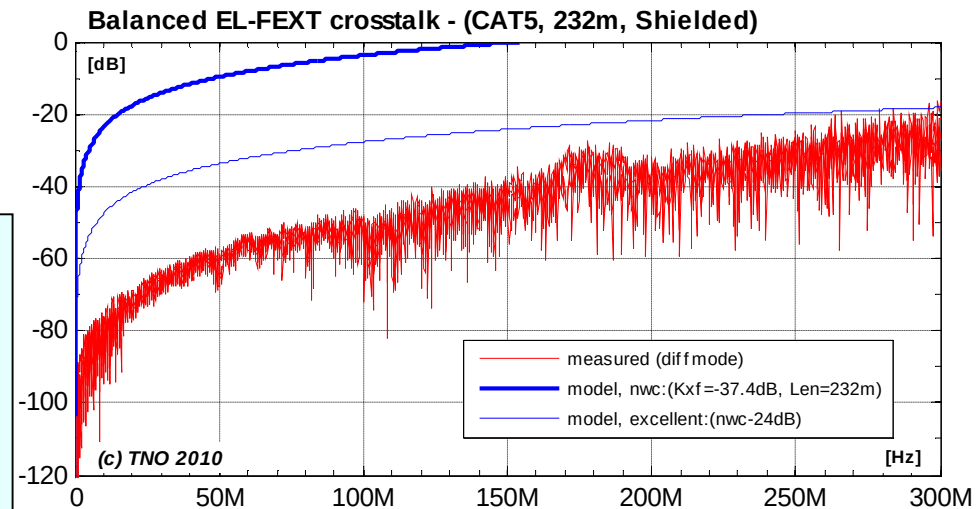
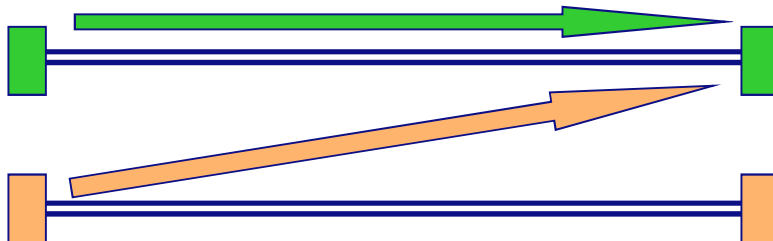
4. Characterizing the copper environment

Balanced EL-FEXT Crosstalk:
much better than “excellent”

Theoretical bitrates (in 2010):
use of VDSL2, 30 MHz spectra:
use of 2 bonded pairs (“quads”)
use of classic simulation models

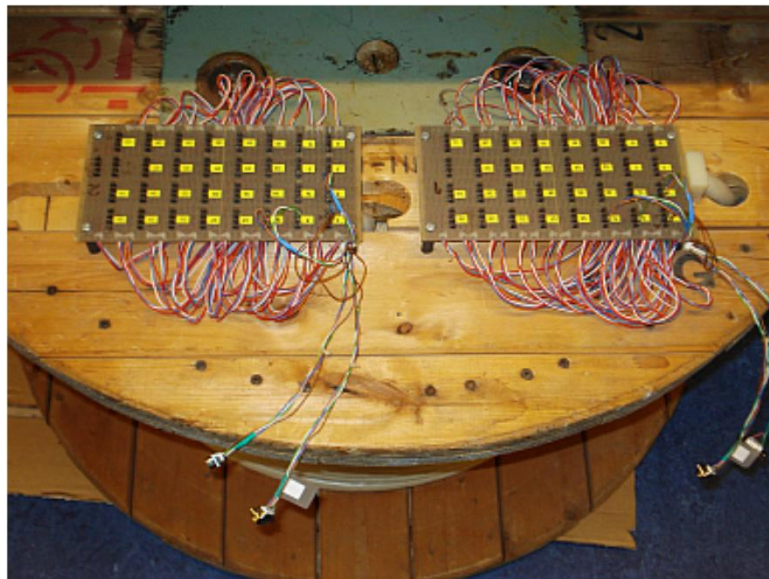
- 50m à >500 Mb/s
- 200m à >460 Mb/s

more with dedicated DSL / G.hn

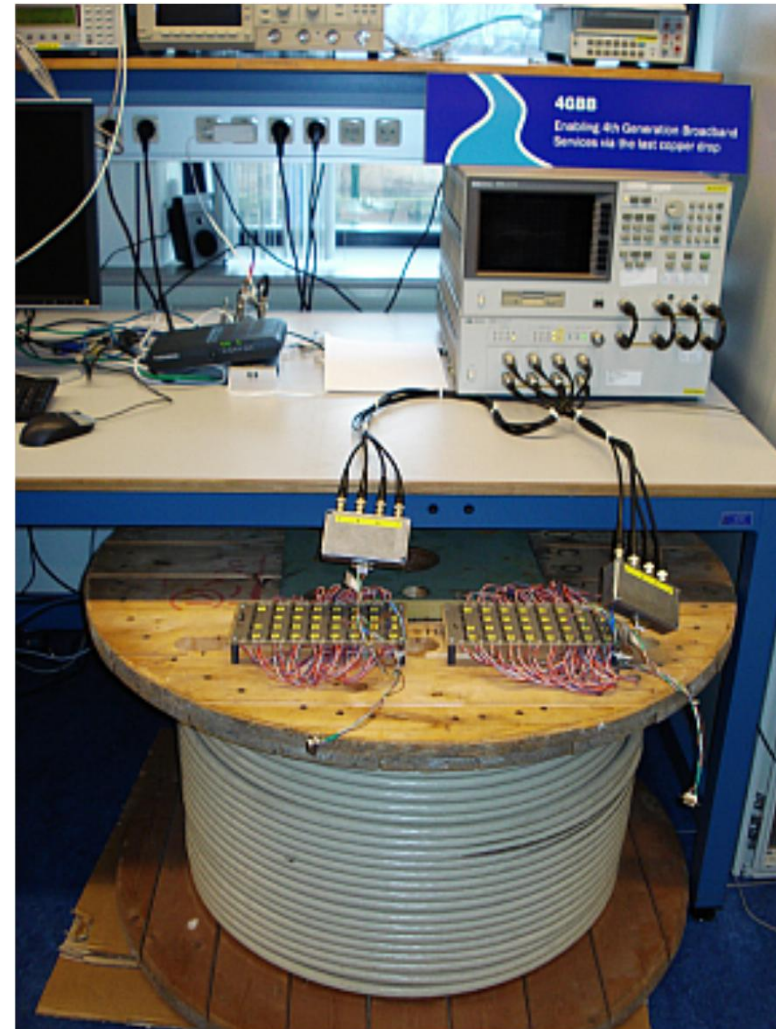


4. Characterizing the copper environment

- 30 twisted-quads (2×2 pair)
- shielded
- telephony wiring for buildings



interconnection with measurement setup



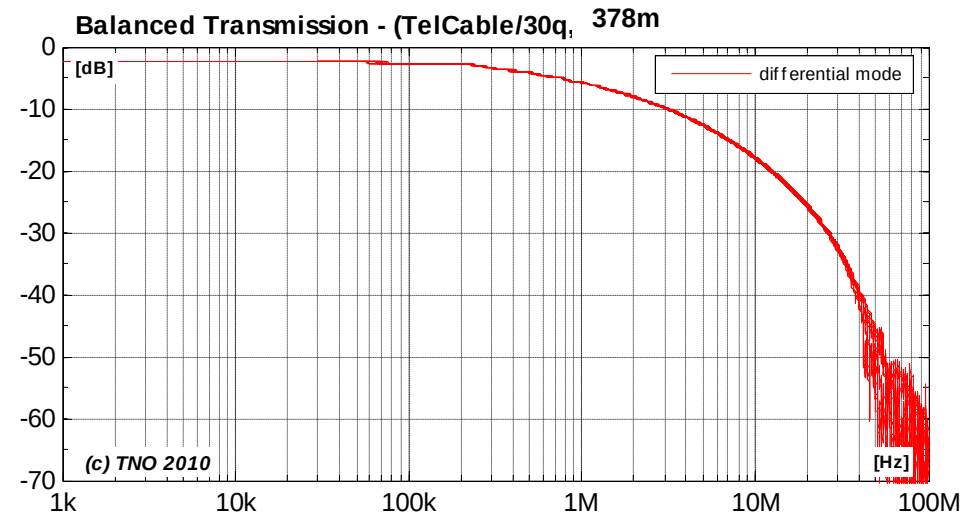
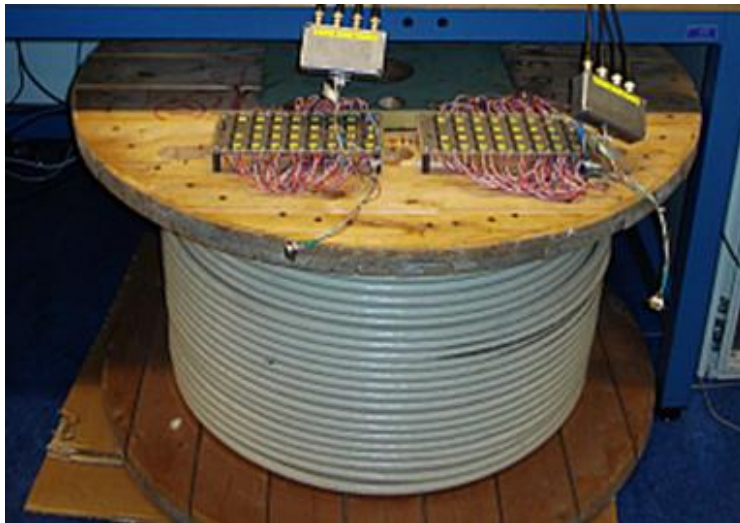
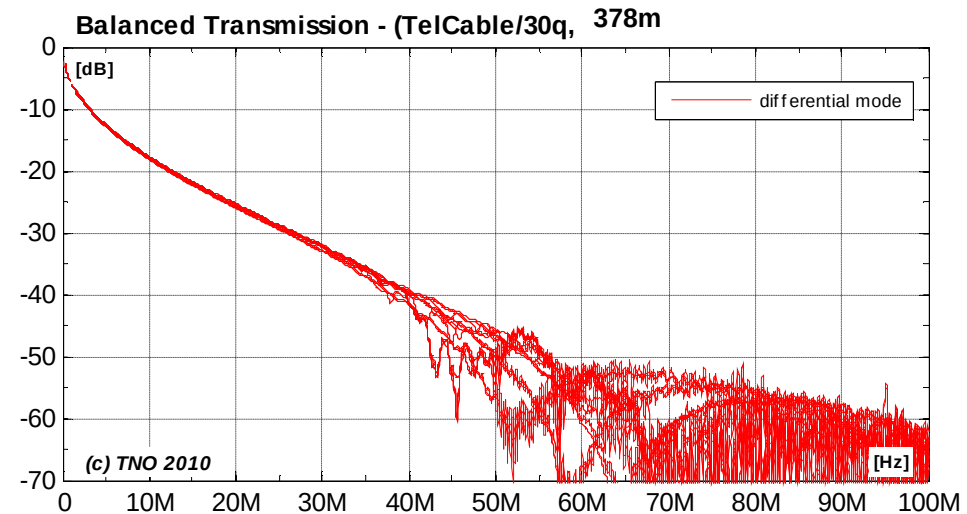
525m on a drum

4. Characterizing the copper environment

Balanced Transmission:

3.5 dB / 100m @ 10MHz

13 dB / 100m @ 100MHz



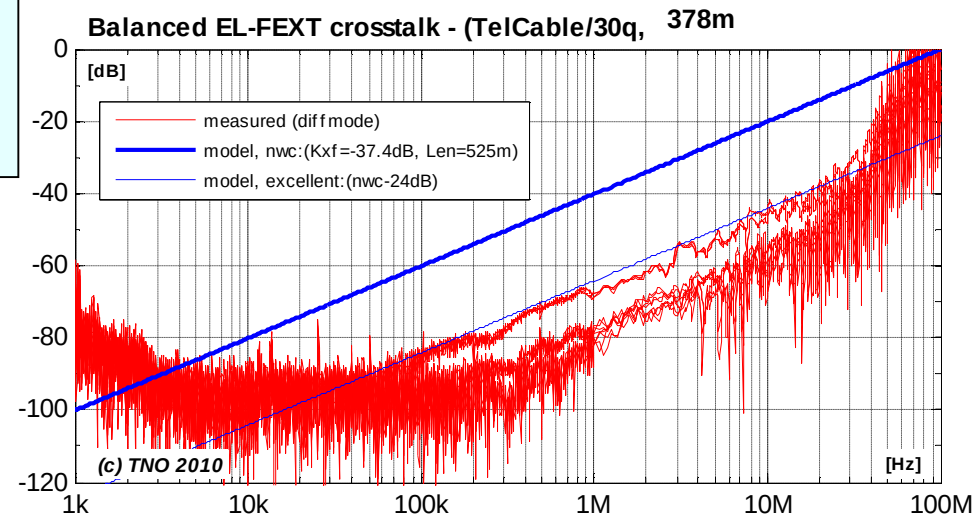
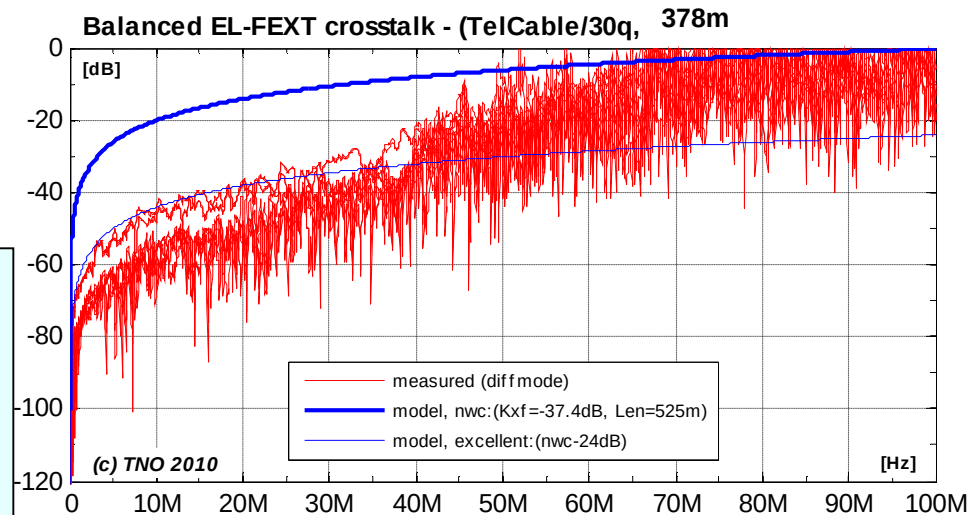
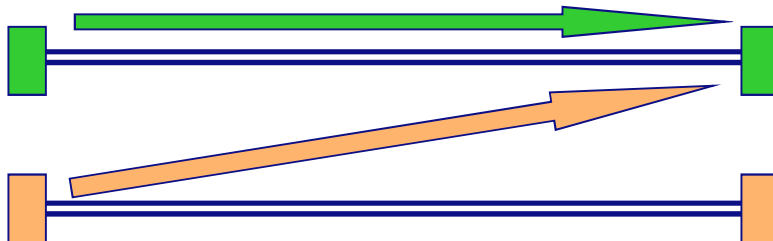
4. Characterizing the copper environment

Balanced EL-FEXT Crosstalk:
“excellent” quality

2010 thoughts on bitrates:
use of VDSL2, 30 MHz spectra:
use of 2 bonded pairs (“quads”)
use of classic simulation models

- 50m à >350 Mb/s
- 200m à >280 Mb/s

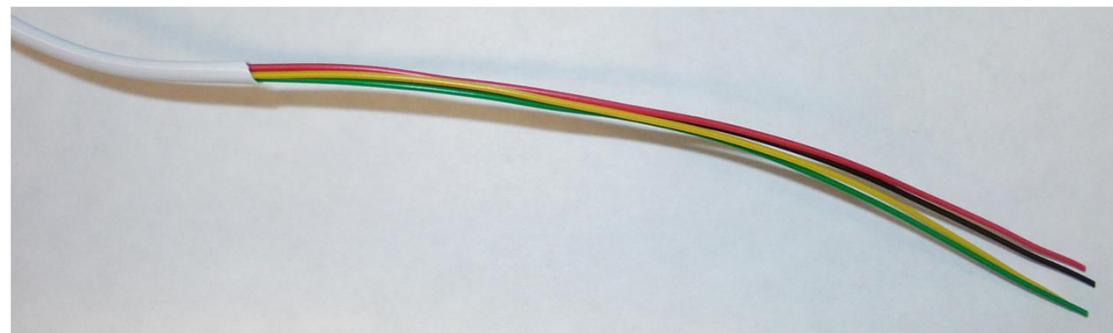
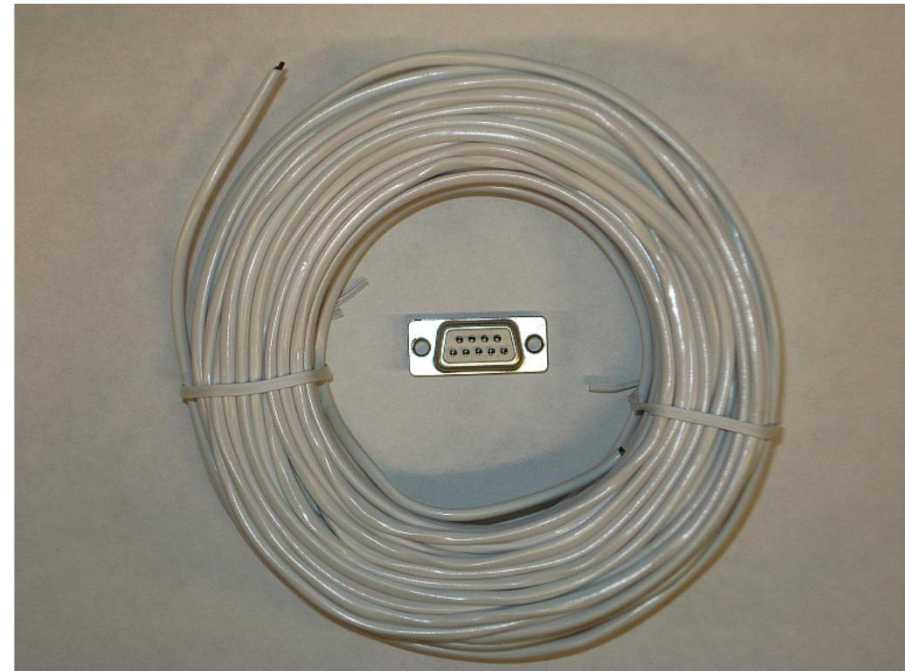
more with dedicated DSL / G.hn



4. Characterizing the copper environment

- fully untwisted
- fully undefined “telephony wiring”
- unshielded
- found in consumer shop “GAMMA”
- 25m

gamma			
Lammenschansweg 130 2321 JX LEIDEN +31 71 5315147			
Klantenkaart: 2611008608619			
AANT	OMSCHRIJVING	PRIJS	BEDRAG BTW
1	HOEK ALUMINIUM 25X25X2MM 1M	4,79	4,79 1
4	TELEFOONDRAAD ROND 4X0,5MM 25M	5,99	23,96 1
1	GAMMA BIG SHOPPER	1,00	1,00 1
1	BERKEN MULTIPLEX 16MM 122X61CM	18,49	18,49 1
7 Totaal		48,24	
Pin		48,24	
BETALAUTOMAAT			
Datum	27/01/10 Tijd	16:09:23	
Kassanr	YMB106 Referentie	01091441	
Totaal		48,24 EUR	
Tlv	0315638842		
BANK	Be1 kenmerk	027AUT	
Acquirer Identifier:	67300110		
U HEEFT BETAALD TOT ZIENS			

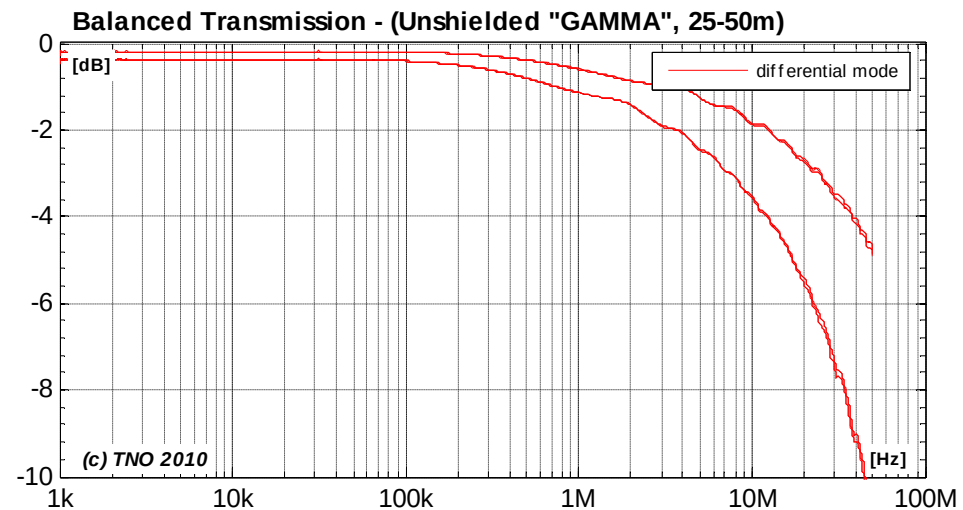
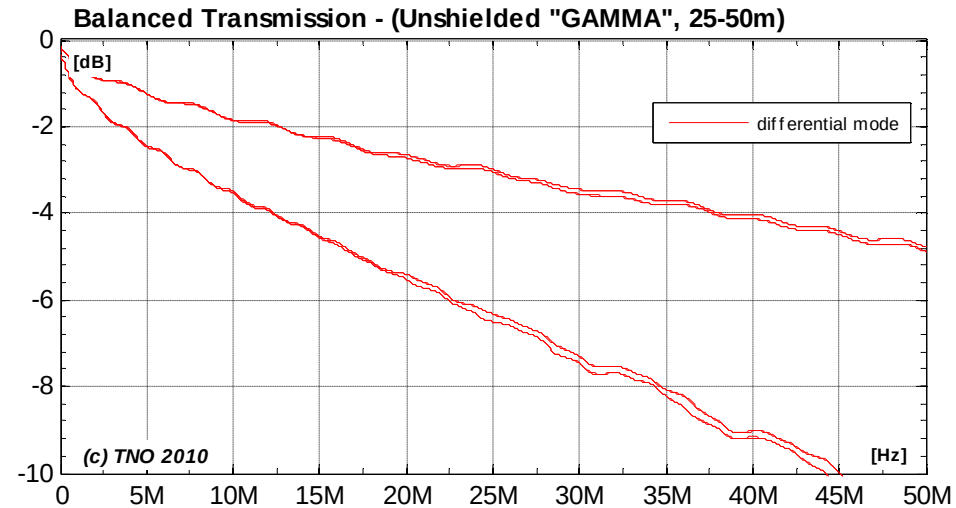
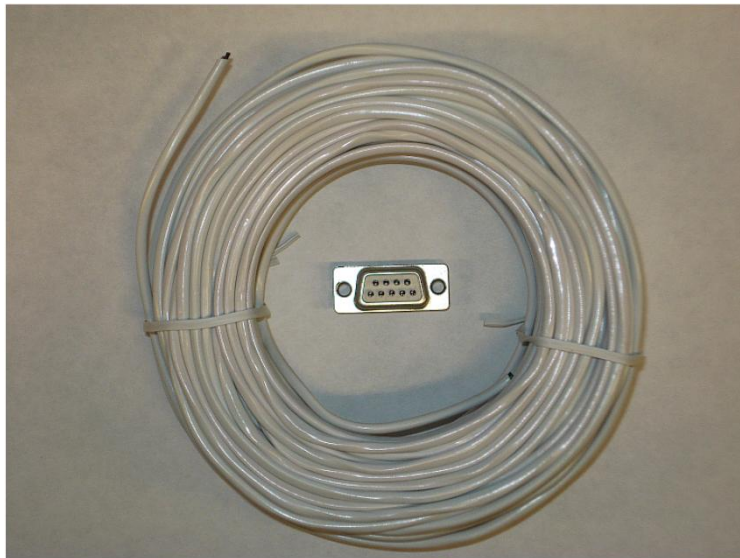


25m or 25+25m spread-out on the floor

4. Characterizing the copper environment

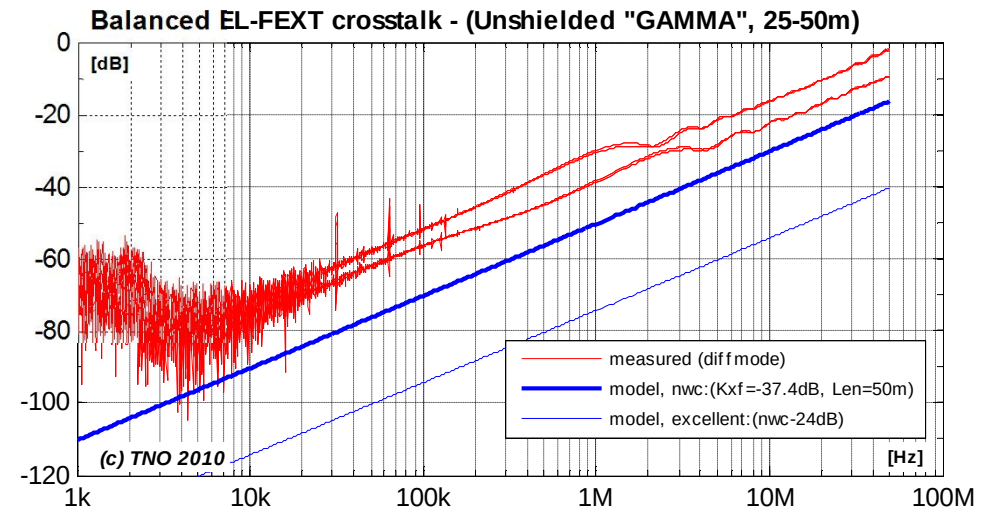
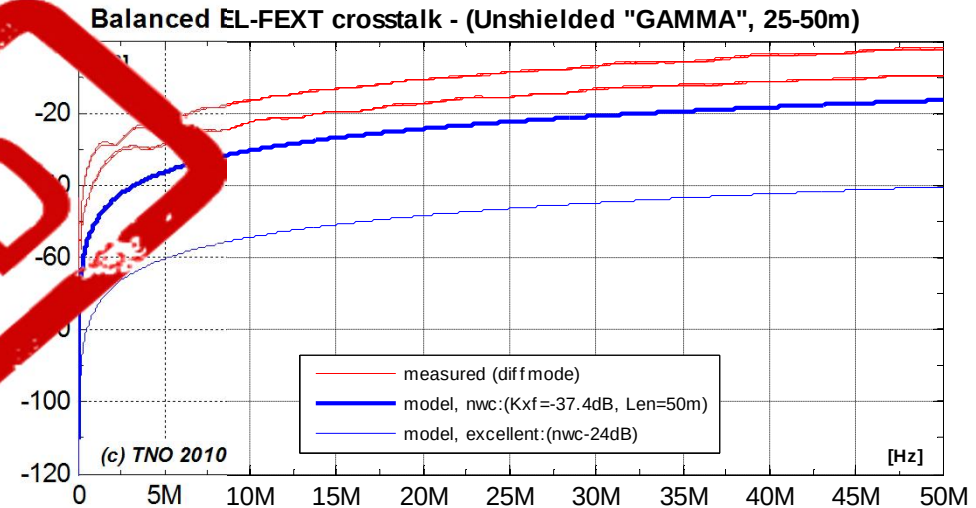
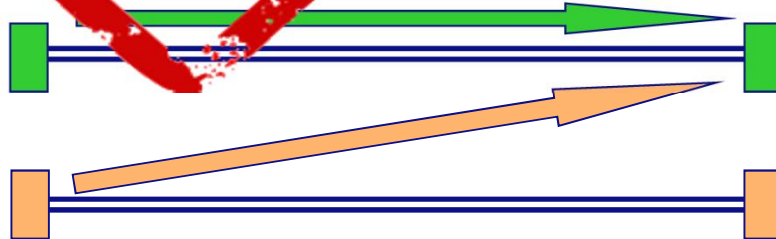
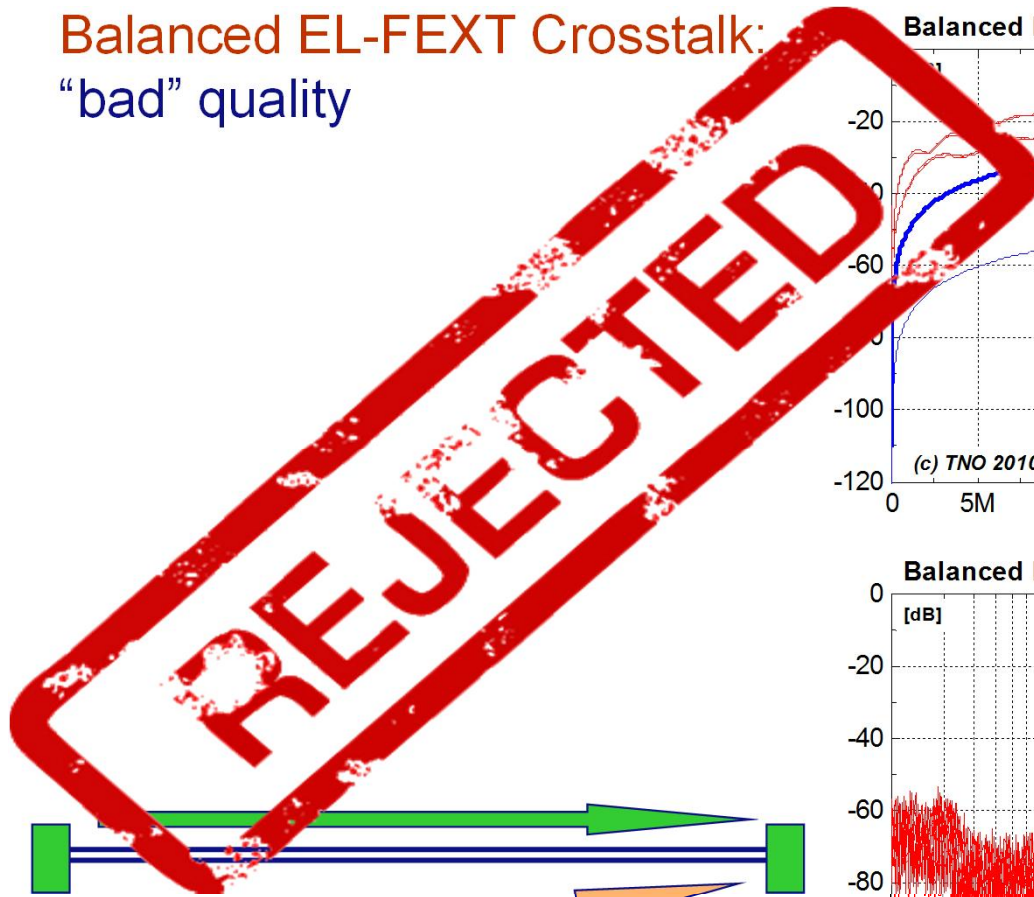
Balanced Transmission:

7 dB / 100m @ 10MHz
40 dB / 100m @ 100MHz

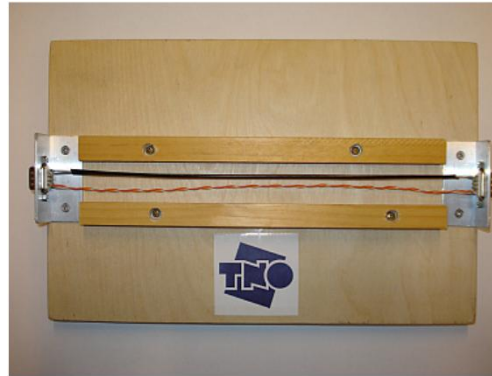
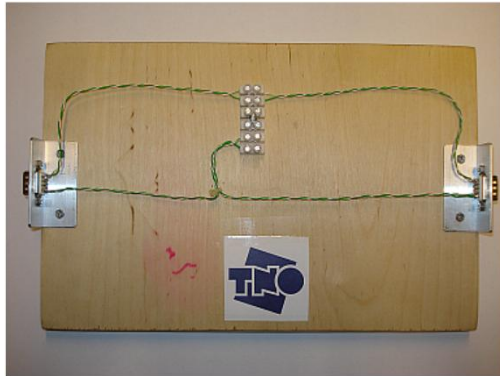


4. Characterizing the copper environment

Balanced EL-FEXT Crosstalk:
“bad” quality



4. Characterizing the copper environment



All kinds of obstacles

- Splices
- Manipulation boxes

cable



splice



cable



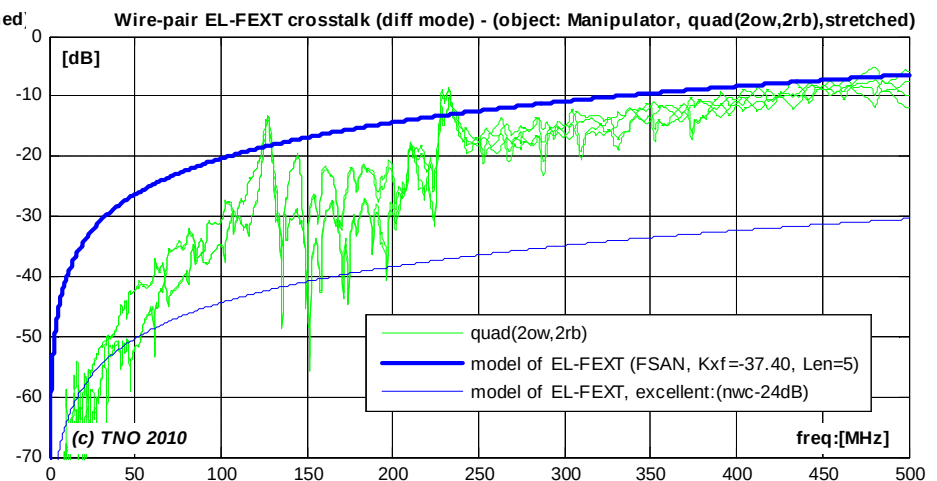
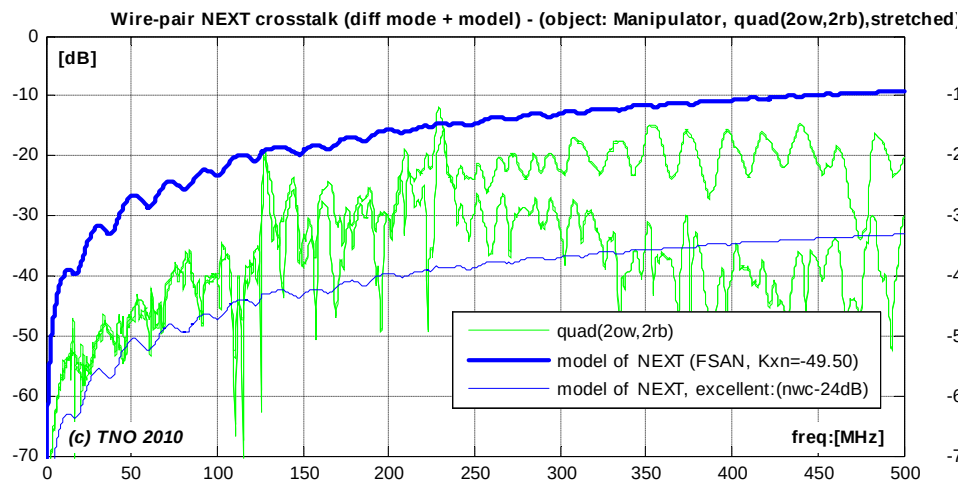
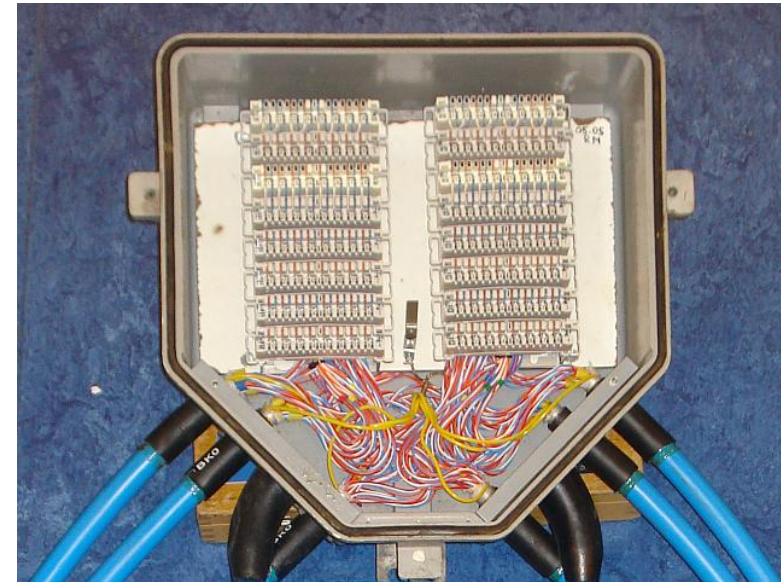
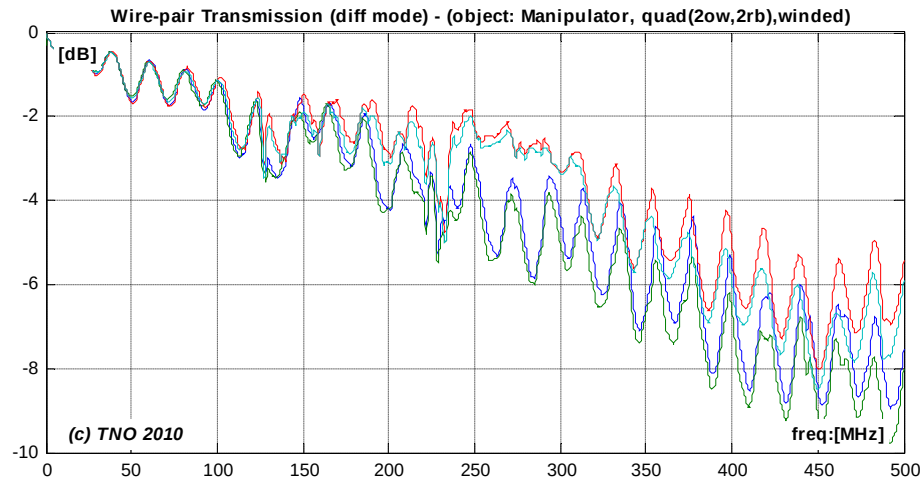
**manipulation
box**



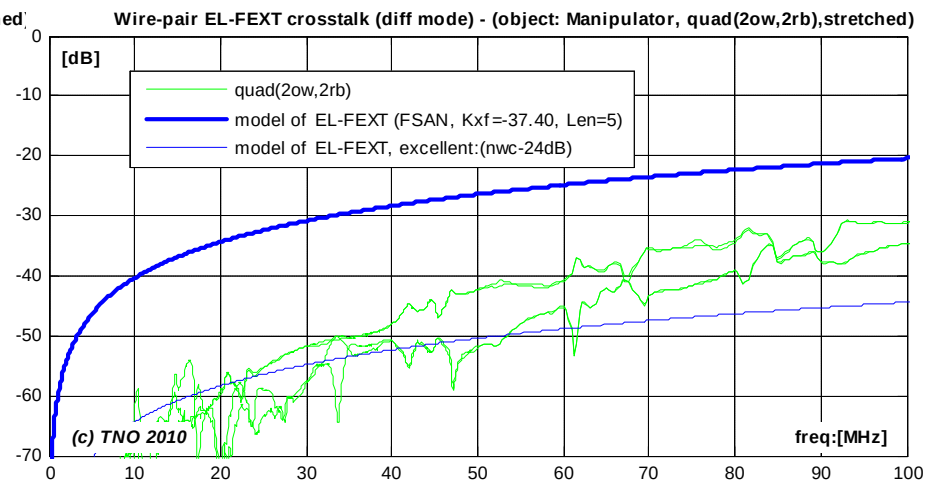
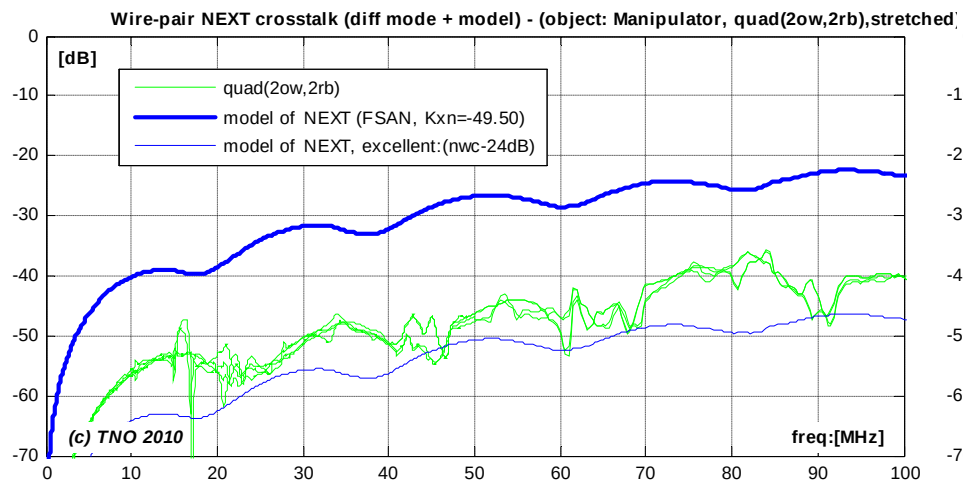
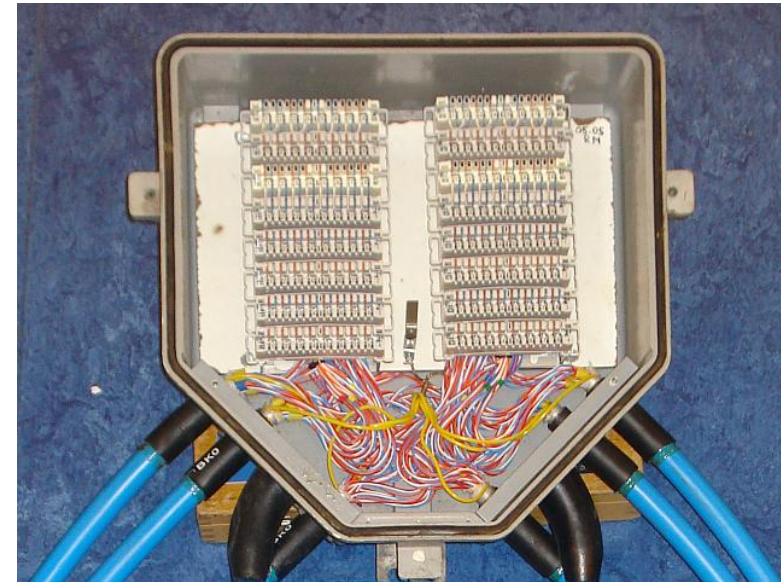
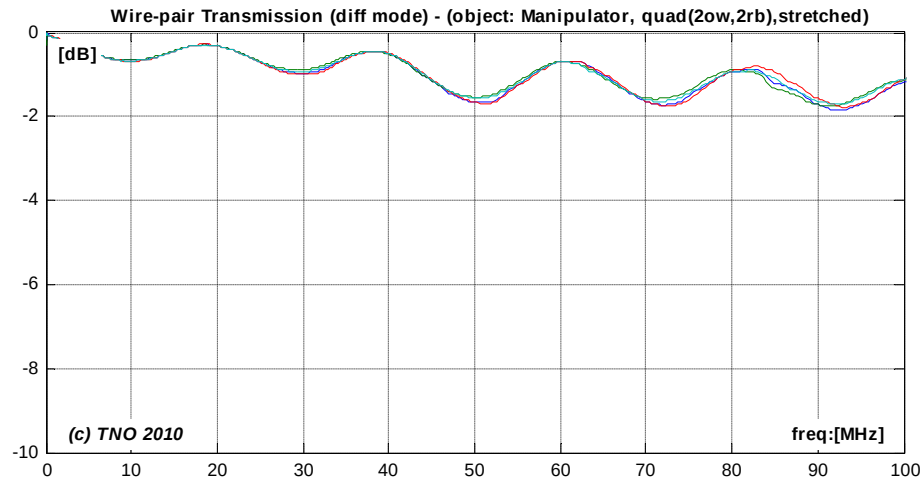
**in-house
wiring**



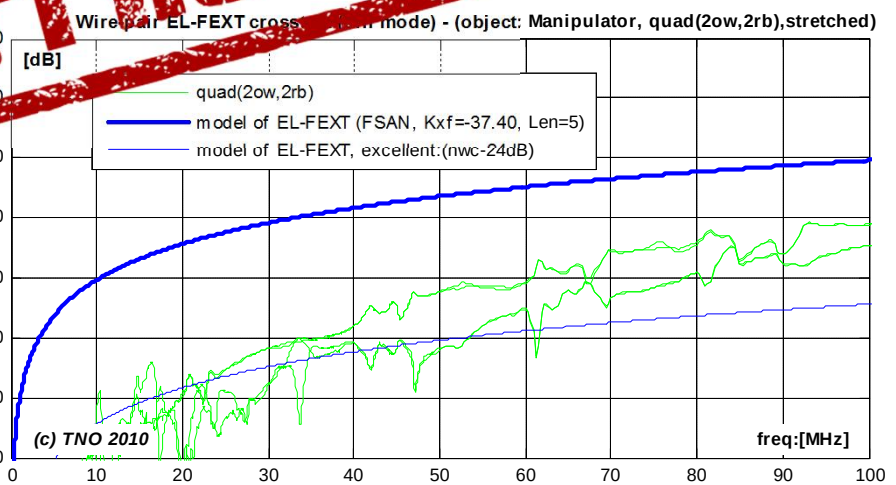
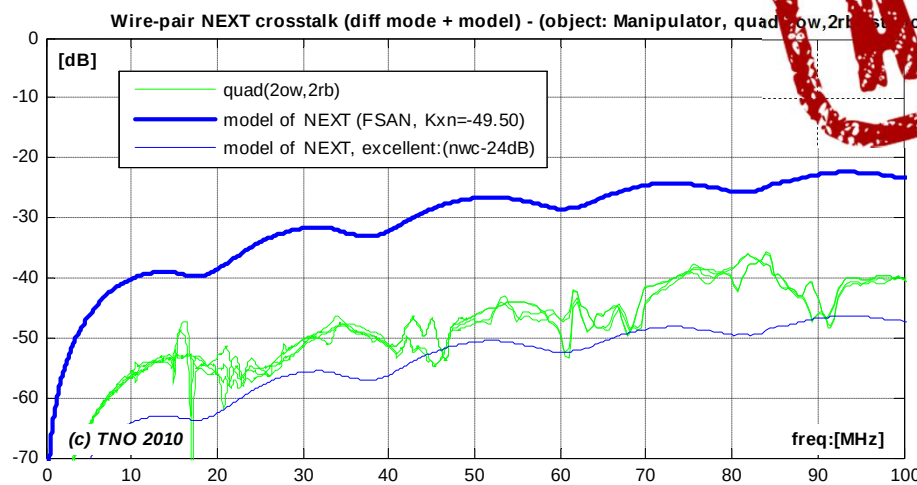
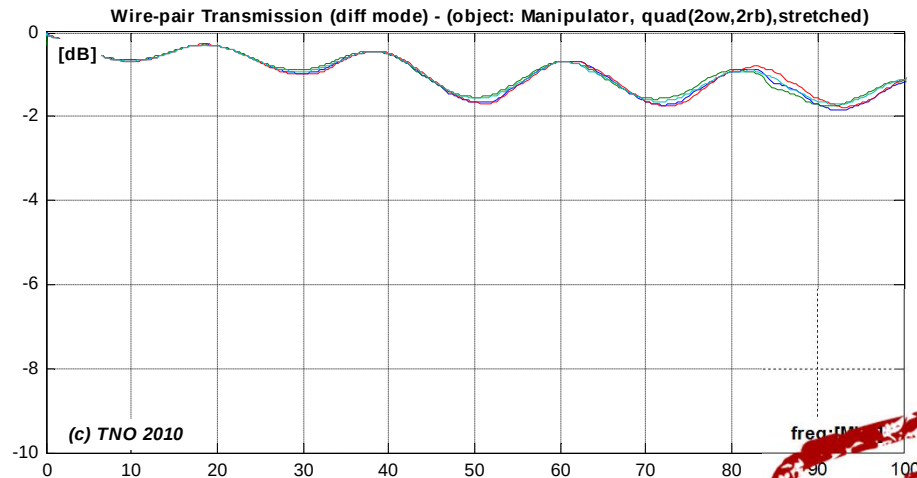
4. Characterizing the copper environment



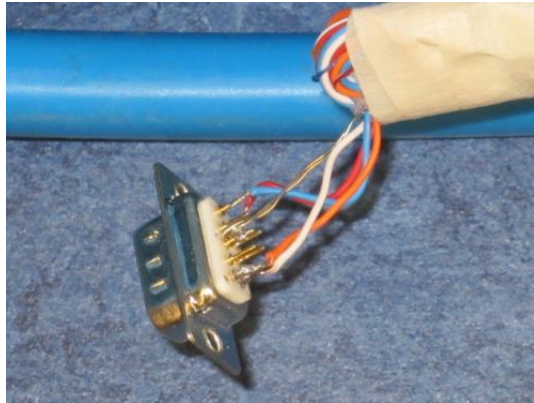
4. Characterizing the copper environment



4. Characterizing the copper environment

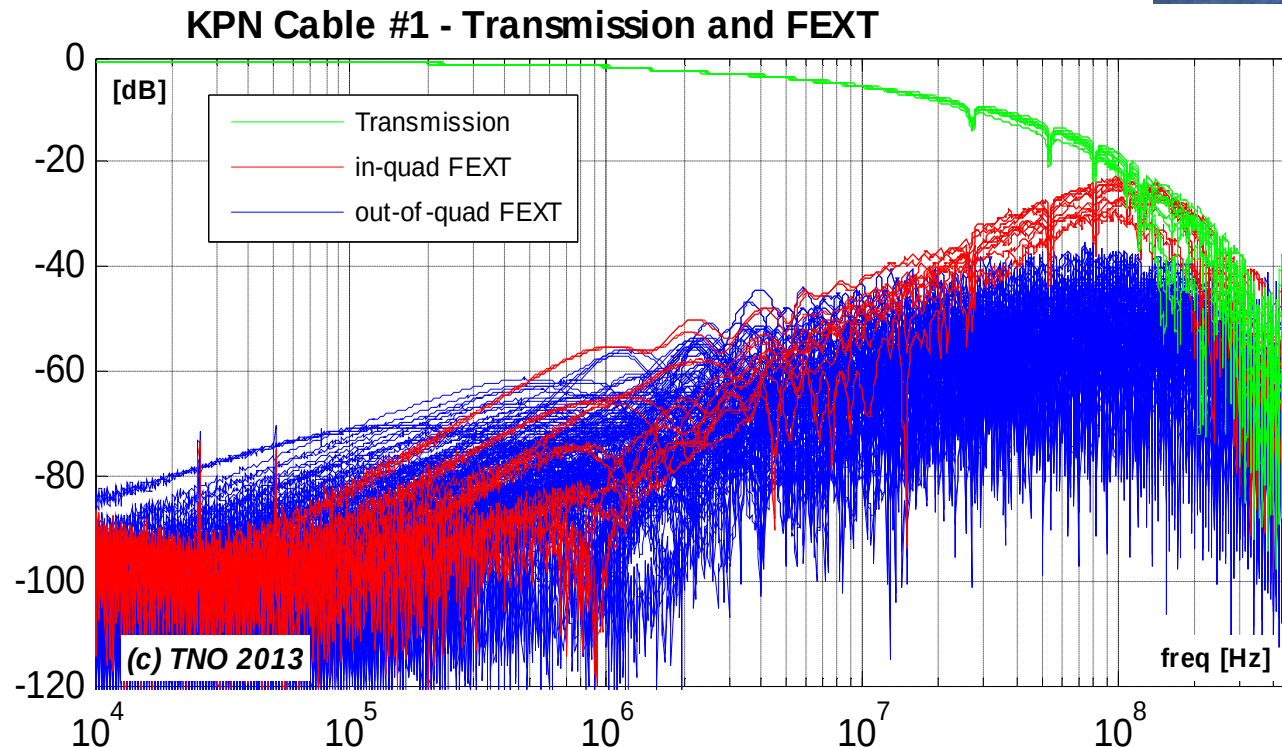


4. Characterizing the copper environment



Bulk measurements

- Spread in cross talk
- Difference between in-quad and out-of-quad



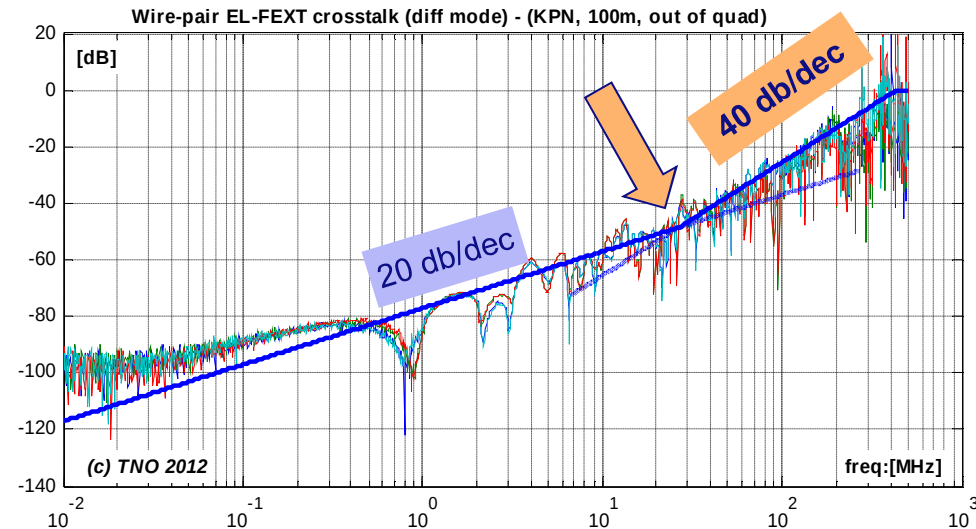
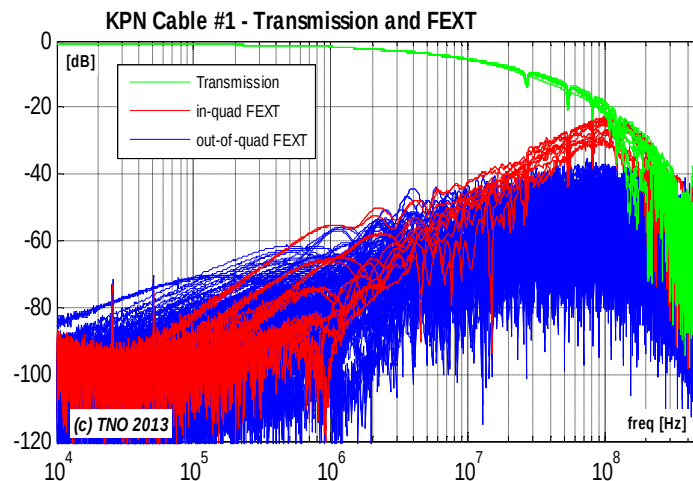
4. Characterizing the copper environment

Discovery of new crosstalk behavior

- Dual-slope of EL-FEXT
- HF crosstalk is higher than assumed
- Simple dual-slope model
(Contributed to ITU-T SG15)

Introduction of new cable models

- Suitable for hundreds of MHz
- Causal by nature
- Replaces legacy BT model
(Contributed to ITU-T SG15)



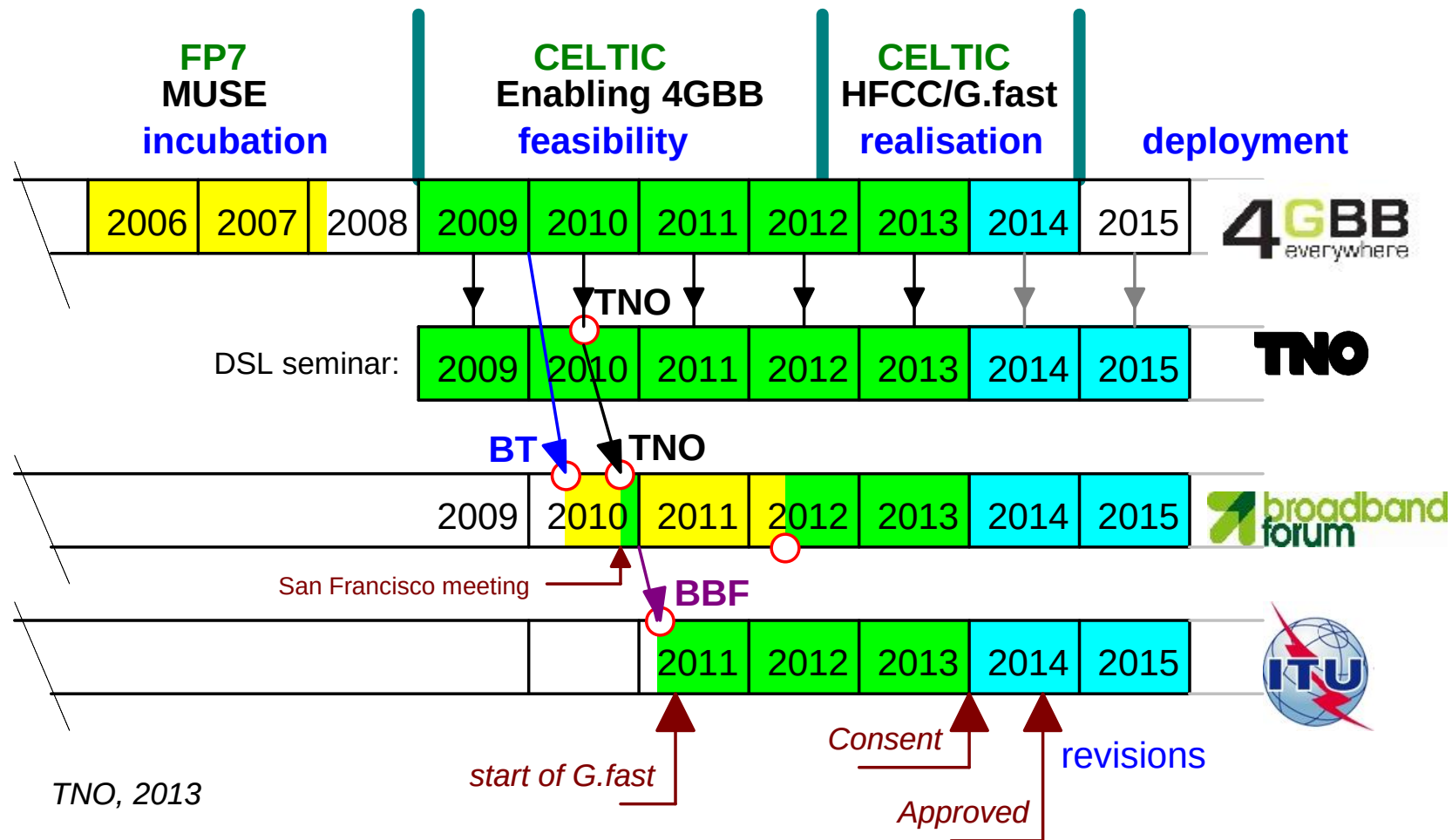
Questions in 2009

Can we initiate a standard?

**Can we bring the industry
into motion?**

5. The making of Hybrid FTTH with G.fast

Initiation of the G.fast standard

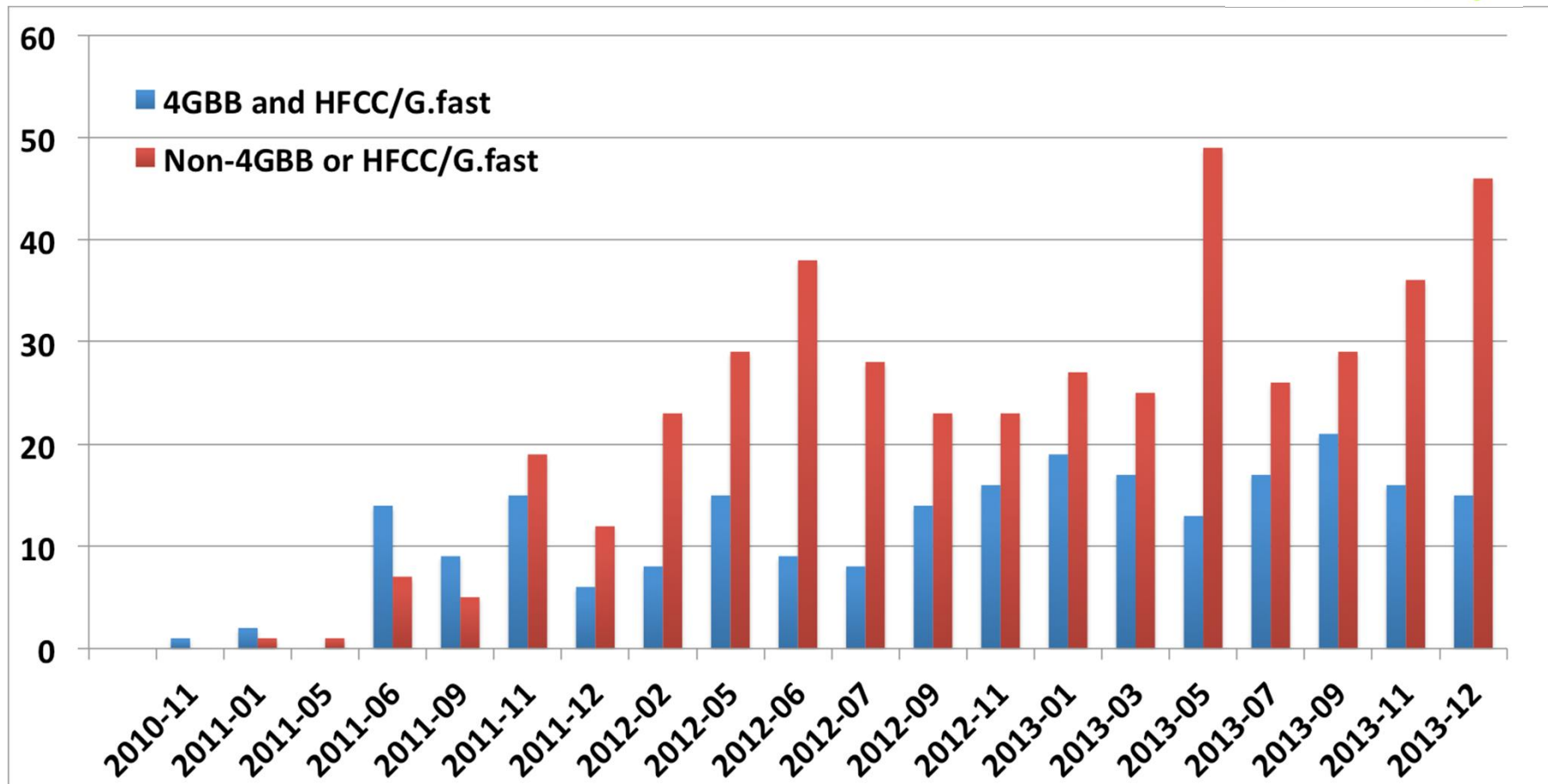


5. The making of Hybrid FTTH with G.fast

**G.Fast contribution to ITU-T
from 4GBB consortium members**

4GBB
everywhere

4GBB
HFCC/G.fast



5. The making of Hybrid FTTH with G.fast

Bringing the industry into motion for Hybrid FTTH with G.fast

BT trials G.fast, FTTdp with Huawei

22 Oct 2013

 United Kingdom

British fixed line incumbent BT and Chinese vendor Huawei are to conduct a G.fast technical field trial, the latter has announced. For the trial, BT will use its Park research and development centre in Ipswich, Suffolk, and Huawei will use its R&D centre in London.

Deutsche Telekom plans G.fast field trial - report

Monday 17 February 2014 | 15:21 CET | News

Deutsche Telekom plans to conduct field trials of G.fast broadband technology in partnership with Alcatel-Lucent and Huawei and carrier 'Wirtschaftswoche' business magazine has learned from company sources. The technology has been developed by Alcatel-Lucent and Huawei and carrier technology connection to up to 500 Mbps, compared to the 100 Mbps achieved with current copper technologies. Using this technology would mean that Telekom would not have to replace all copper cables with fibre-optic connections, saving billions in network roll-out costs.

Categories: Fixed / Internet
Companies: Alcatel-Lucent / Deutsche Telekom / Huawei
Countries: Germany

TeliaSonera trials G.fast in Finland in partnership with Huawei

19 Feb 2014

 Finland

Chinese vendor Huawei has performed a field trial using its G.fast copper broadband technology in partnership with the Finnish subsidiary of Sweden's TeliaSonera. Revealing the development in a press release, Huawei noted that the solution has been deployed in the TeliaSonera network in Helsinki, 'serving real customers and delivering real services'. According to the vendor, the technology allows for the provision of speeds of up to 1Gbps to customers connected by the legacy copper network. While there was no indication of a timeframe for a commercial introduction of the technology, Huawei did claim that the field trial had demonstrated that G.fast technology meets not only the requirement of current services, but also offers the bandwidth demand of future broadband and video services, such as 4KTV.

Commenting on the development, Isto Pasanen, Head of Consumer Services in Networks at TeliaSonera, noted: 'We continue to drive innovation to provide the best experience for our customers and build the digital society. The technology to deliver ultra-high-speed broadband connections over old copper lines makes it possible for us to improve the experience for more customers faster and thus making the most of our copper network.'

Finland, TeliaSonera, TeliaSonera Finland, Huawei Technologies, Broadband

... And suddenly there was G.fast

2009-2012: Celtic project “Enabling 4G BB”



2013-2014: Celtic project “HFCC/G.fast”



Current 4G BB Consortium members:



LUND UNIVERSITY



TNO