SmartClass ADSL/Copper Combo Kickstart Training

Customer Name

Presenters Name

Place

Date

Version 3.0

Welcome!

At the end of this training you will:

- **Be familiar with the use of the SmartClass ADSL Copper Combo**

- **Be able to troubleshoot and analyze ADSL2+, IP and Copper related problems**

Dag Hauge – JDSU Nordic

Training Course Highlights

- **DSL Fundamentals**

- **Instrument Features and Capabilities**

- **Instrument Quick Tour and Setup**

- **ADSL and Copper testing**

- **Configuring Tests**

- **Interpreting Test Results**

- **Documenting Test Results**
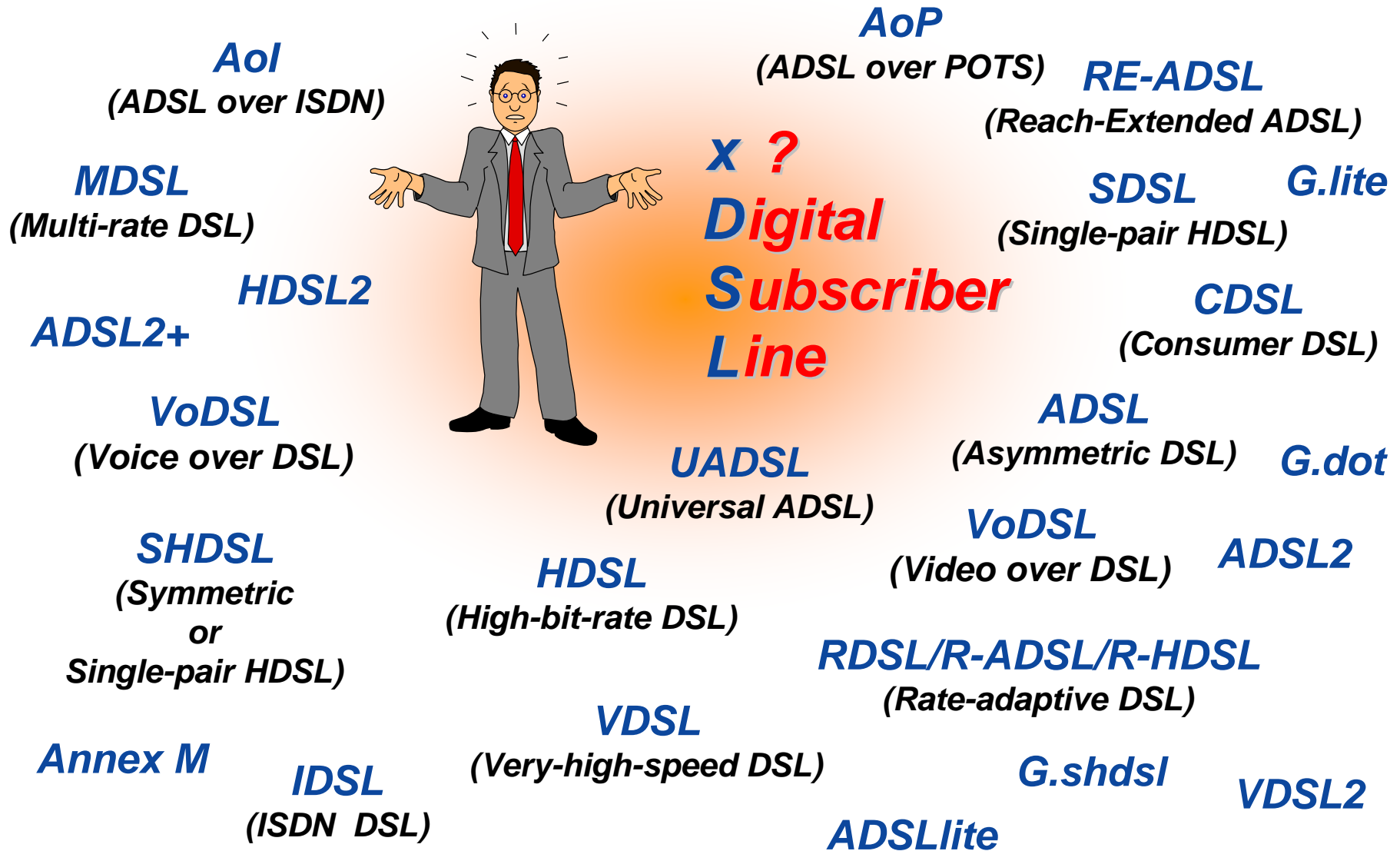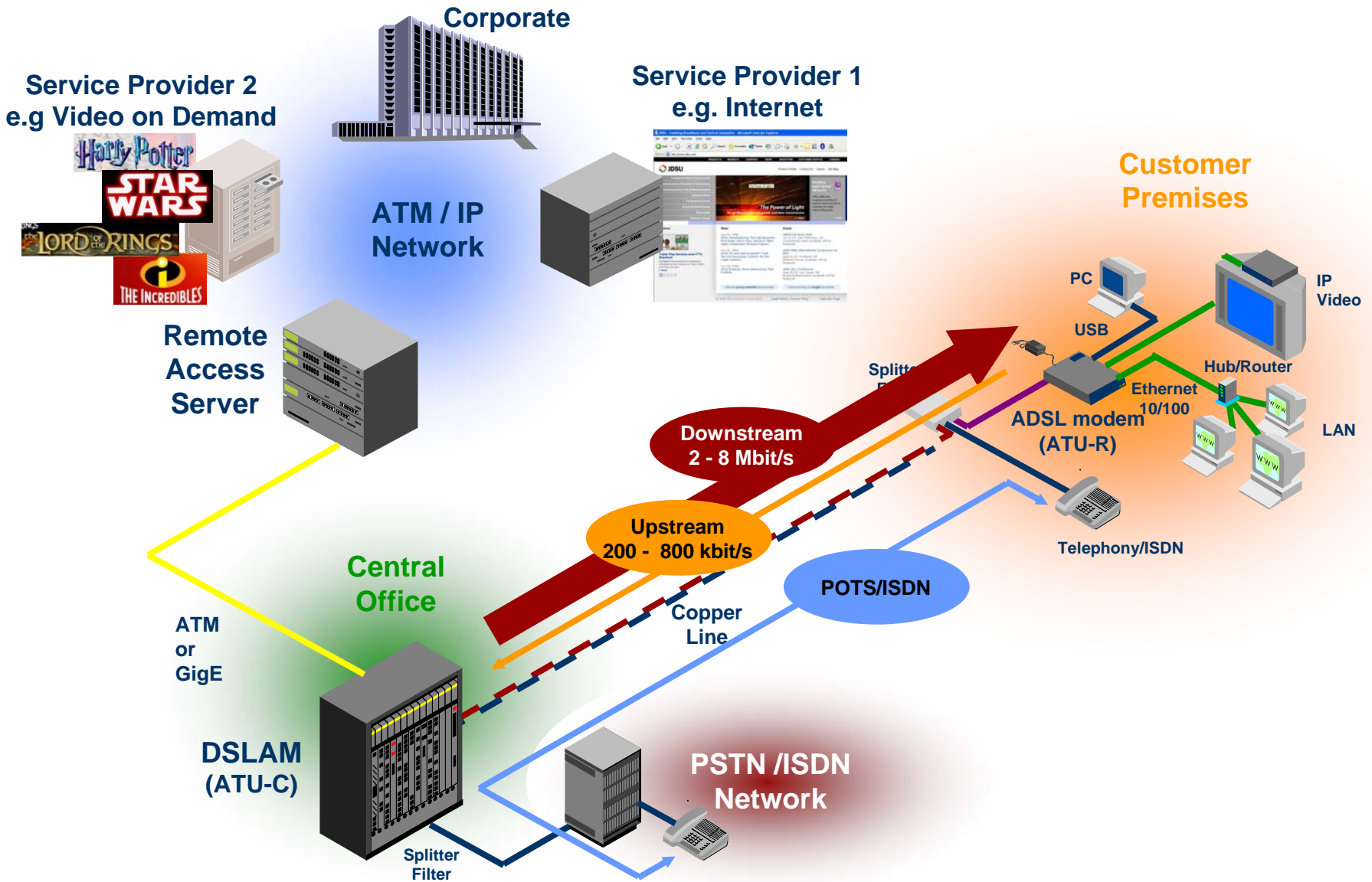
Dag Hauge – JDSU Nordic

SmartClass ADSL

DSL Fundamentals

 Dag Hauge – JDSU Nordic

The xDSL Jungle

AoP
(ADSL over POTS)

AoI
(ADSL over ISDN)

RE-ADSL
(Reach-Extended ADSL)

MDSL
(Multi-rate DSL)

x ?
Digital
Subscriber
Line

SDSL
(Single-pair HDSL)

G.lite

HDSL2

ADSL2+

CDSL
(Consumer DSL)

VoDSL
(Voice over DSL)

UADSL
(Universal ADSL)

ADSL
(Asymmetric DSL)

G.dot

SHDSL
(Symmetric
or
Single-pair HDSL)

HDSL
(High-bit-rate DSL)

VoDSL
(Video over DSL)

ADSL2

RDSL/R-ADSL/R-HDSL
(Rate-adaptive DSL)

Annex M

IDSL
(ISDN DSL)

VDSL
(Very-high-speed DSL)

G.shdsl

VDSL2

ADSLlite

Dag Hauge – JDSU Nordic

JDSU

ADSL in the Network

Corporate

**Service Provider 2
e.g Video on Demand**

**Service Provider 1
e.g. Internet**

**ATM / IP
Network**

**Customer
Premises**

**Remote
Access
Server**

PC

IP
Video

USB

Hub/Router

Splitter
Filter

Ethernet
10/100

LAN

**ADSL modem
(ATU-R)**

**Downstream
2 - 8 Mbit/s**

**Upstream
200 - 800 kbit/s**

**Central
Office**

Telephony/ISDN

POTS/ISDN

**ATM
or
GigE**

**Copper
Line**

**DSLAM
(ATU-C)**

**PSTN /ISDN
Network**

**Splitter
Filter**

Dag Hauge – JDSU Nordic

JDSU

ADSL and DMT (Discrete Multi Tone)
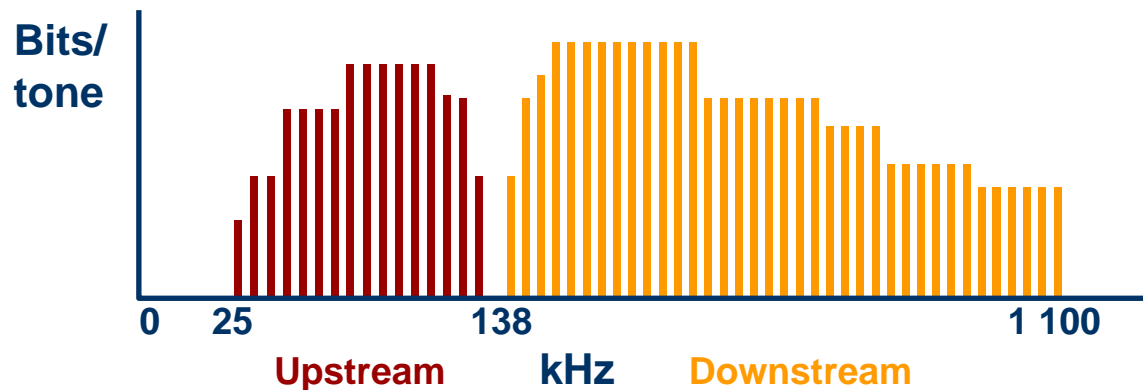
- **Worldwide standard line code for ADSL**
- **Wideband variable spectrum signal**
- **Bit swapping helps to adapt to loop problems**
- **Maintains BER $<10^{-7}$**
- **Many ways of carrying IP over ATM**

- **256 Carrier tones (512 for ADSL2+)**
- **Each tone carries a QAM signal**
- **4.3125 kHz/tone**
- **4096 baud/tone**
- **Up to 15 bits/Baud (bits/tone)**
- **0 to 61.440 bits/second/tone**

Dag Hauge – JDSU Nordic

Signal to Noise Ratio (SNR) and DMT

Bits per tone

Frequency

40 kHz   1.1 MHz

Dag Hauge – JDSU Nordic

JDSU
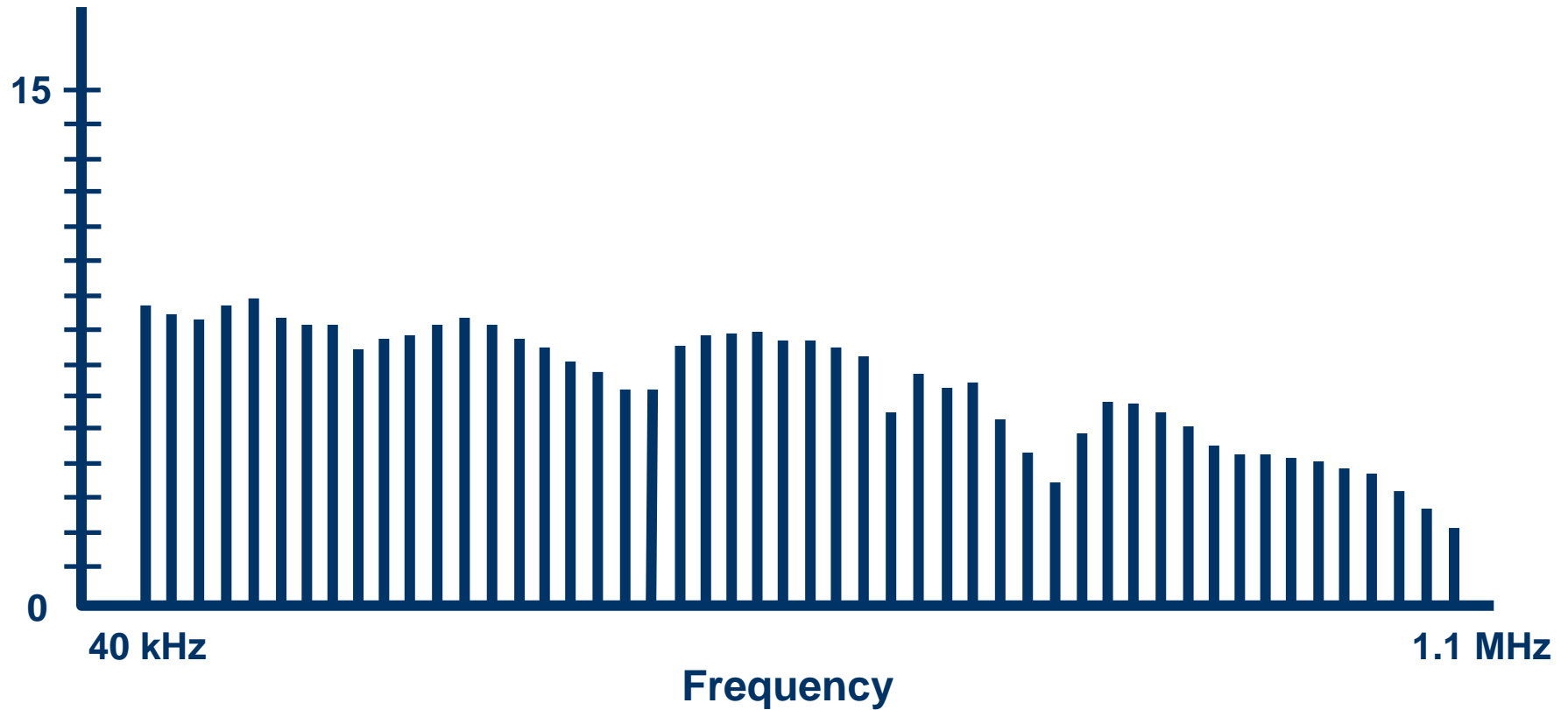
Fast or Interleaved Transmission Mode (1)

Fast	Interleaved
Corrects small errors bursts	**Corrects large error bursts**
⬇	⬇
Low latency	**High latency**
⬇	⬇ Greater Interleaving depth means greater latency
For delay sensitive, but not error rate sensitive applications	*For error rate sensitive, but not delay sensitive applications*

Explain Interleaving

Dag Hauge – JDSU Nordic

JDSU

Fast or Interleaved Transmission Mode (2)

- **Interleaving allows impulse hits to be corrected**
- **Greater Interleaving depth means greater latency**
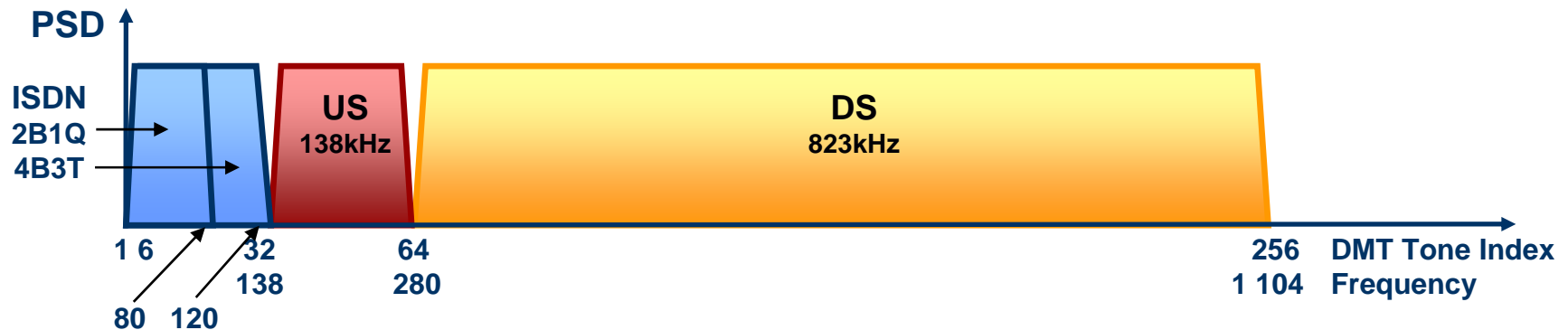- **Impulse hits are spread out so that the FEC can correct**

Dag Hauge – JDSU Nordic
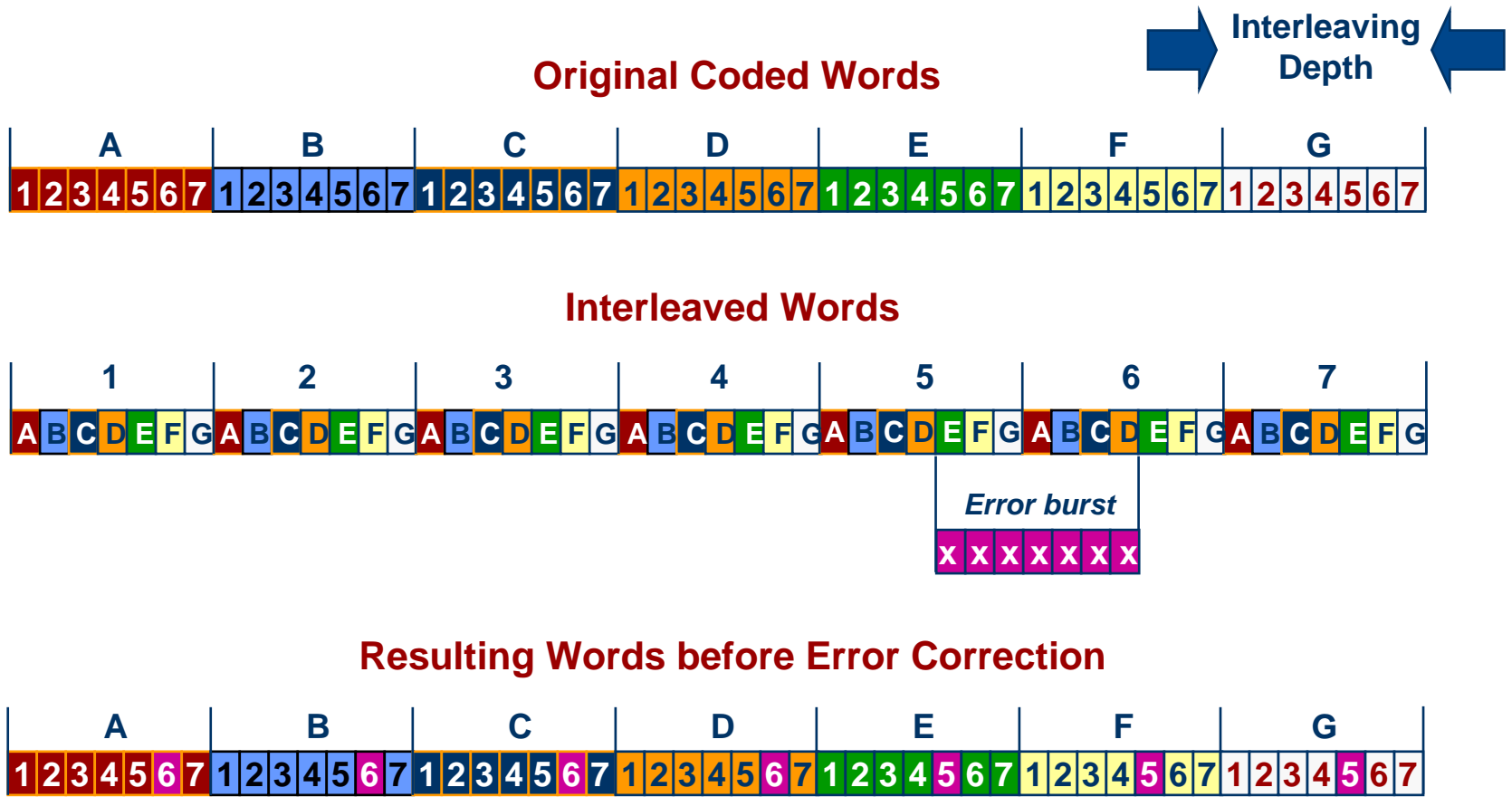
ADSL over POTS vs. ADSL over ISDN

ITU-T G.992.1 Annex A vs. Annex B

ITU-T G.992.1 Annex A, AoPOTS, Non-overlapped spectrum (FDM)
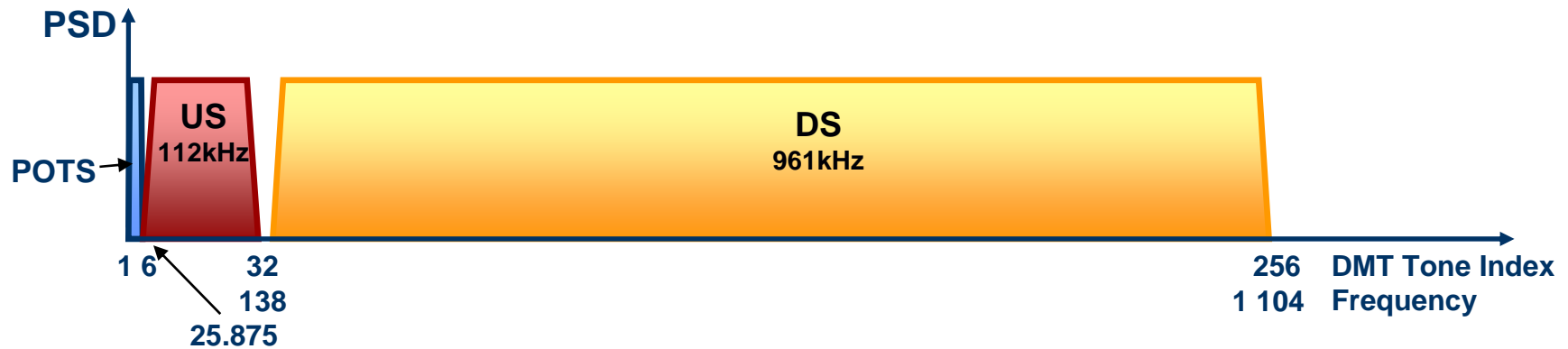
ITU-T G.992.1 Annex B, AoISDN, Non-overlapped spectrum (FDM)
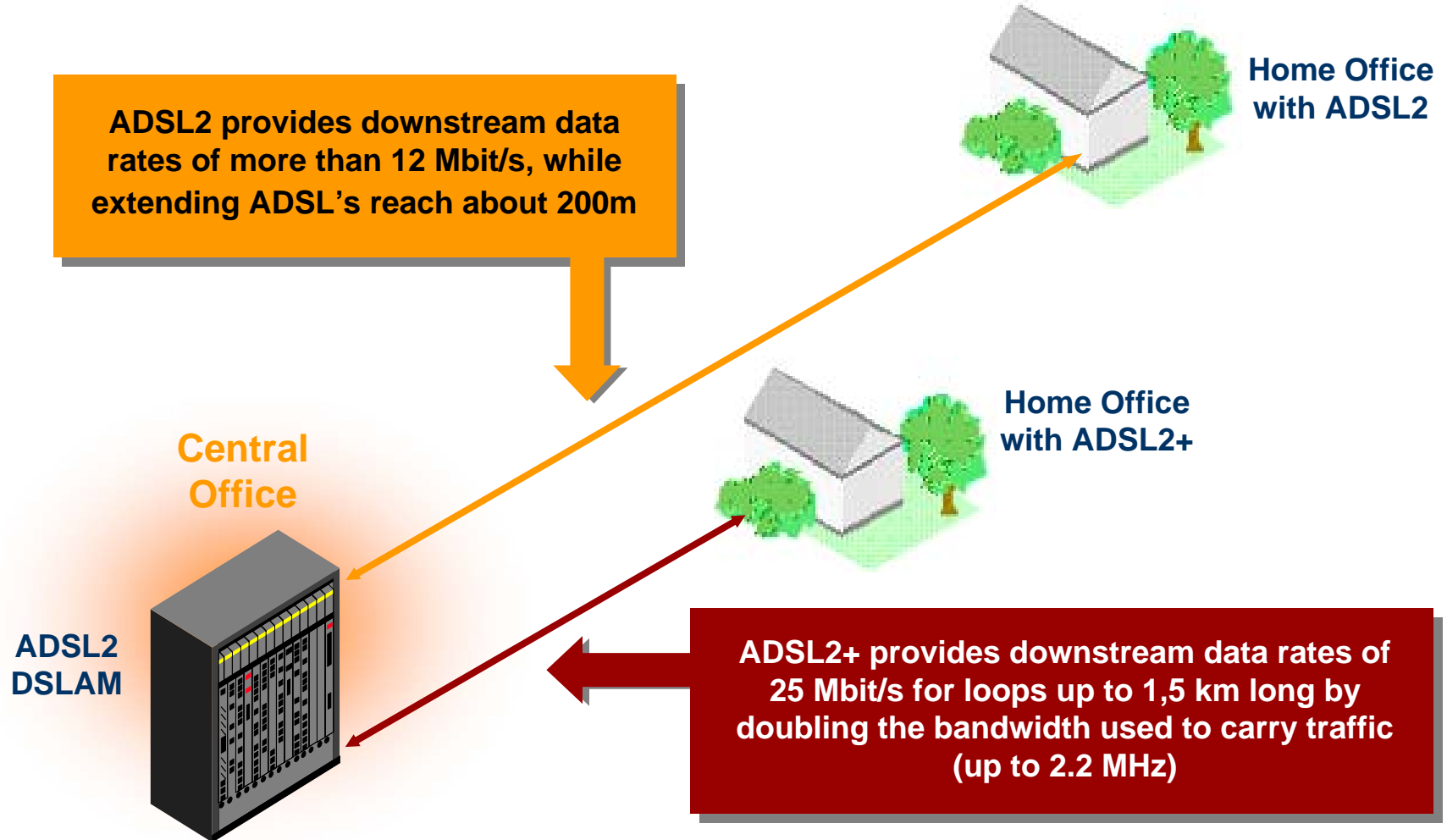
Dag Hauge – JDSU Nordic

ADSL2 and ADSL2+

- **New modem technology made in two parts; ADSL2 and ADSL2+**

- **ITU-T: G.992.3 (ADSL2), G.992.4 (ADSL2lite), G.992.5 (ADSL2+)**

- **Builds on all previous ADSL work and is backward compatible**

- **New modem chips and designs (hardware and software) required for test support**

- **Features additions:**
  - **Much improved reach and significant increase in data rates**
  - **IMUX supported (typically up to 4 lines in CPE)**
  - **New power modes that reduce power consumption and cross talk**
  - **New diagnostic information available from ATU-R**
  - **Supports Channelized Voice over DSL (CVoDSL)**
  - **New spectrum management and improved noise immunity with "block-out" masks**
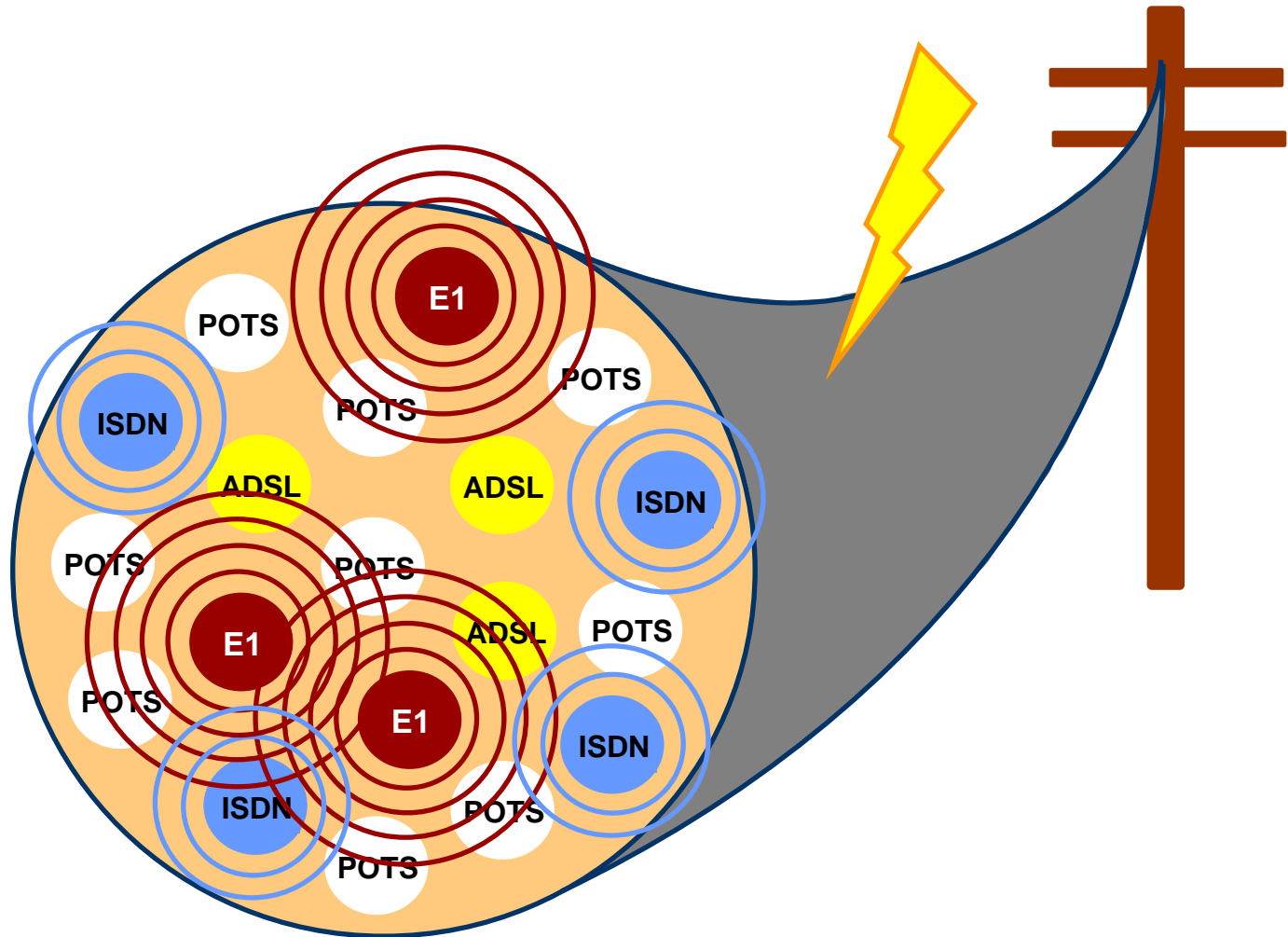
 Dag Hauge – JDSU Nordic

ADSL2 and ADSL2+

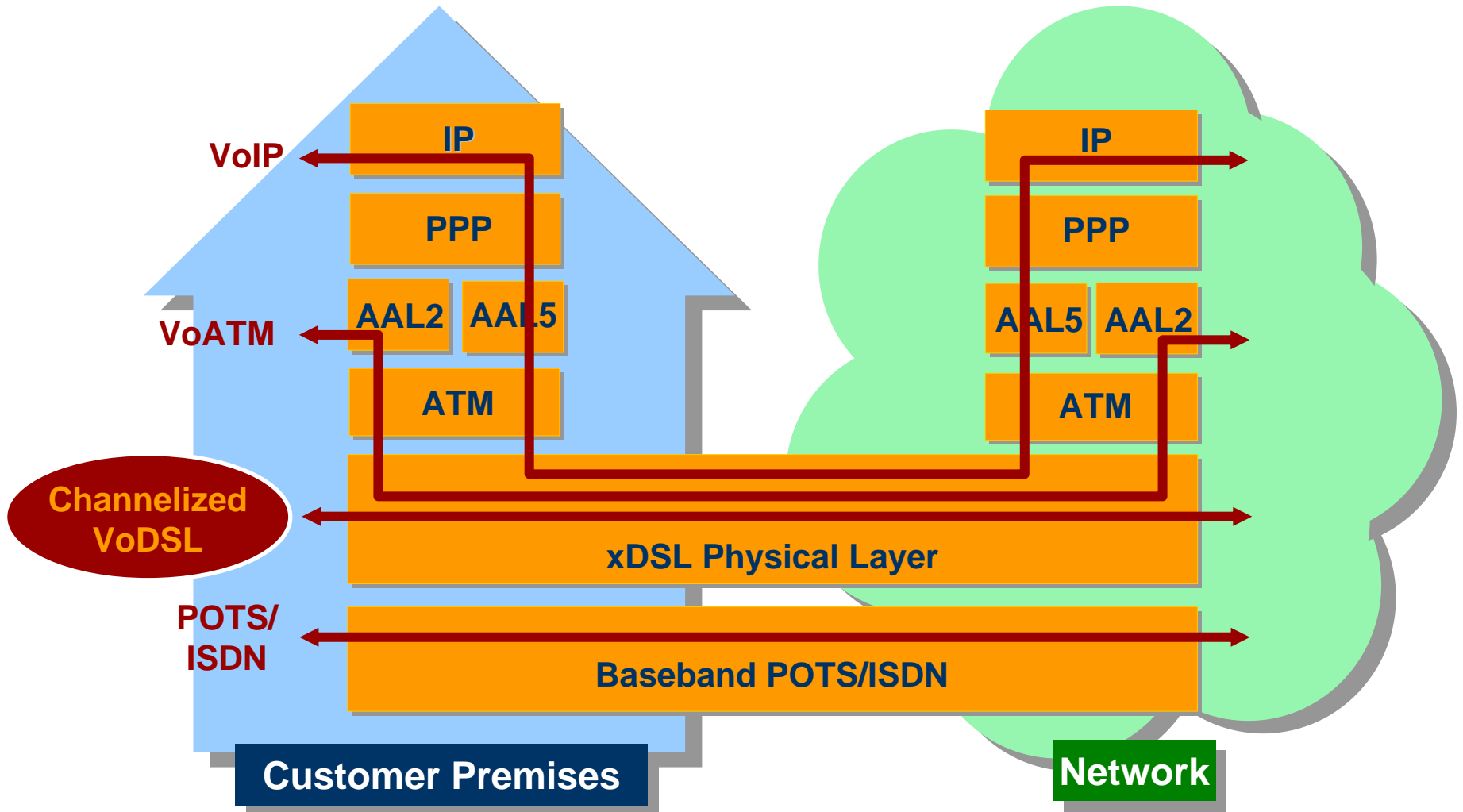**The ADSL2 and ADSL2+ standards improve on the original ADSL by offering higher downstream data rates and longer reach**

Home Office with ADSL2

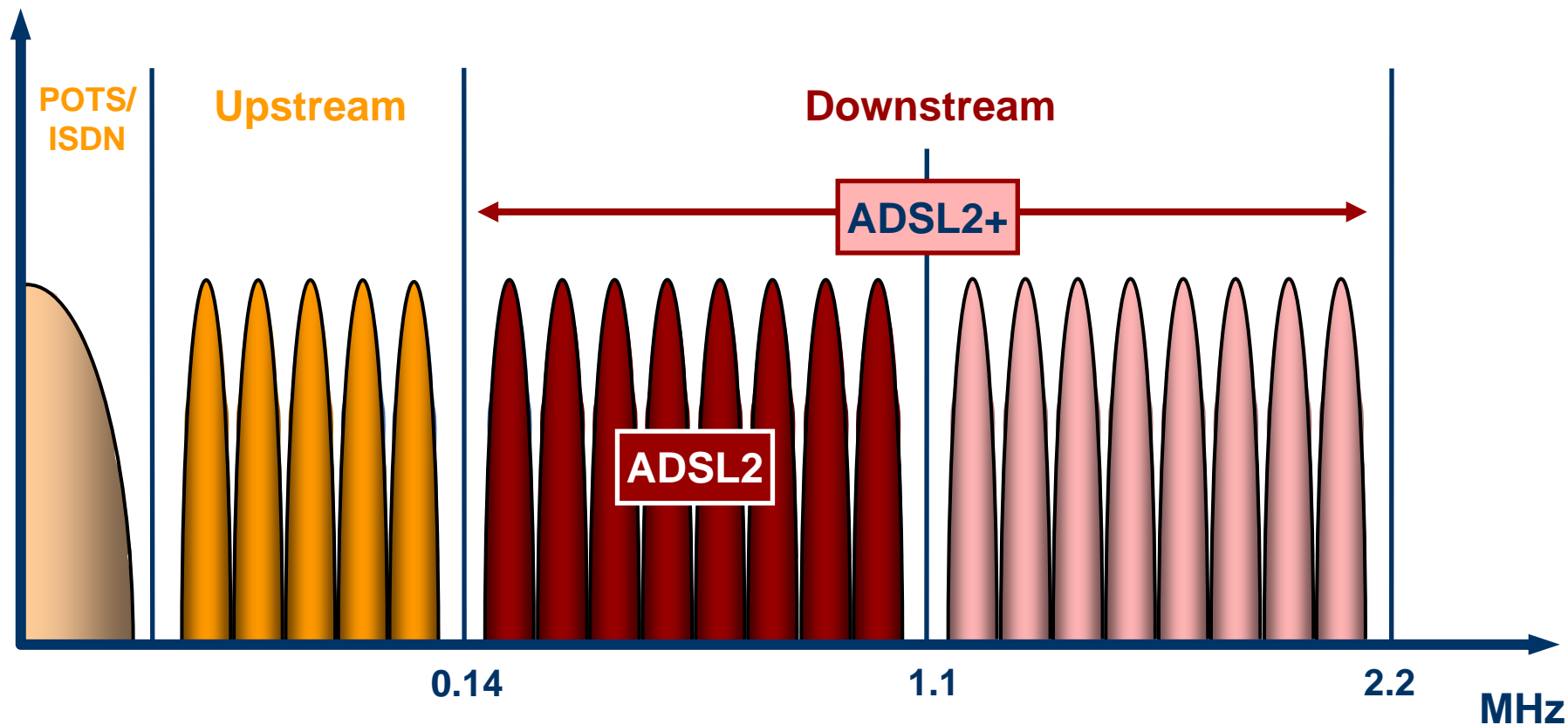ADSL2 provides downstream data rates of more than 12 Mbit/s, while extending ADSL's reach about 200m

Home Office with ADSL2+

Central Office

ADSL2 DSLAM

ADSL2+ provides downstream data rates of 25 Mbit/s for loops up to 1,5 km long by doubling the bandwidth used to carry traffic (up to 2.2 MHz)

Dag Hauge – JDSU Nordic

JDSU

ADSL2 Seamless Rate Adaptation

Addressing problems like crosstalk from adjacent copper pairs

Dag Hauge – JDSU Nordic

JDSU

CVoDSL vs. VoATM and VoIP

VoIP

VoATM

Channelized VoDSL

POTS/ ISDN

IP

PPP

AAL2   AAL5

ATM

xDSL Physical Layer

Baseband POTS/ISDN

Customer Premises

IP

PPP

AAL5   AAL2

ATM

Network

Dag Hauge – JDSU Nordic

JDSU

ADSL2+ Doubles the Downstream Bandwidth

Dag Hauge – JDSU Nordic

JDSU

ADSL Standards Annexes

ANNEX	ENVIRONMENT	USE OF TONES					APPLICABLE TO:		
		1-5	6-31	32-64	65-255	256-512	ADSL G.992.1	ADSL2 G.992.3	ADSL2+ G.992.5
A	POTS	POTS	UP	DOWN	DOWN	DOWN*	YES	YES	YES
B	ISDN	ISDN	ISDN	UP	DOWN	DOWN*	YES	YES	YES
C	TCM-ISDN	POTS	UP	DOWN	DOWN	N/A	YES	YES	YES
I (ADSL)	TCM-ISDN	POTS	UP	DOWN	DOWN	DOWN	YES	NO	NO
I (ADSL2/2+)	POTS	UP	UP	DOWN	DOWN	DOWN*	NO	YES	YES
J	ISDN	UP	UP	UP	DOWN	DOWN*	NO	YES	YES
L (RE-ADSL2)	POTS	POTS	UP**	DOWN**	DOWN**	N/A	NO	YES	NO
M (ADSL2/2+)	POTS	POTS	UP	UP	DOWN	DOWN*	NO	YES	YES

Use of the tones applies to the non-overlapped PSD masks only
* ADSL2+ only
** Not all tones are used

Dag Hauge – JDSU Nordic

ADSL2, ADSL2+ and RE-ADSL2 vs. ADSL rate and reach improvement

Dag Hauge – JDSU Nordic

JDSU

Copper Testing
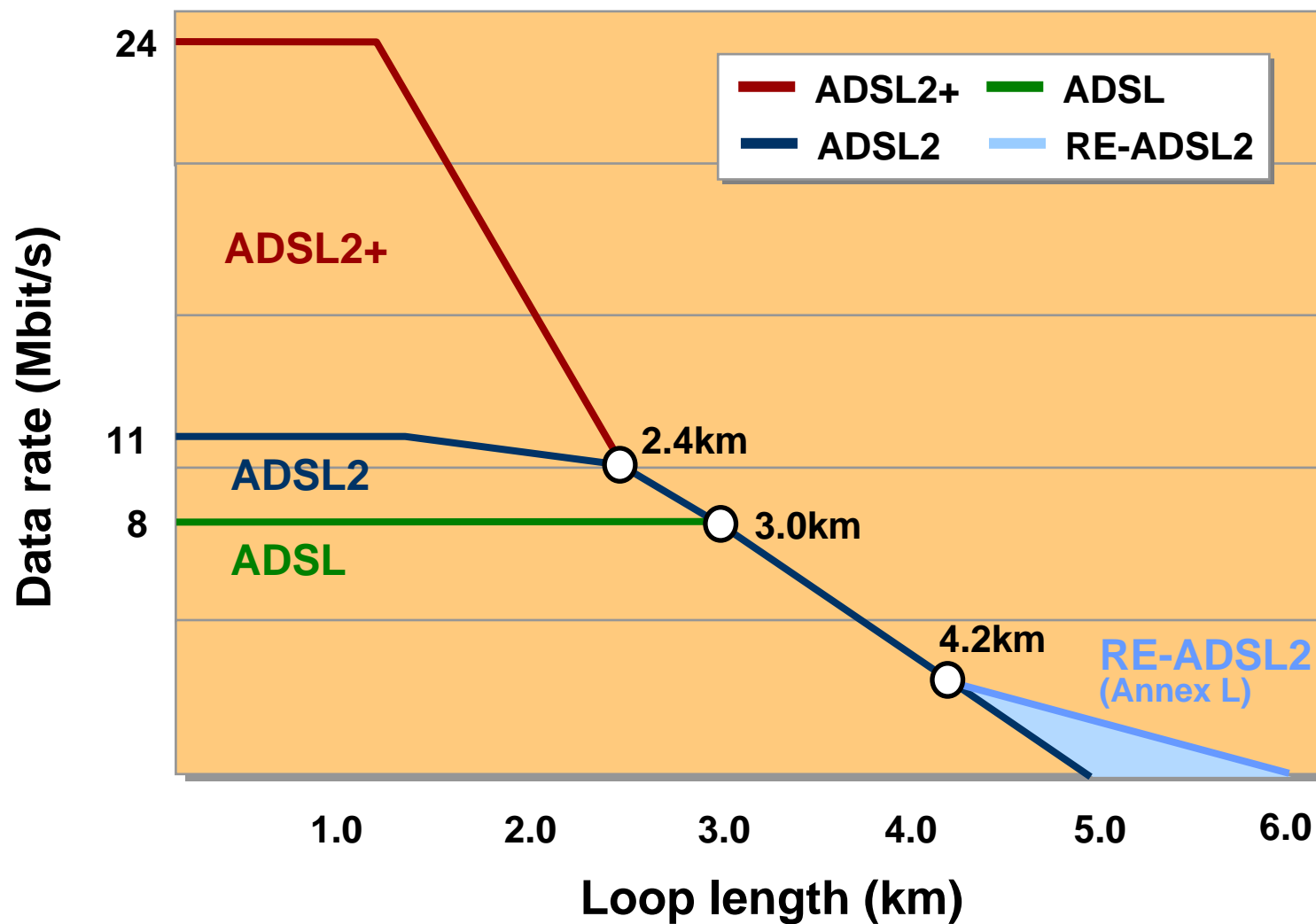
Copper Wire Characteristics

- **Resistance**

- **Capacitance**

- **Inductance**

- **Bridged Taps**

- **Bonding and Grounding**

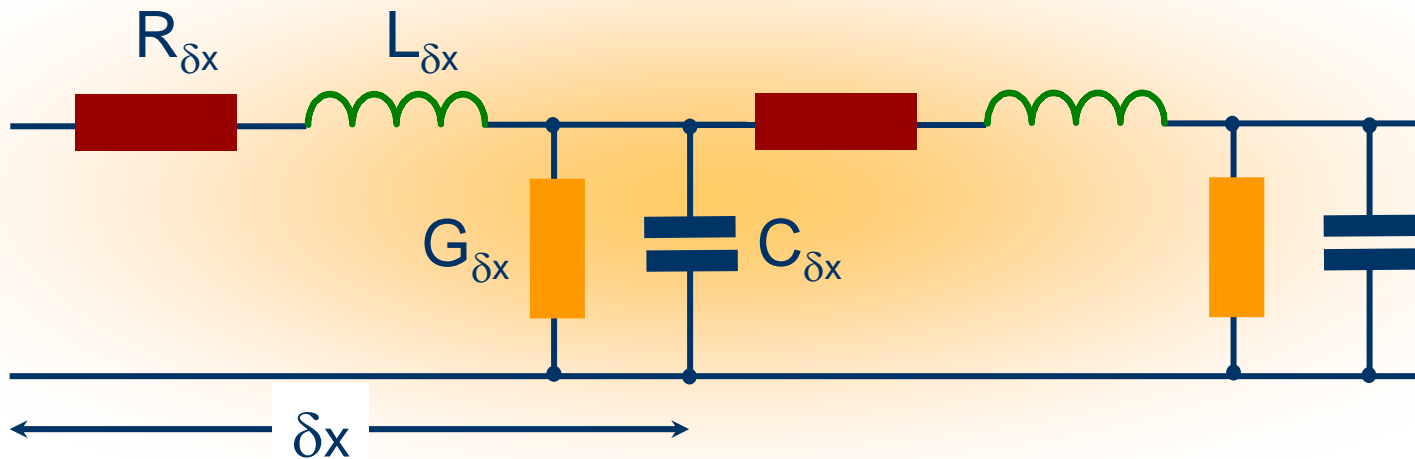**Dag Hauge – JDSU Nordic**

Copper wire characteristics

Twisted Pair Lines

Typical values per km

Capacitance: 30 to 60 nF

Resistance: 100 ohms

Inductance: 0.5 to 1 mH

Conductance: > 5M ohms

$R_{\delta x}$ $L_{\delta x}$

$G_{\delta x}$ $C_{\delta x}$

δx

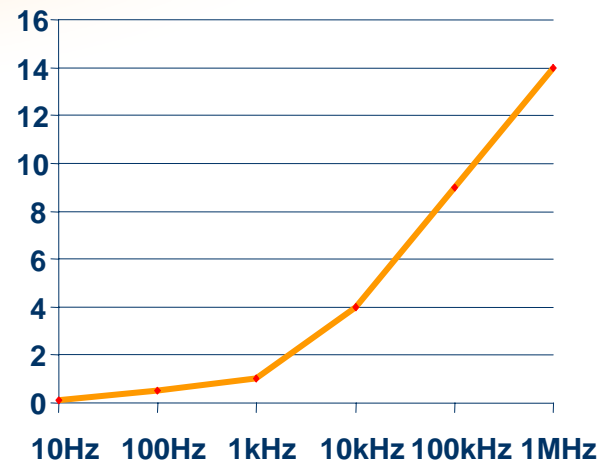**Dag Hauge – JDSU Nordic**   JDSU

Copper wire characteristics

The transmission line acts like a low-pass filter
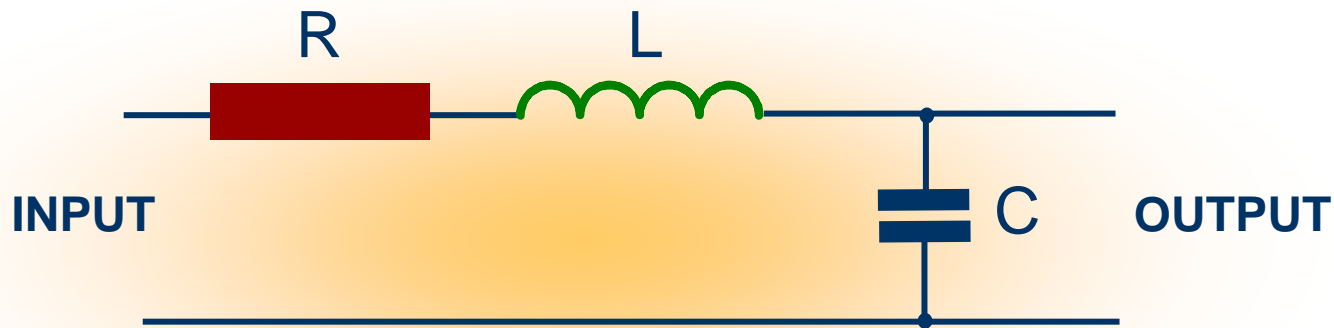
At higher frequencies the effects of "X_C" and "X_L" become more prevalent
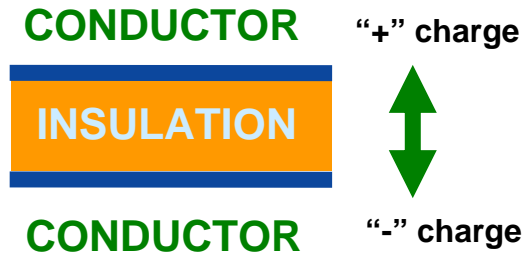
Dag Hauge – JDSU Nordic

Resistance

- **Causes attenuation of signals**
- **Signals must be amplified or repeated before they attenuate too much**
- **Dependent on cable dimension**
- **Changes with temperature**
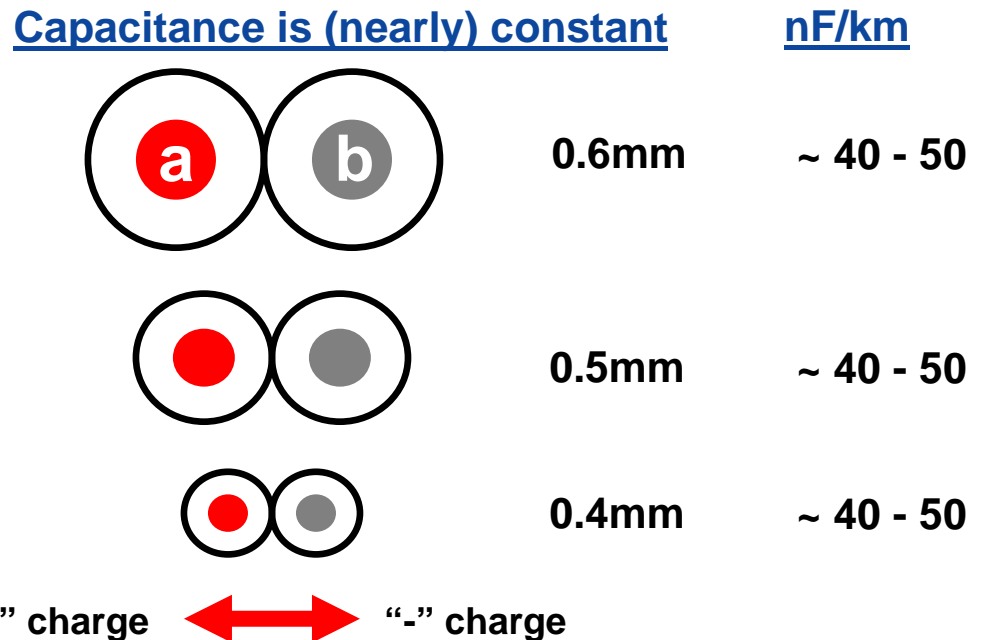- **Can be used to measure loop length (short required at far end)**

Dag Hauge – JDSU Nordic

Capacitance

A capacitor:

CONDUCTOR   "+" charge

INSULATION

CONDUCTOR   "-" charge

Capacitance is *the natural tendency of a conductor to develop and hold a charge*

Note! Capacitance varies with different fill types

Let's turn our capacitor sideways *(look familiar?)*:

<u>Capacitance is (nearly) constant</u>   **<u>nF/km</u>**

(a) (b)	0.6mm	~ 40 - 50
● ●	0.5mm	~ 40 - 50
● ●	0.4mm	~ 40 - 50

"+" charge ⟷ "-" charge

Dag Hauge – JDSU Nordic
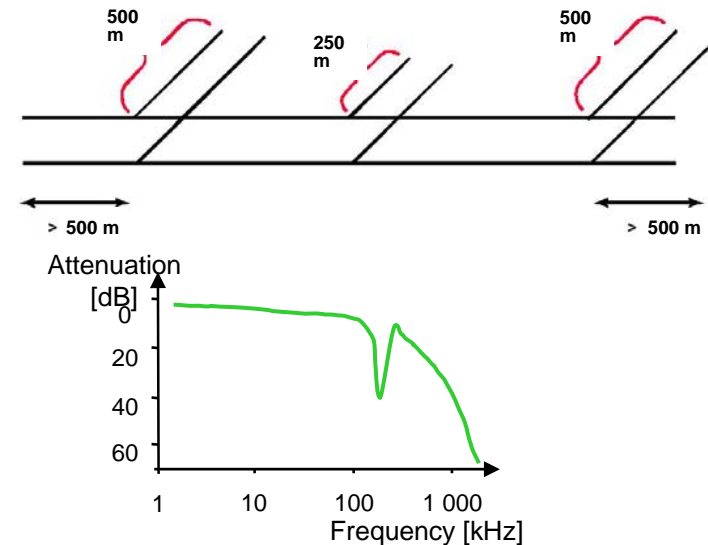
JDSU

Inductance (Load coils) and Bridged taps

Inductance

- **Add inductance - counters effects of too much capacitance.**
- **Used to improve the quality of speech on long POTS lines.**
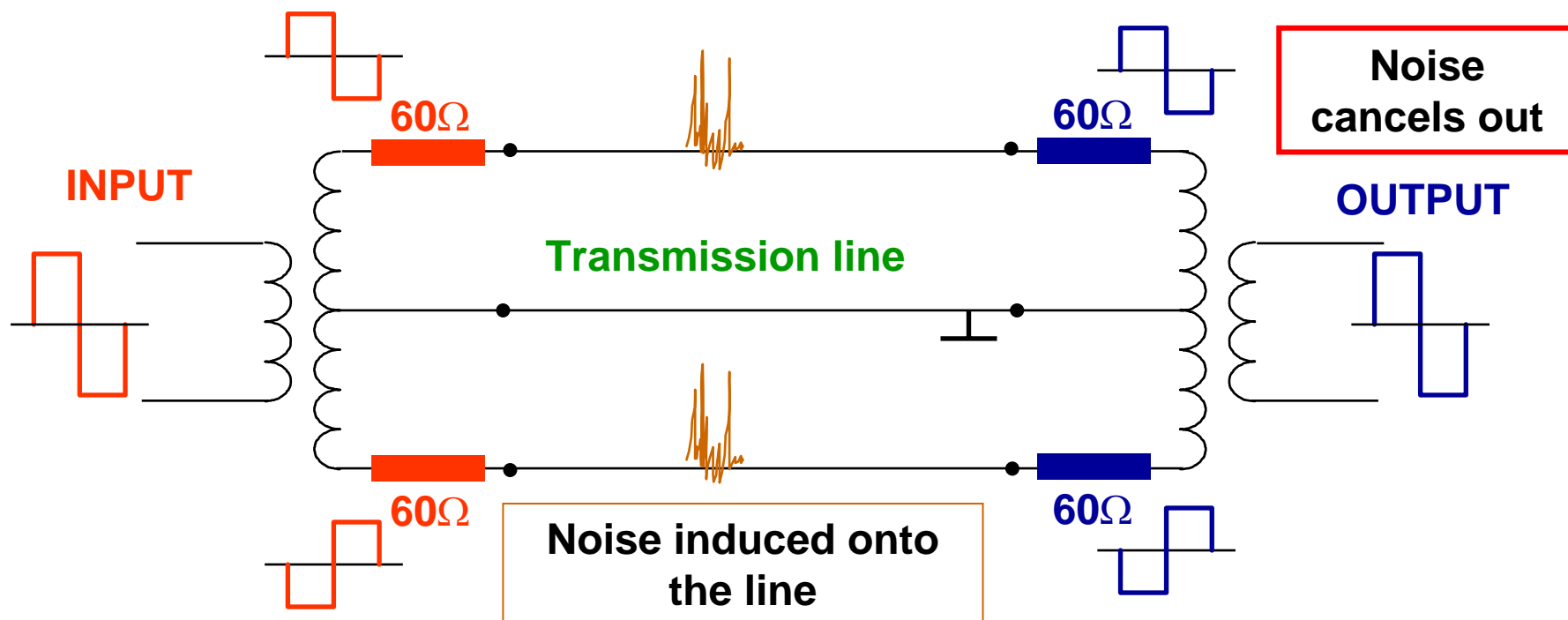- **Not allowed on "special" pairs.**
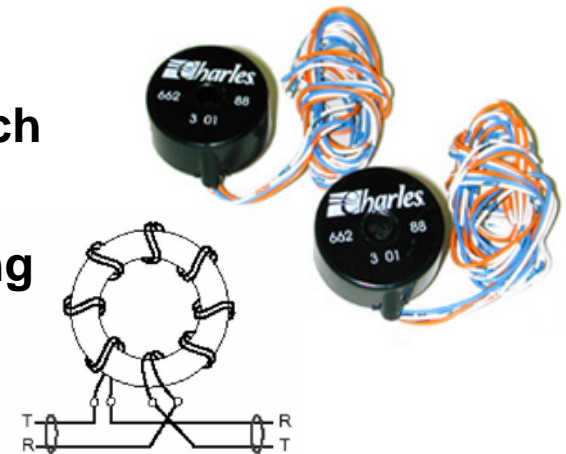
Bridged taps

- **Length of dangling, unterminated cable on a communications line.**
- **Usually left over from an earlier POTS line.**
- **Causes mismatch and other undesired effects (reflections/echos) in transmission.**

Dag Hauge – JDSU Nordic   JDSU

Balanced line

INPUT

60Ω

60Ω

Transmission line

Noise cancels out

OUTPUT

60Ω

60Ω

Noise induced onto the line

Dag Hauge – JDSU Nordic

JDSU

xDSL Testing Principle

End to End TCP/IP Section - TP4

PPP Authentication Section - TP3

xDSL Service Section - TP2

Transmission Section - TP1

Service Provider

ATM Data Network

Network Element Manager

Central Office

RAS Gateway

Loop

Customer Premises

Splitter

Modem (xTU-R)

DSLAM (xTU-C)

Dag Hauge – JDSU Nordic

JDSU