



45th Congress
30 Aug - 2 Sept
2006 Athens

Estimation of the achievable DSL service



TELECOM WARS: The Return Of The Profit



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Overview



- Cable



- Wireless



- Power lines



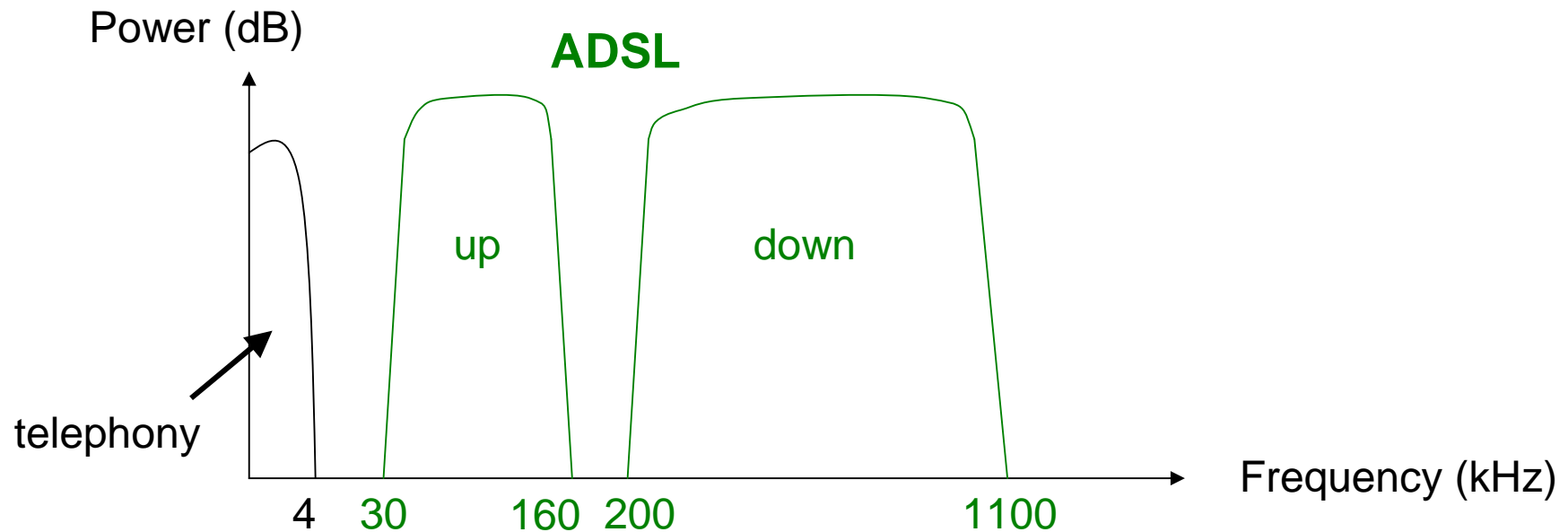
- Copper telephone network (DSL)





xDSL services

- Copper telephone network → 4kHz
- ADSL → Higher frequencies





xDSL services (cntd.)

☺ xDSL

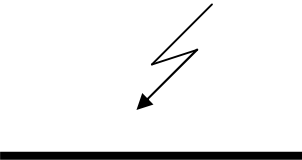




- *HDSL, SDSL*
- *ADSL, ADSL2, ADSL2+*
- *VDSL, VDSL2*

☹ Impairments

- *Is the line suitable? Channel capacity?*
- *Loop Qualification*



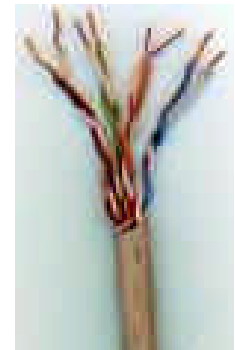
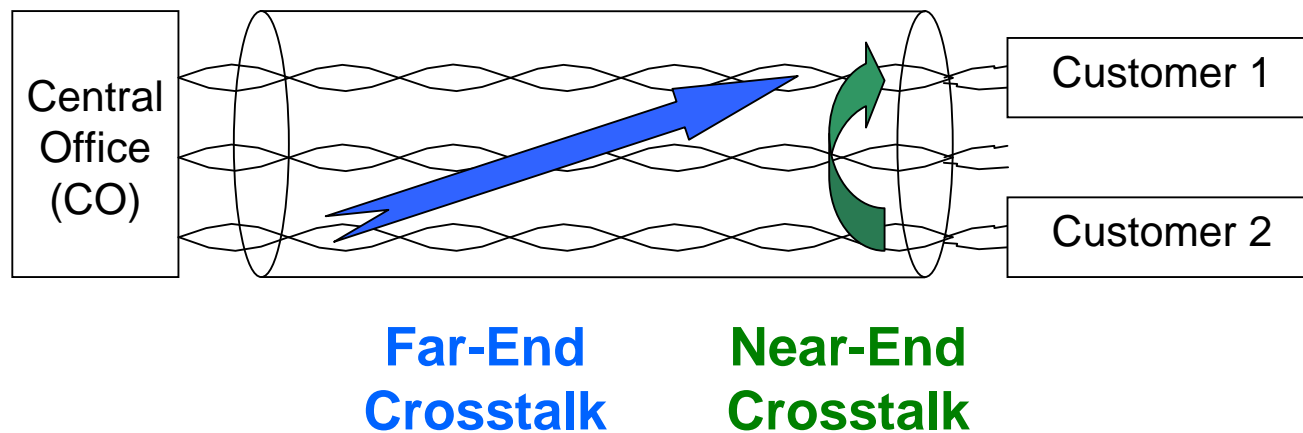
Impairments

- Noise 
- Line length 
- Gauge change 
- Tap 
- Load coil 



Impairment: noise

- Classical noise sources
- Crosstalk

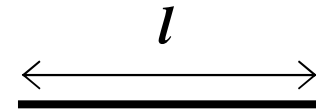


→ Errors, influence on SNR



Impairment: line length

- Transfer function



$$TF \div e^{-\gamma l}$$

$\gamma = \text{propagation function}$

$$TF \div e^{-(\alpha + j\beta)l}$$

$$TF \div e^{-\alpha l} \cdot e^{-j\beta l}$$

Phase distortion

Attenuation : fct(l)

fct(f) because $\alpha(f)$

→ Constraints max. length

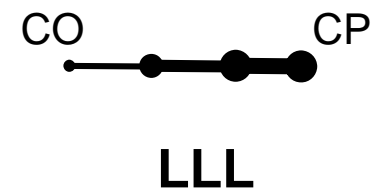
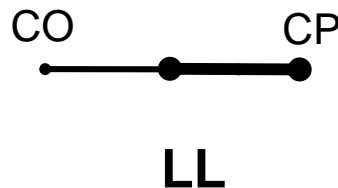
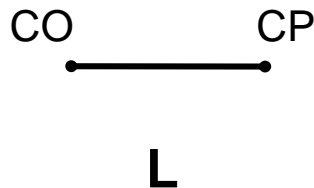


Impairment: gauge change

- Wire diameter
 - 0.4 mm, 0.6 mm, ...
 - Loop resistance ↓ with ↑ diameter

- Consequence:

cascade of line segments with ↑ diameter

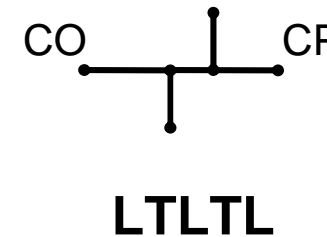
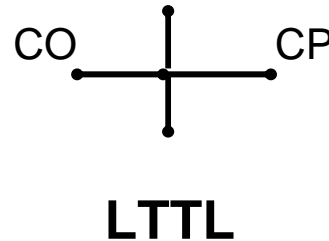
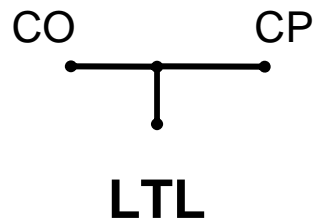


→ Reflections at junctions

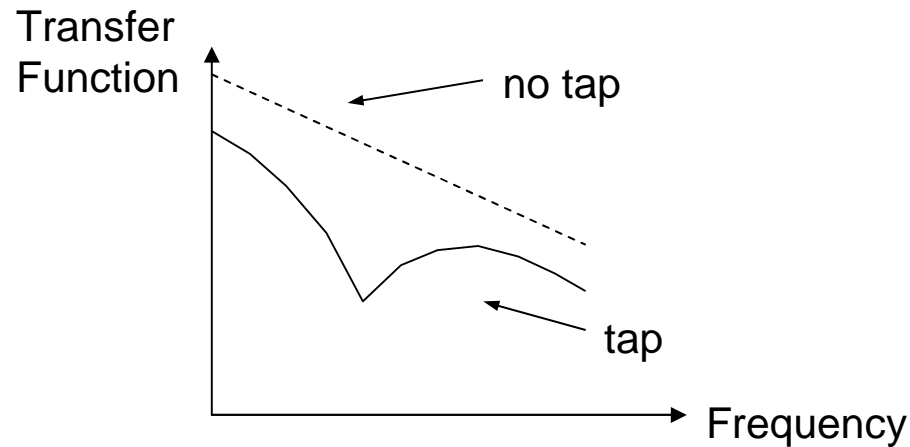


Impairment: tap

- Taps



- Interference



→ Certain frequency bands unusable



Impairment: load coil

- Why?
 - *Improve the voice transmission*
- How?
 - *Place coils at regular intervals*
 - *Improves LF transmission*









→ **High frequencies highly attenuated**

→ Must be removed for xDSL



Impairments

- Noise   → Errors, SNR
- Line length  → Maximum length
- Gauge change  → Reflections
- Tap  → Usable freq-band
- Load coil  → Must be removed!

→ *Loop Qualification*



Loop Qualification

- Records → incomplete, inaccurate
- Measurements
 - *Dual Ended Line Testing (DELT)*
 - *Single Ended Line Testing (SELT)*

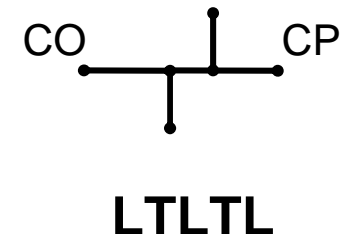
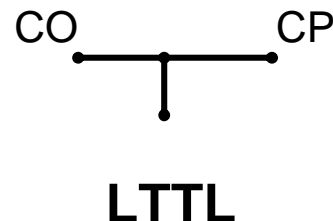
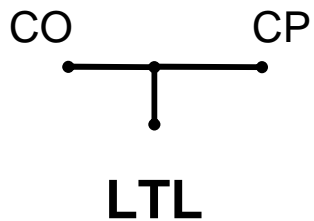
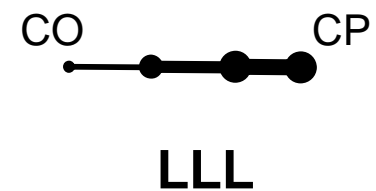
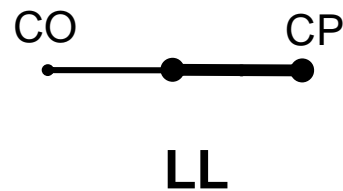
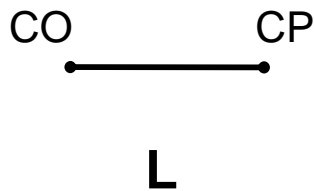
Channel capacity

- *Transfer function*
- *Noise environment*



Loop Qualification with SELT

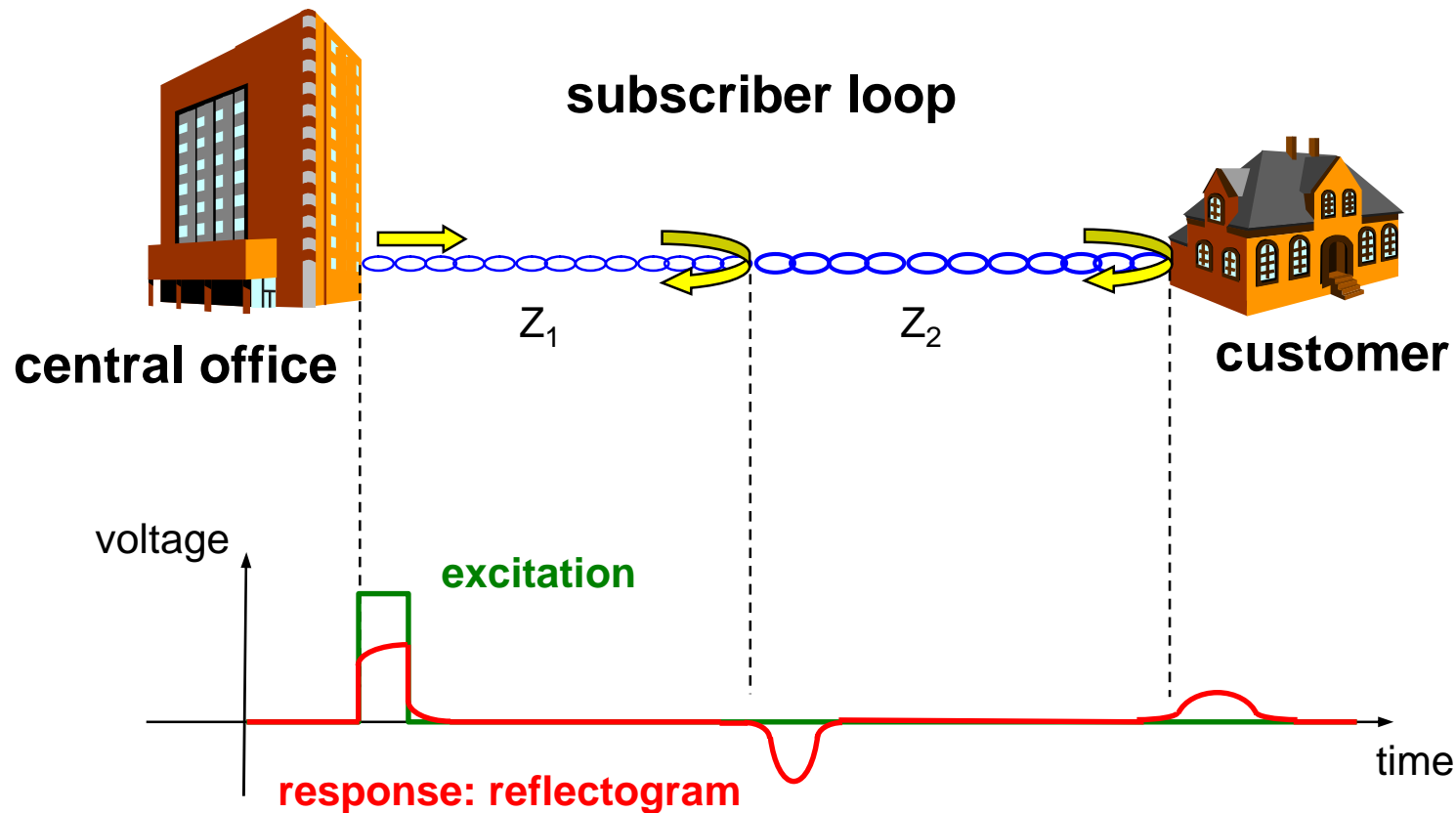
- Loop qualification
 - Loop identification (transfer function)



- Noise estimation

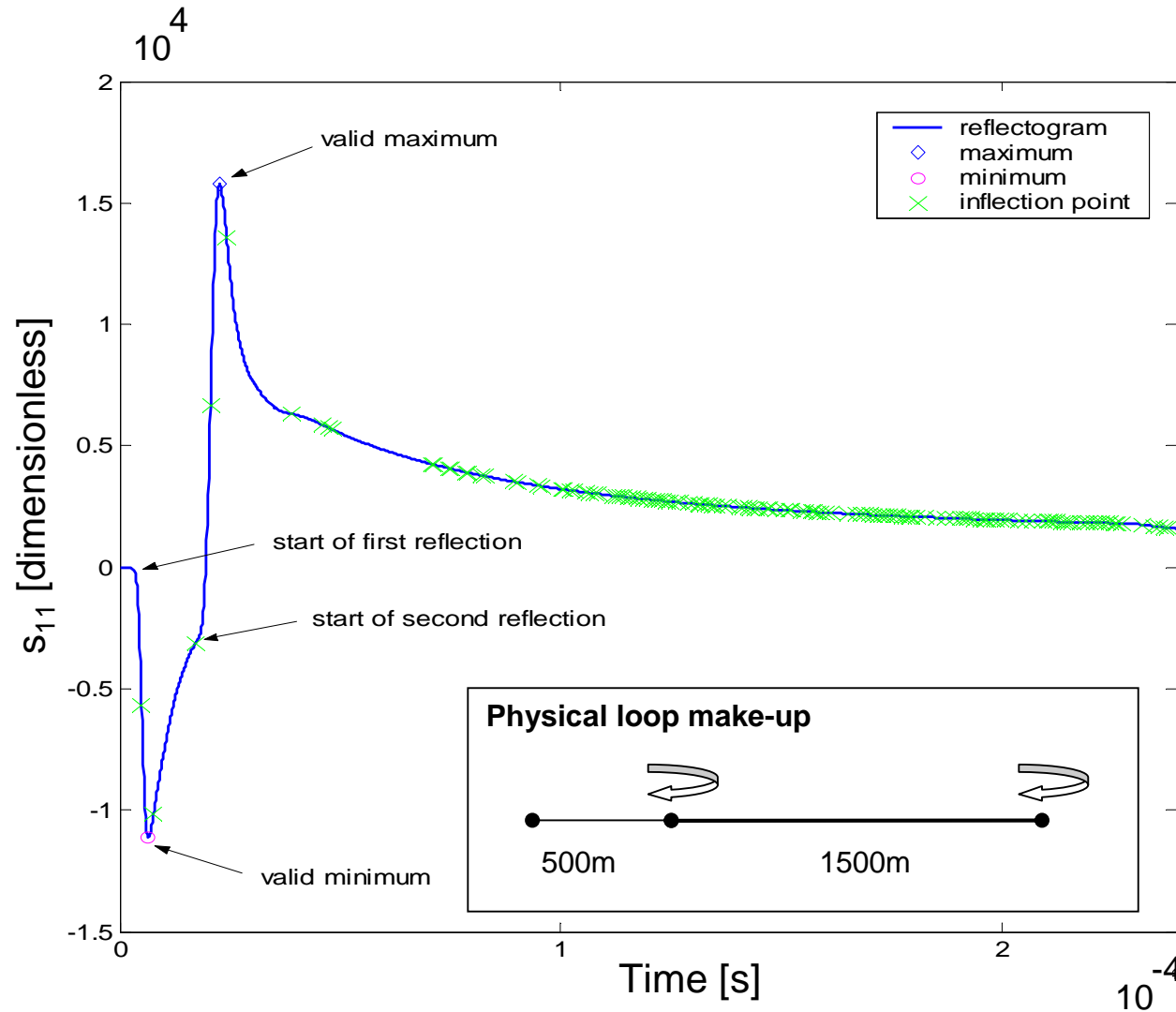


Time Domain Reflectometry





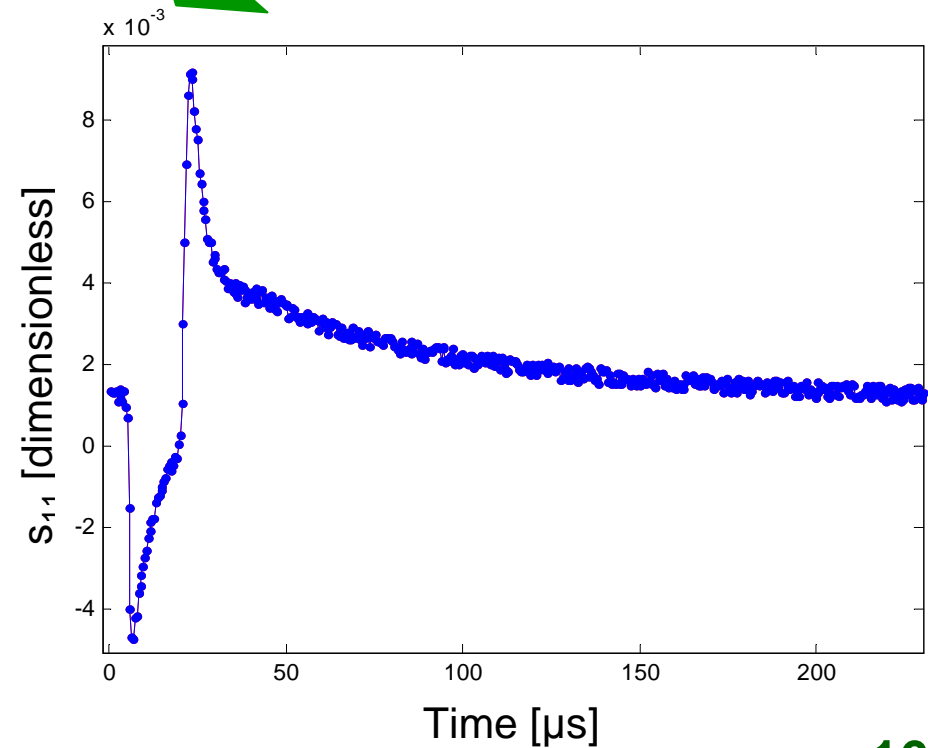
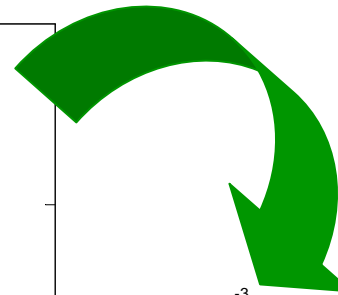
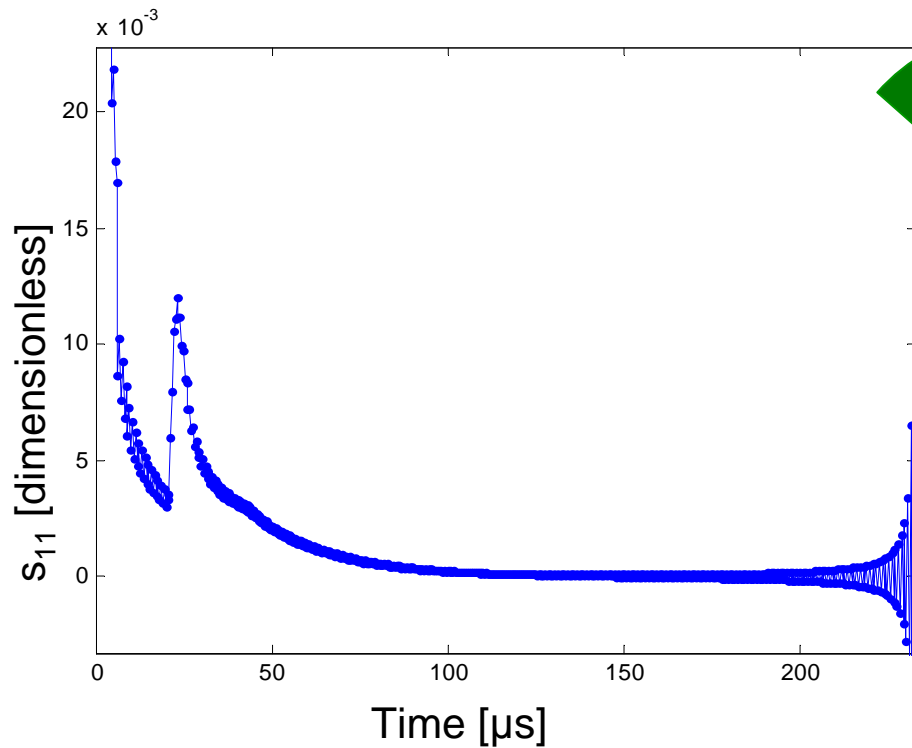
Approach



$$l = \frac{v \cdot \Delta t}{2}$$



Difficulty: pre-processing





Difficulty: reasoning system

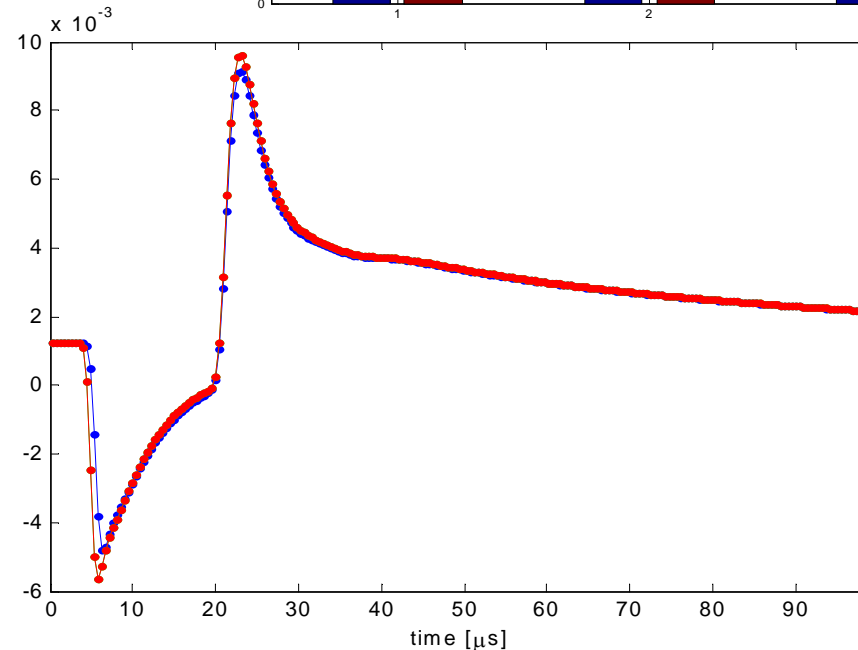
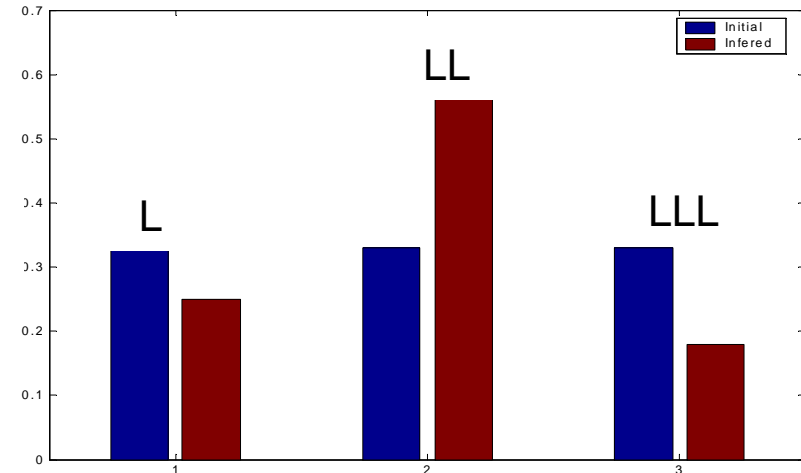
→ Find topology

$$P(T|F) = \frac{P(F|T) \cdot P(T)}{P(F)}$$

- F : Feature

- T : Topology

→ Find lengths
optimization





Application 1: Estimation of the achievable xDSL service

- Make-up of the subscriber loop
- Accurate knowledge of the network = *valuable asset* for the operators

→ *Deployment VDSL*

→ *More personal approach*



Application 2: Updating records

- Incomplete or missing records
- Testing on regular base
 - complete & up-to-date records

→ *Easier maintenance & administration*

→ *Better customer service (e.g. troubleshooting)*



Application 3 : Quality control tool

- Liberalization of telecom markets in Europe
 - *shared network infrastructure*
 - Service providers leasing lines
 - *only access at certain points*
- *Quality control tool*



Conclusion

- xDSL
 - ☺ *Wide deployment*
 - ☹ *Impairments*
 - Line qualification
 - *Necessity*
 - *Preferably with SELT*
 - Perform all *measurements and identification* from central office
- New applications