Swisscom's path from VDSL2 to G.fast

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DSL Seminar

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Broadband

Today Swisscom meets Switzerland's needs using a mix of technologies

Fibre to the Home (FTTH)

- 770'000 Homes Passed
- Fastest Surf-Speed in Switzerland: 1 Gbit/s

Fibre to the Curb (FTTC) , Fibre to the Street/ Building (FTTS/B)

- >92% coverage with digital TV
- >88% coverage with HDTV



Mobile broadband

- >99% coverage 2G
- >98% coverage 3G
- 91% coverage 4G/LTE
- 5th consecutive time winner of Connect test

Universal service & ADSL

- >98% with broadband (>1Mbit/s)

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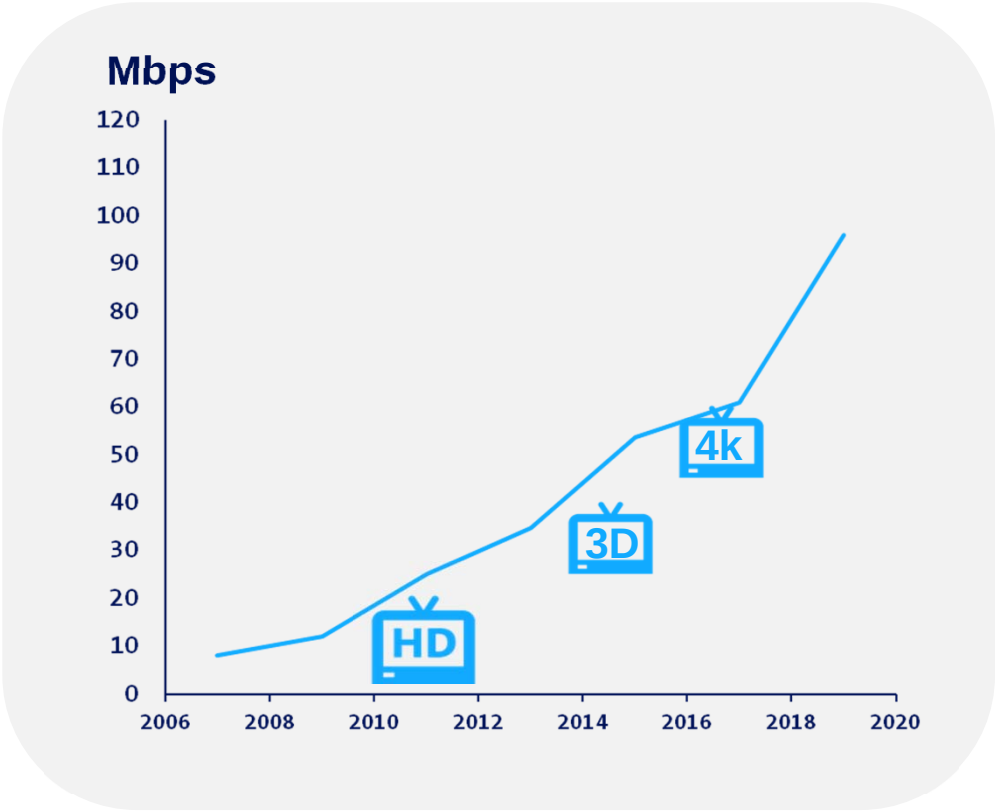
Increasing bandwidth requirements

Parallel use of devices, better image quality and bandwidth-hungry services









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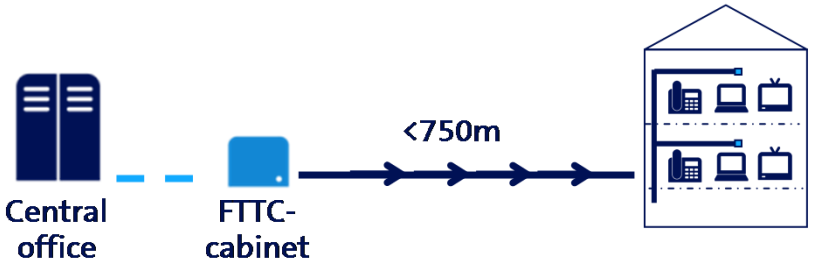
Innovative fibre technologies

Thanks to a mixture of access technologies, Swisscom can offer its customers multimedia services throughout Switzerland

Since 2008: Fibre to the home (FTTH)



2013ff: Vectoring applied to FTTC



2013ff: Fibre to the street (FTTS)



2013ff: Fibre to the building (FTTB)

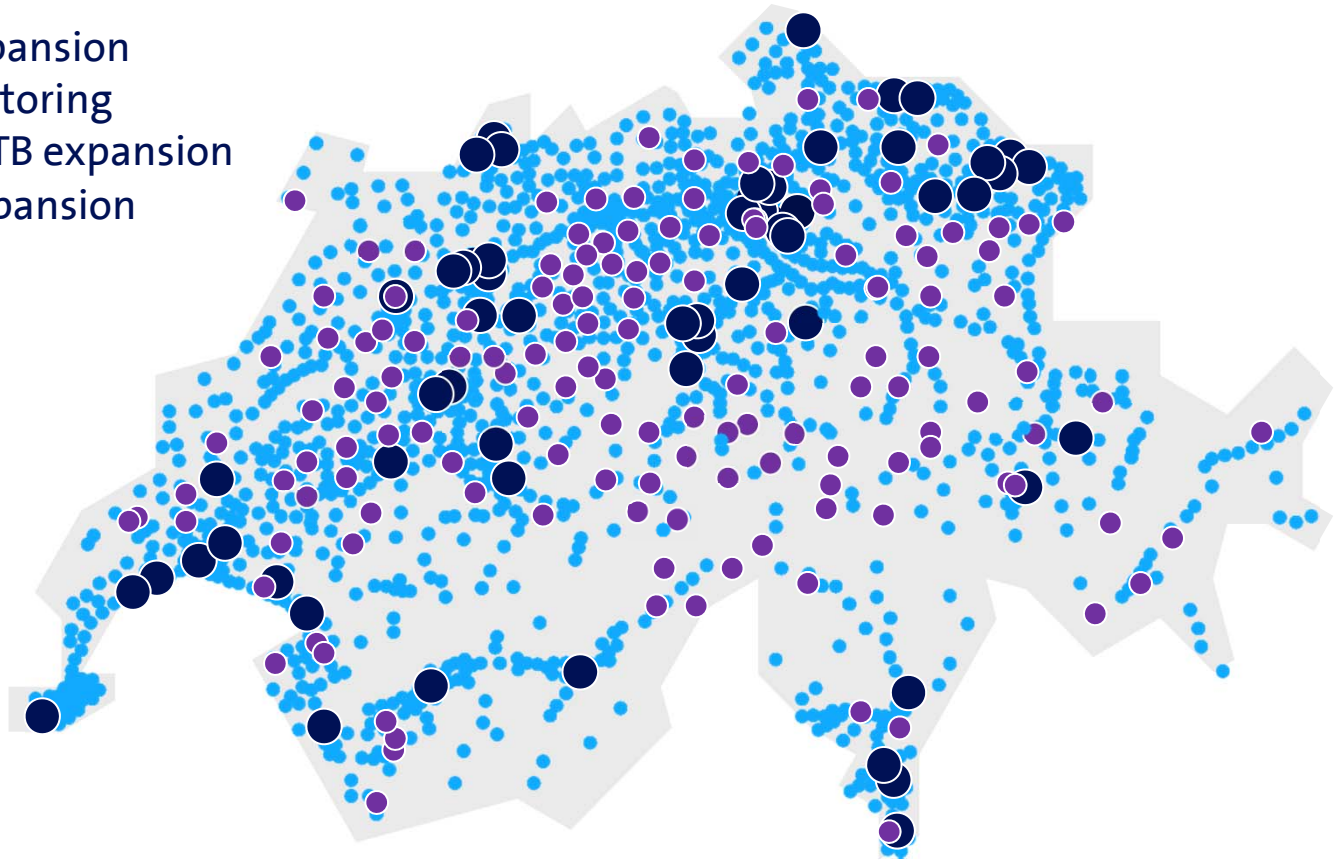


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High-speed expansion

Swisscom is pushing ahead with the widespread expansion of ultra-broadband at the end of 2014

- FTTC expansion with vectoring
- FTTS/FTTB expansion
- FTTH expansion



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Informations from a vectoring pilot

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Results from a vectoring pilot

Overview

- FTTC Vectoring details:
  - Solution based on Huawei MA5603T, R12
  - Vectoring in Downstream direction only, above 2.2 MHz
  - Mixed CPE scenario (vectoring- & legacy-CPE) with Vectoring Auto Sense function (aka FFM - Forced Friendly Mode)
  - Use of G.INP and SRA (DS & US) with vectored lines
  - Use of IFEC, no SRA (DS & US) with legacy lines

- March/April 2014: Extended Pilot with 5'000 lines
- Starting Rollout in May 2014 → Status mid June
  - ca. 400 DSLAMs
  - >20'000 vectored lines
  - ca. 30'000 legacy lines (FFM mode)

- In addition, we are in the pilot phase of FTTS and FTTB with vectoring.

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Results from a vectoring pilot

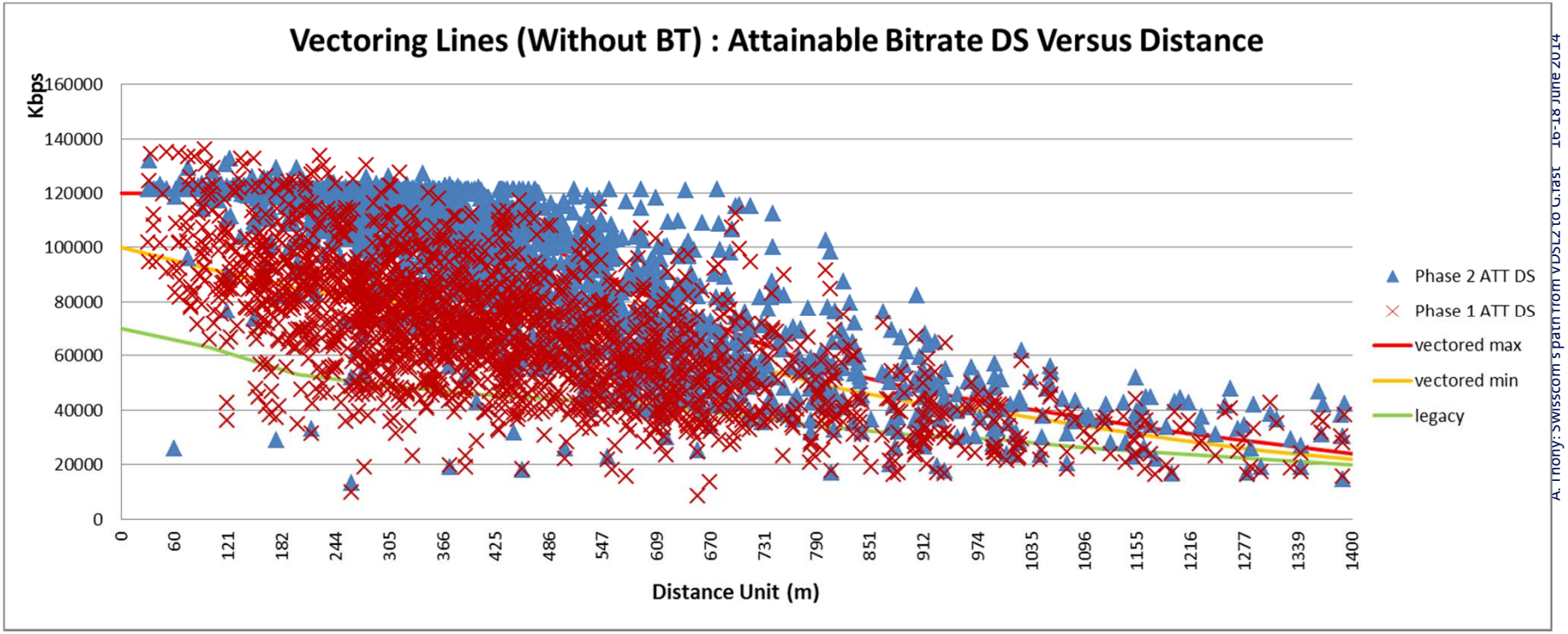
Results from vectoring pilot – 5000 lines

- General:
  - Satisfying results concerning increased DS bandwidth and stability.
  - No degradation of service quality (TV performance, DHCP sessions)
  - No increase of customer ticket rate

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Results from a vectoring pilot

Vectoring Gain

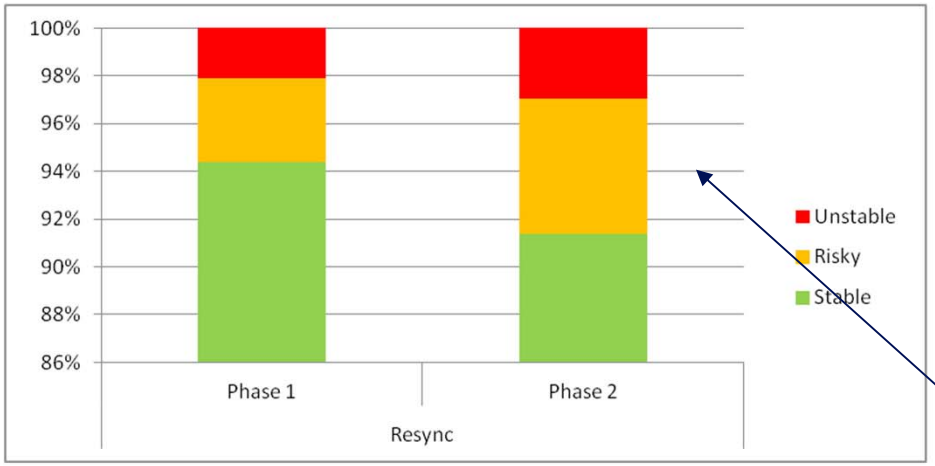


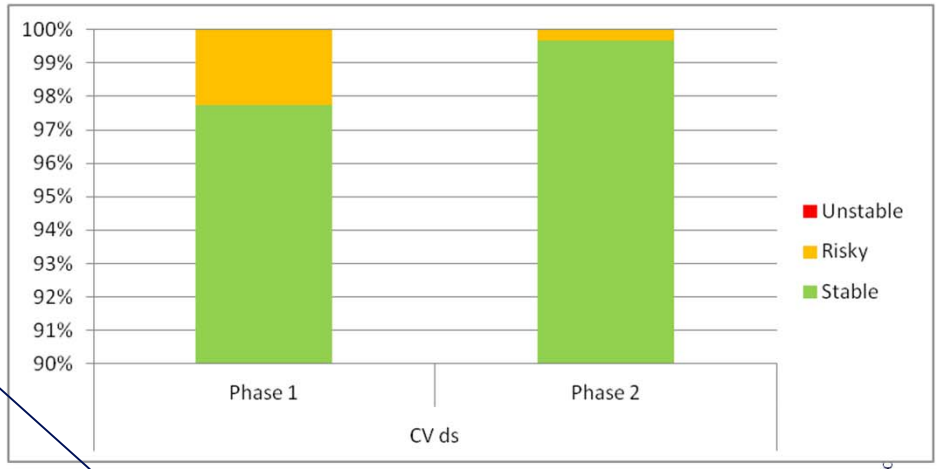
- average vectoring gain overall: 1.34 (with BT: 1.30, without BT: 1.38)
- average vectoring gain <500m: 1.40 (with BT: 1.35, without BT: 1.45)
- Of all vectored lines without BT: att. BR >100Mb/s: 51%, att. BR >80Mb/s: 67%

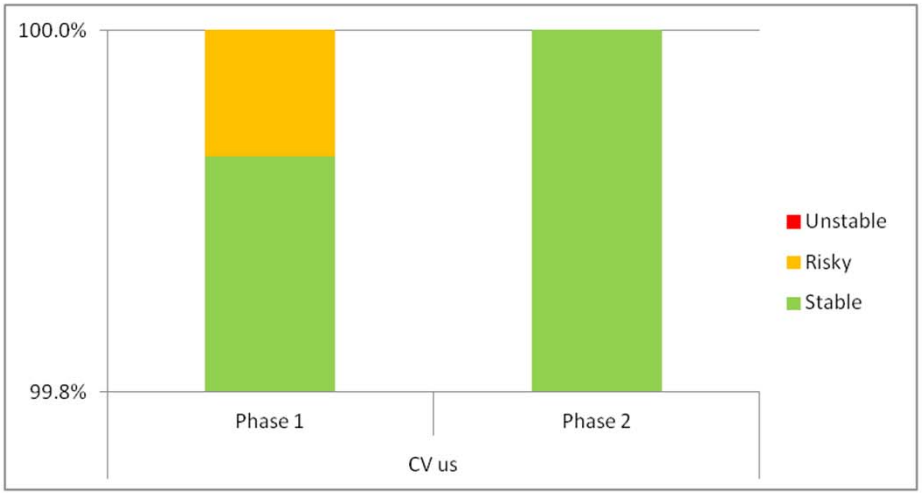
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Results from a vectoring pilot

Stability (Resynchs & CVs) of all lines







- **Phase 1: without vectoring**
- **Phase 2: with vectoring**

- Degradation of resynch behaviour:
  - known resynch issue due to tracking bug, will be fixed with newest patch
  - increased BR, but not yet stabilized
  - resyncs on legacy lines also increased form phase 1 to phase 2 (variation between phase 1 and phase interval)

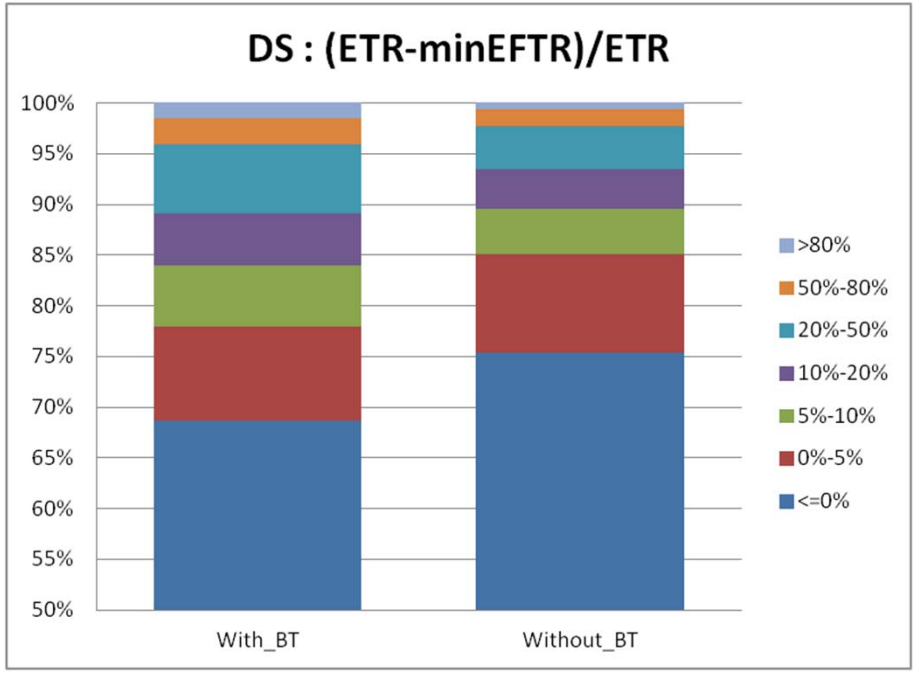
A. Thöny, Swisscom

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Results from a vectoring pilot

Stability (SES-DS) of all lines

- SES DS:
  - Phase 1: 96% of lines with no SES
  - Phase 2: 95% of lines with no SES
- Degradation of SES behaviour, possible explanation:
  - Occurence of seftr (severe loss of EFTR) defects → EFTR < ETR/2 causes SES
  - Statistics below implies that several "seftr" defects (>50%) should be observed



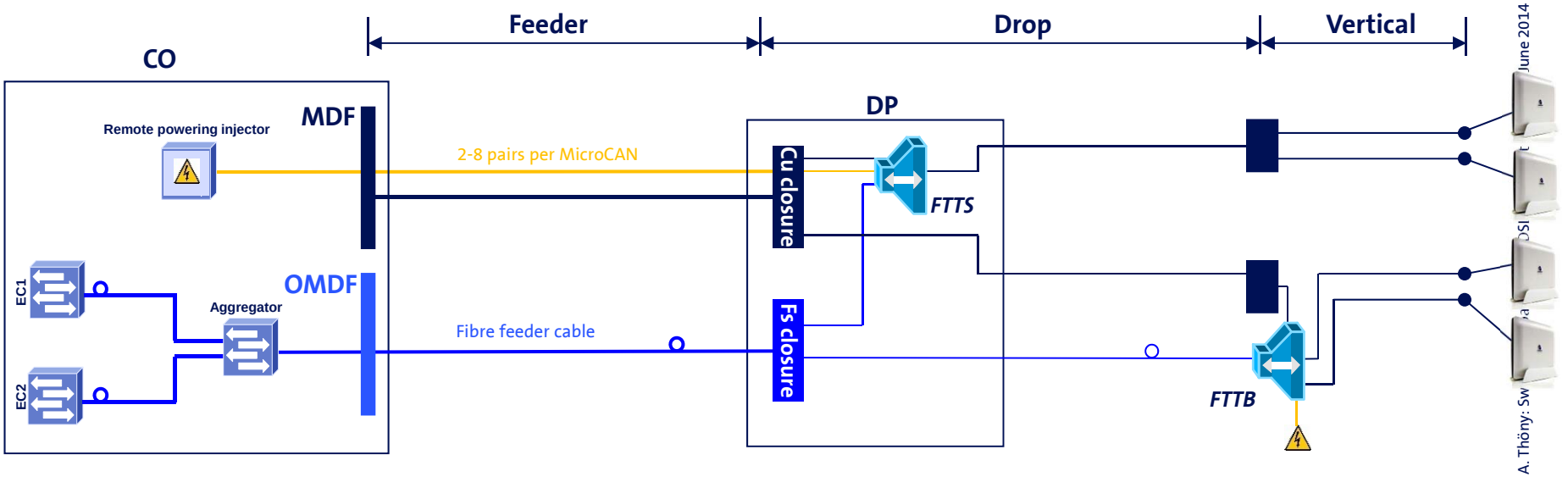
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FTTS/ B

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FTTS/FTTB

Network architecture



- Design distance for FTTS <220m (90%), max 1300m
  - The number of MicroCANs with loops >400m should be minimized
- 48 and 16 port MicroCANs
- Max 2 MicroCANs per manhole (distribution point DP) → condition: separate cables per MicroCAN (due to vectoring)
- Remote power feeding from CO (RFT-V with ±190VDC): up to 8 pairs per MicroCAN
- Fibre feeder dimensioned for future upgrade to FTTH (xPON)

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Key features of the FTTS MicroCAN

Delivering high performance in a harsh environment

FTTS MicroCAN:
- 48 ports/16 ports variants
- Small dimensions to fit in manholes

« **salt waterproof** » & **gas** environment (the box should never be opened by Swisscom→ replacement of the whole box)

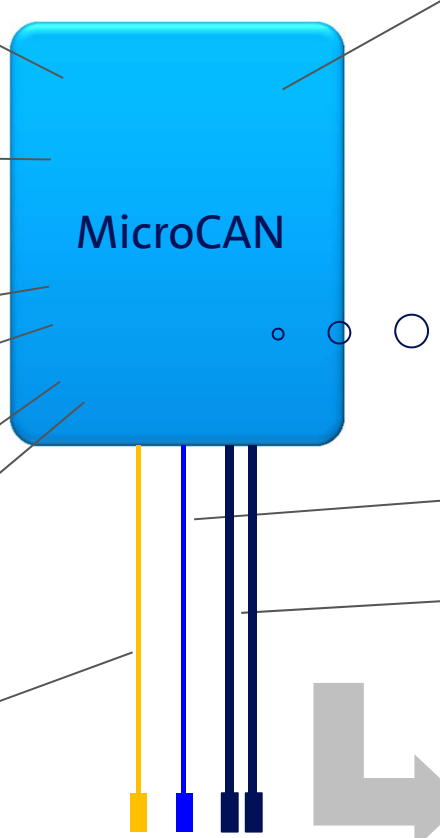
vibration tolerance

heat dissipation without fan
(-40 +70°C)

lightning protection

grounding

Power cable: RFT-V ±190V DC
Remote power feed from the CO



- **VDSL2, 17a, vectoring → future version with G.fast**
- **Long lifetime, high MTBF**
- Relay (**unbundling support**)
- Universal splitter (POTS & ISDN CPE support)

Process and IT for build / fulfillment / assurance

Fibre cable to central office

2 copper cables:
1. CO direction
2. Customer direction

Swisscom manhole



AC powered MicroCAN variant for FTTB

waterproof connectors for quick exchange

Manholes





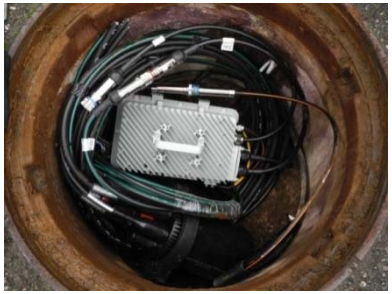
Manhole half filled with water



Manhole with 2 MicroCANs

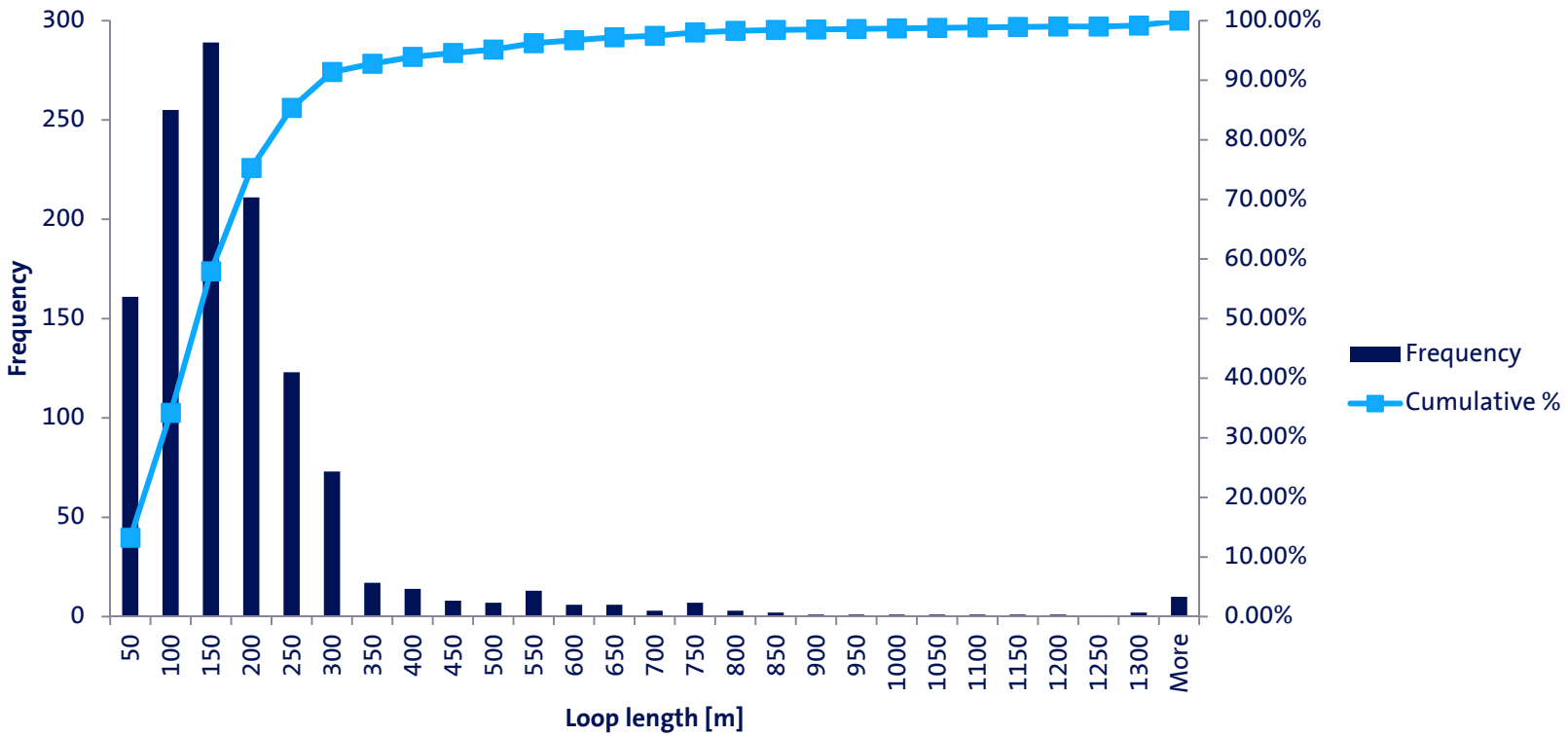


Test with MicroCAN in control chamber



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Drop loop length distribution



- Copper lengths in the figure above are from the manhole (DP) to the building
  → an additional copper segment for the in-house part needs to be added (ca. 30m)
- Mostly 0.6mm cable is used in the drop section

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G.fast

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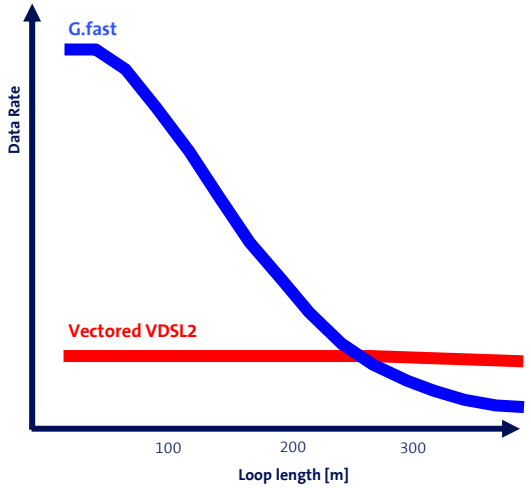
The high speed, next generation copper based access technology

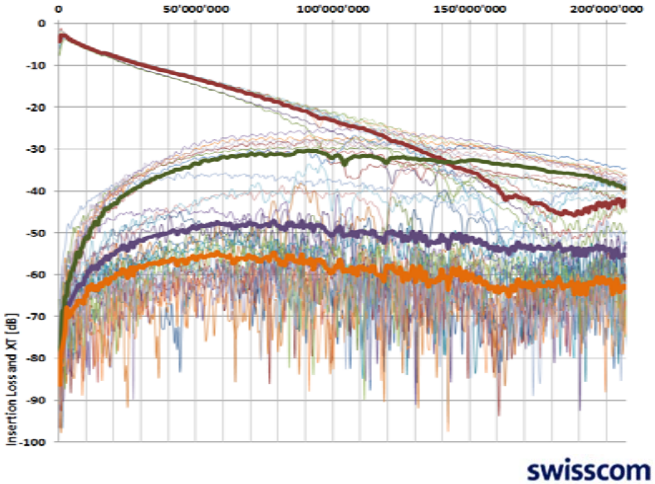
Core idea

- G.fast is the crucial next technological variant of FTTS/B
- Swisscom's goal is to deploy G.fast based MicroCANs instead of vectored VDSL2 MicroCANs from 2016 on
- a VDSL2 MicroCAN must be 1:1 replaceable by a G.fast MicroCAN
- G.fast technology: Short range, high bandwidth, high bit rate

Challenges

- Support of loops >250m (up to 400m) to cope with Swisscom's network architecture
- Node size: Vectoring across 48 ports
- VDSL2 backward compatibility to enable smooth migration
- Paper insulated cables have higher attenuation and higher crosstalk at high frequencies
- Timing (standard delay, chip and product availability)

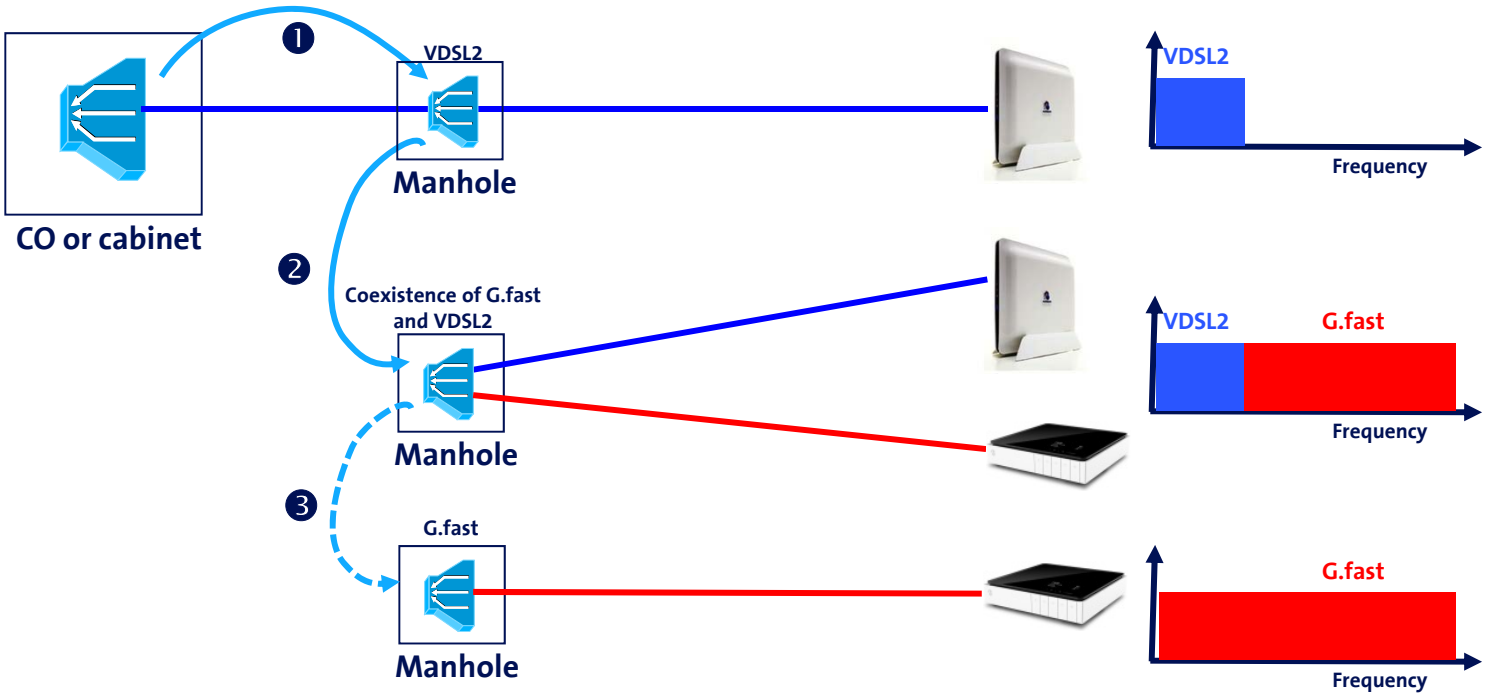




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Evolution from VDSL2 to G.fast

Exchange of the VDSL2 MicroCAN with a G.fast MicroCAN



Migration steps:

1. Install MicroCAN and shorten the line → FTTS with VDSL2 (VDSL2 MicroCAN)
   - Enabling of vectoring on the MicroCAN
2. Exchange MicroCAN (VDSL2 box → G.fast box) (starting in 2016)
   - VDSL2 / G.fast coexistence mode (G.fast only above 17a)
   - service-driven CPE migration
3. Complete migration to G.fast → pure G.fast
   (G.fast starting at 2.2MHz in order to achieve an additional 100 Mbps in performance)
   - Except for MicroCANs with loops >400m which would remain in dual mode

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Technical requirements on G.fast

Dictated by the characteristics of Swisscom's copper access network and the expected customer needs

- net data rate expectations on 0.6mm cable:

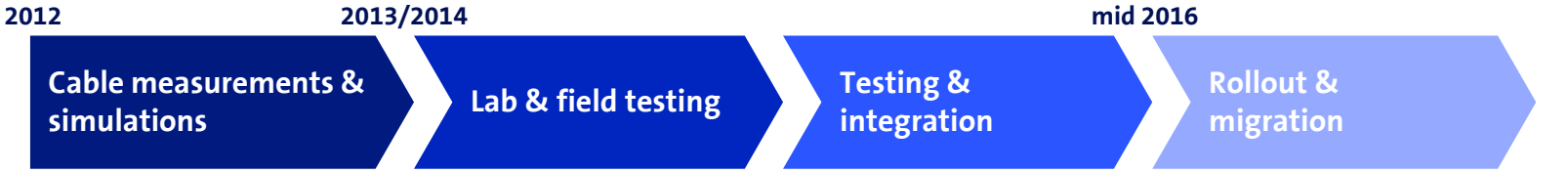
Loop length	Vectored VDSL2 (17a) mode on G.fast port (DS/US)	G.fast with VDSL2 coexistence (>17MHz) (aggregated DS+US)	G.fast only (full spectrum for G.fast) (aggregated DS+US)
100m	115/25 Mbps	580 Mbps	700 Mbps
200m	115/25 Mbps	280 Mbps	380 Mbps
400m	95/22 Mbps	40 Mbps	140 Mbps
800m	45/17 Mbps	n/a	n/a
1300m	22/3 Mbps	n/a	n/a

- G.fast/VDSL2 (17a) dual-mode ports with vectoring support on G.fast and VDSL2
- Node size: 16 and 48 ports, including vectoring across all ports
- Physical requirements are the same as for the first generation VDSL2 MicroCANs:
  - Same connectors
  - Same physical size limits, same mounting
  - Same environmental conditions
  - Same power consumption limit (to support remote powering with the same number of pairs; no reverse powering required)

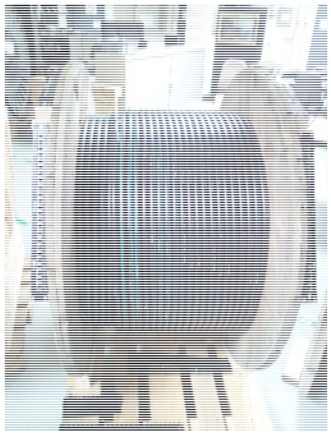
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Path forward with G.fast

From theory to rollout







- Cable measurements
- Simulations
- FPGA based prototype lab testing ← we are here
- Chip based prototype lab testing
- Chip based prototype field testing
  → proof of concept
- Product testing (factory acceptance test, interoperability) and network integration (IT)
- Pilot (with final HW, SW to rollout, including IT and processes)
- Rollout

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Thank you!