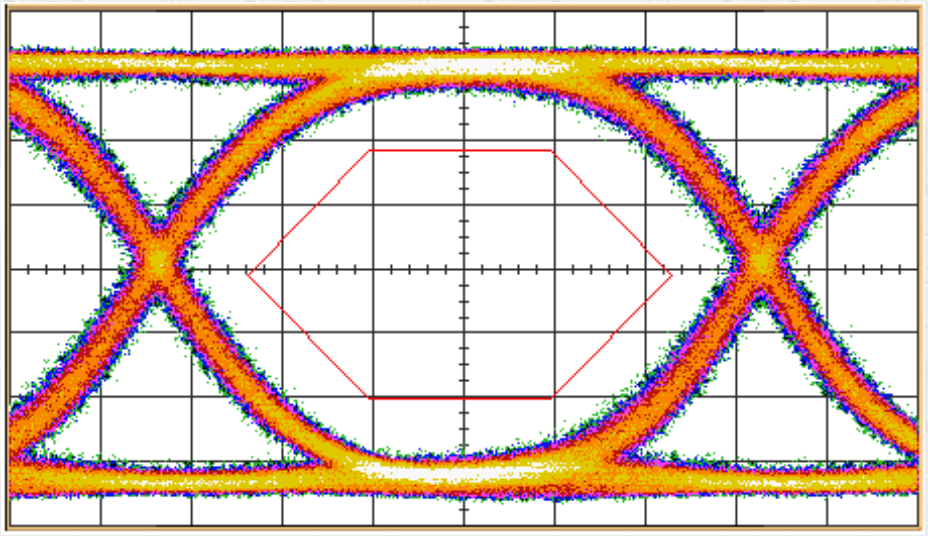
Using VDSL2 over Copper in the Vertical String

Copper, a traditional view

Serial Link



‘0’ and ‘1’ are transmitted as pulses

Depending on **transmission speed**, this will only work for a **limited distance** of twisted pair due to:

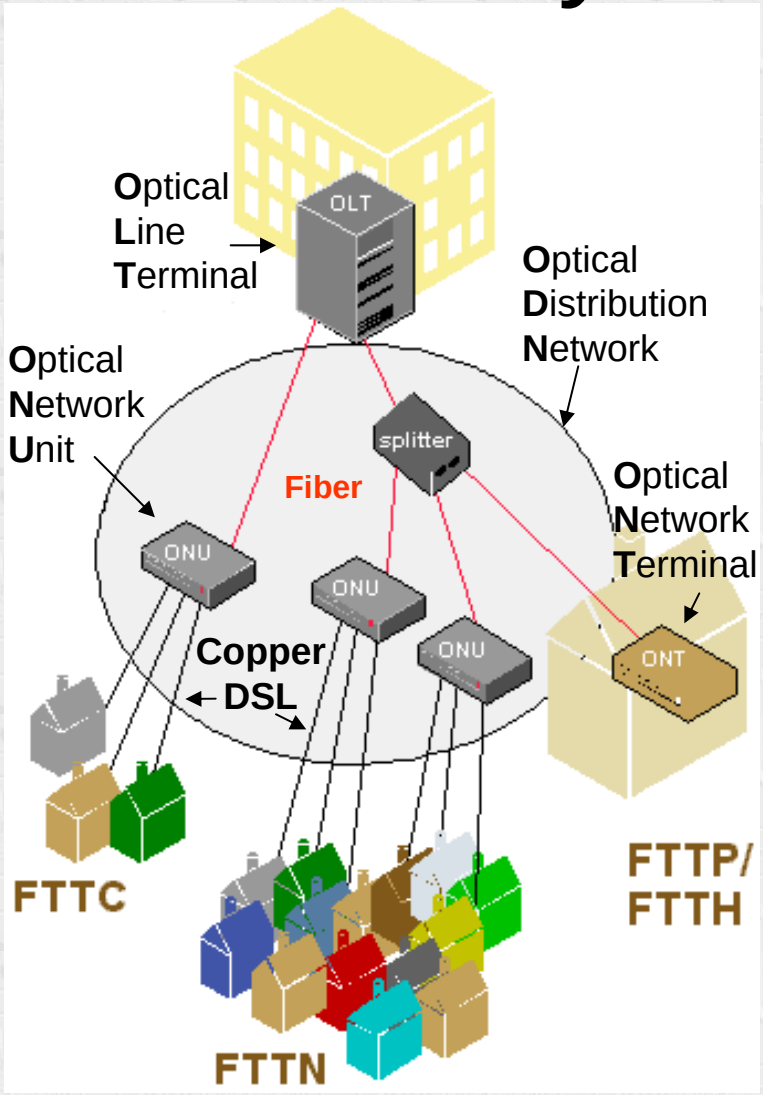
- Dispersion
- High Frequency Attenuation

Telecommunications Industry

Want to provide "Triple Play" (Voice, Video, Data)

Today, most subscribers are connected via copper

Replacing copper by fiber is a major investment



ADSL, ADSL2, ADLS2plus

Asymmetric Digital Subscriber Line

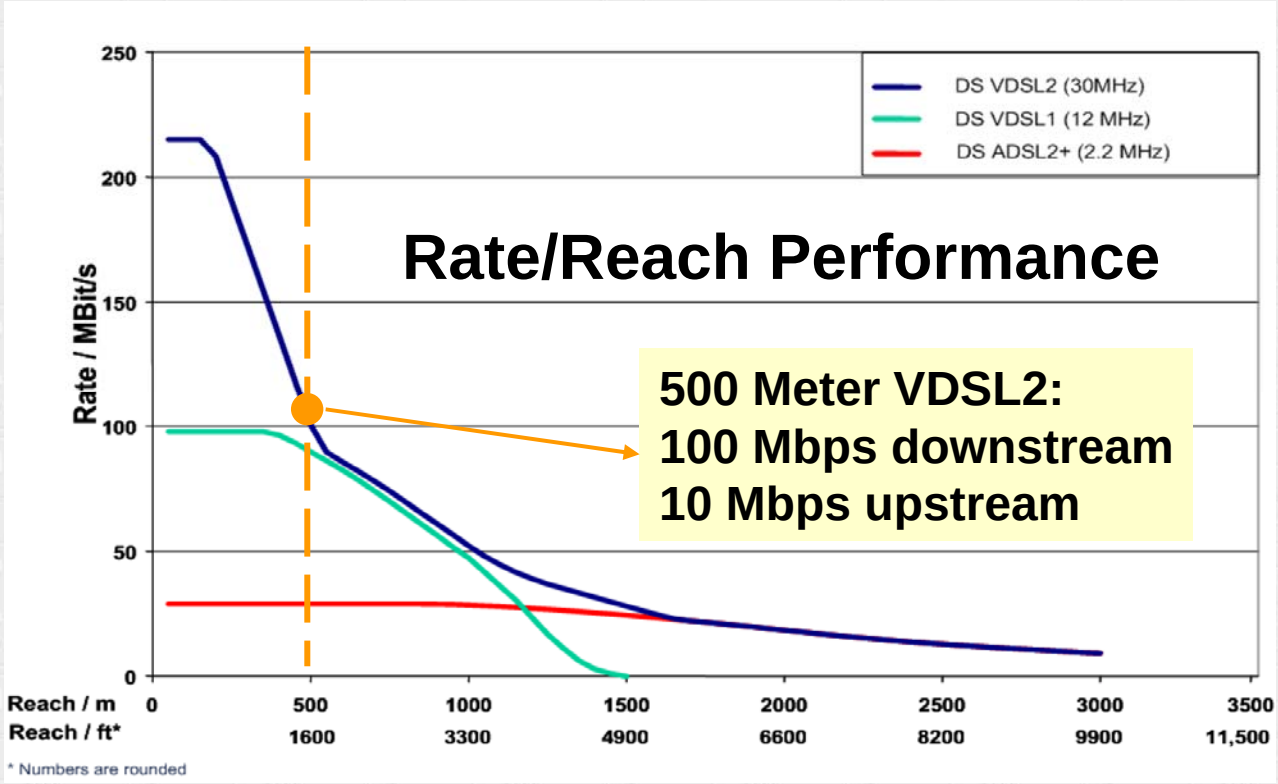
VDSL, VDSL2

Very high speed Digital Subscriber Line

VDSL2

Bandwidth up + down stream total: 200 Mbps

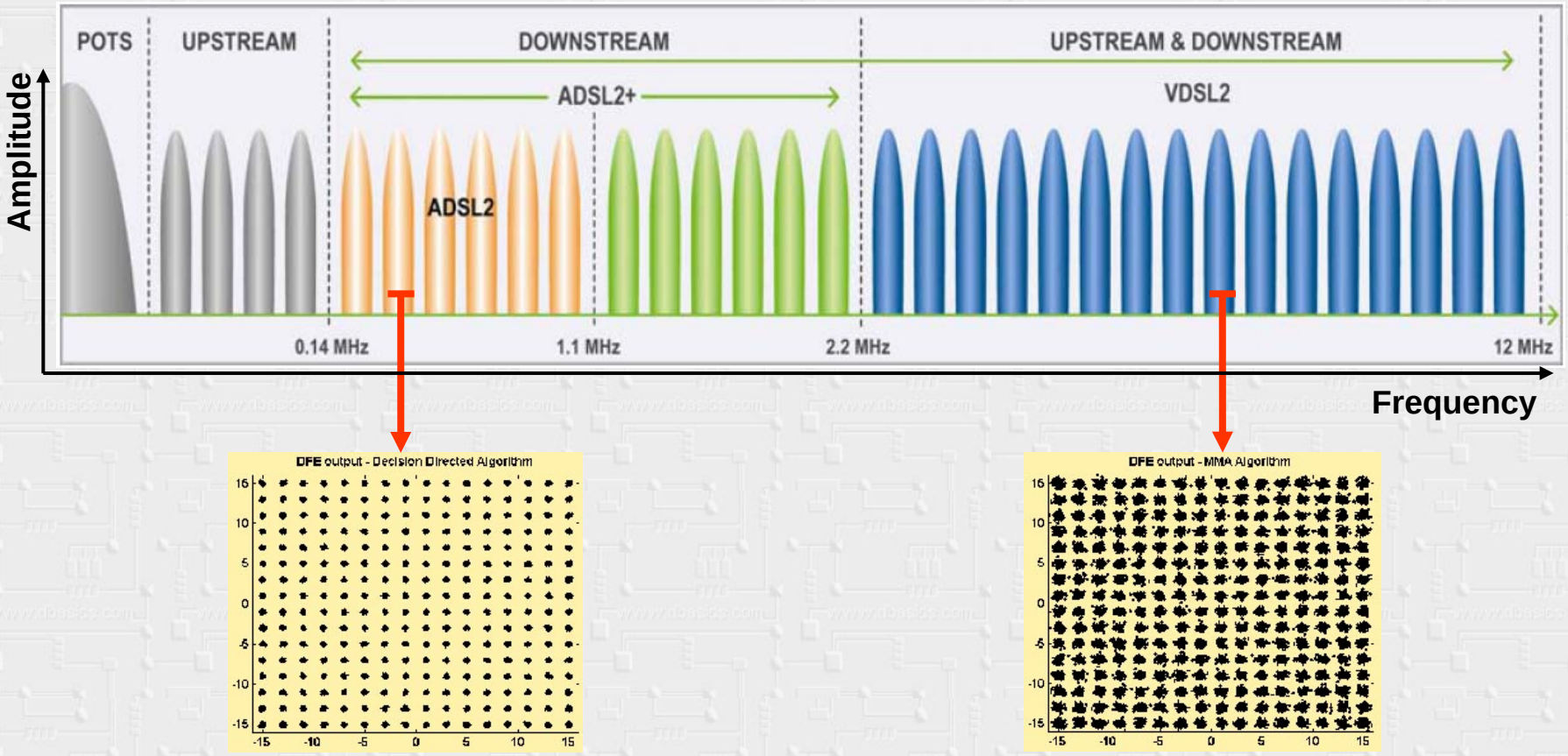
25 KHz – 30 MHz



Source:
http://www.infineon.com//upload/Document/VDSL2_WP_072005_v1.1.pdf

ADSL / VDSL

OFDM Orthogonal Frequency Division Multiplexing



ADSL / VDSL

THOMSON images & beyond

Alcatel·Lucent

2.3 MILJOEN MODEMS
VERKOCHT IN NEDERLAND

All intelligence in a single chip:

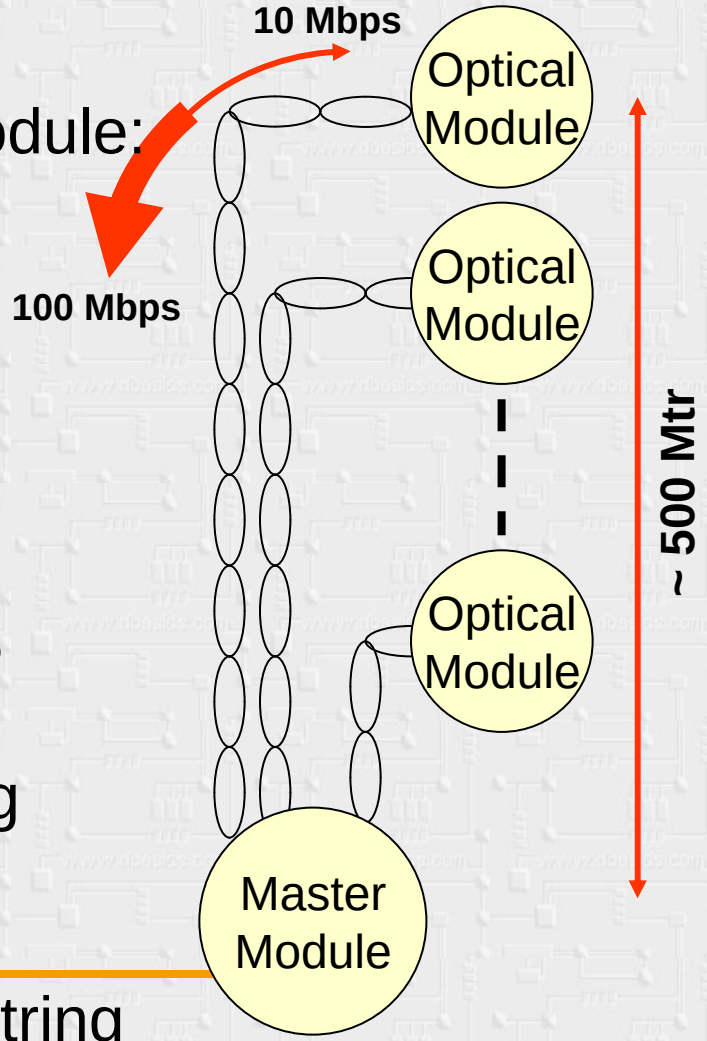
Vertical String Architecture

One **Single** Twisted Pair per Optical Module:

- Bi-directional Data Transport
- DC - Power

Estimated Bandwidth:

- 20 Mbps per Optical Module
- Packet overhead and **safety factor 5**
  100 Mbps per Optical Module
- 24 Optical Modules per Vertical String
  2.4 Gbps <= **3.1625 Gbps**



Fiber one λ / Vertical String
in a DWDM system

Are all problems solved?

VDSL does not have a fixed latency

↓

Store and Forward Data Acquisition System

Create a Time Stamp at the origin of an Event

↓

Need a **Local Clock** in each Optical Module

- Synchronous
- Calibrated

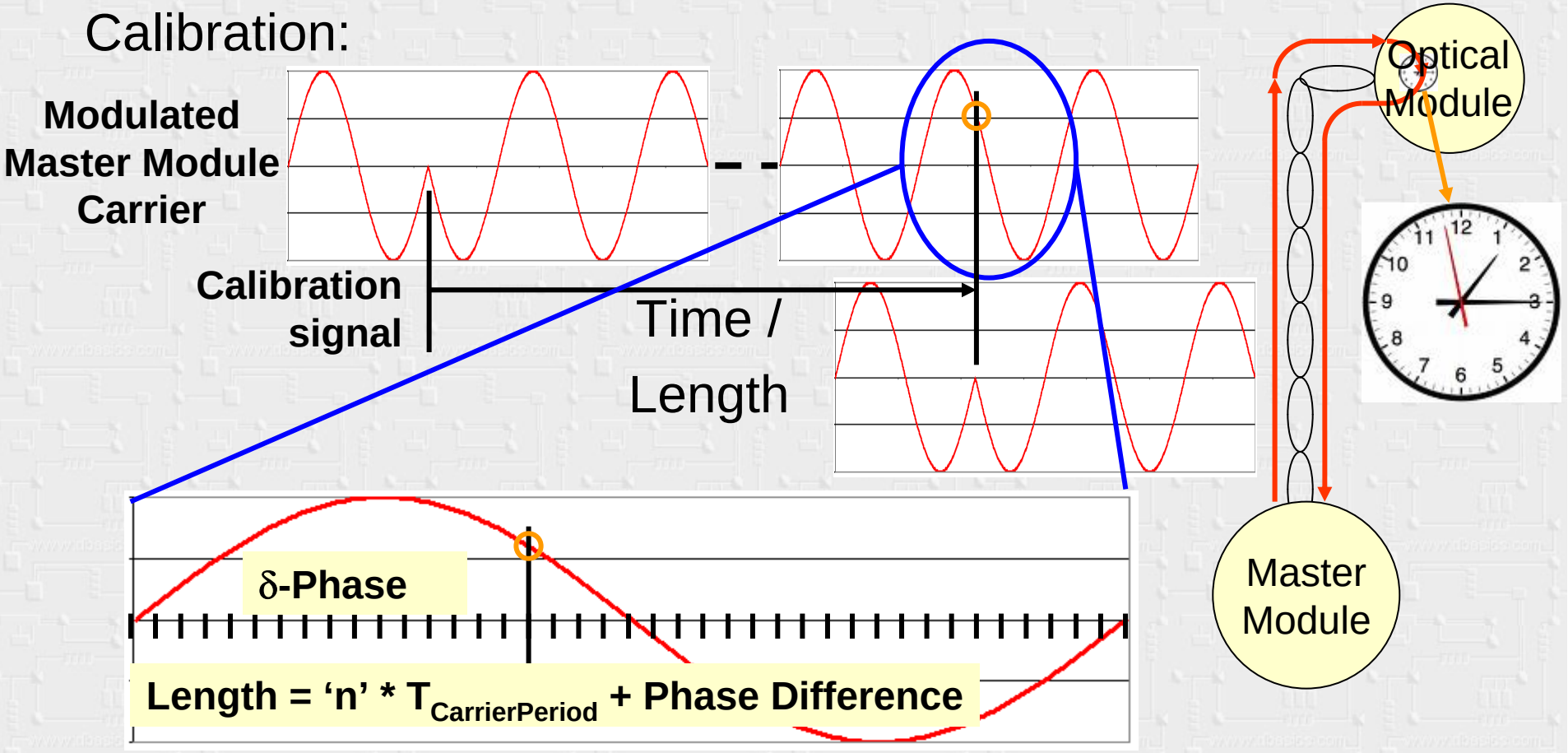
Timing Calibration How?

Timing Calibration Over Copper

Take a carrier above the VDSL2 Bandwidth (> 30 MHz)

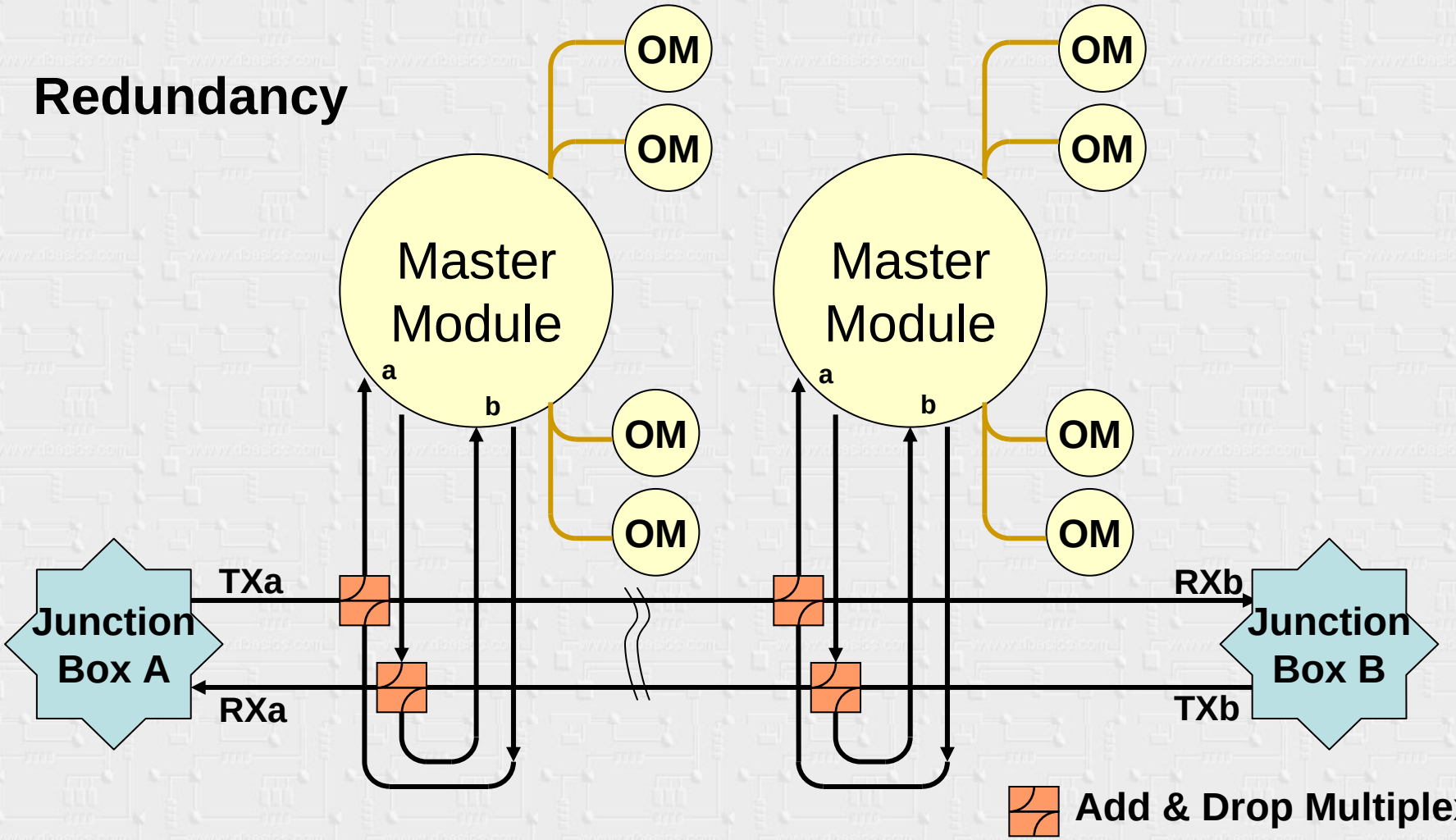
Synchronous: ➡ Local Clock is Phase locked to Shore Station

Calibration:

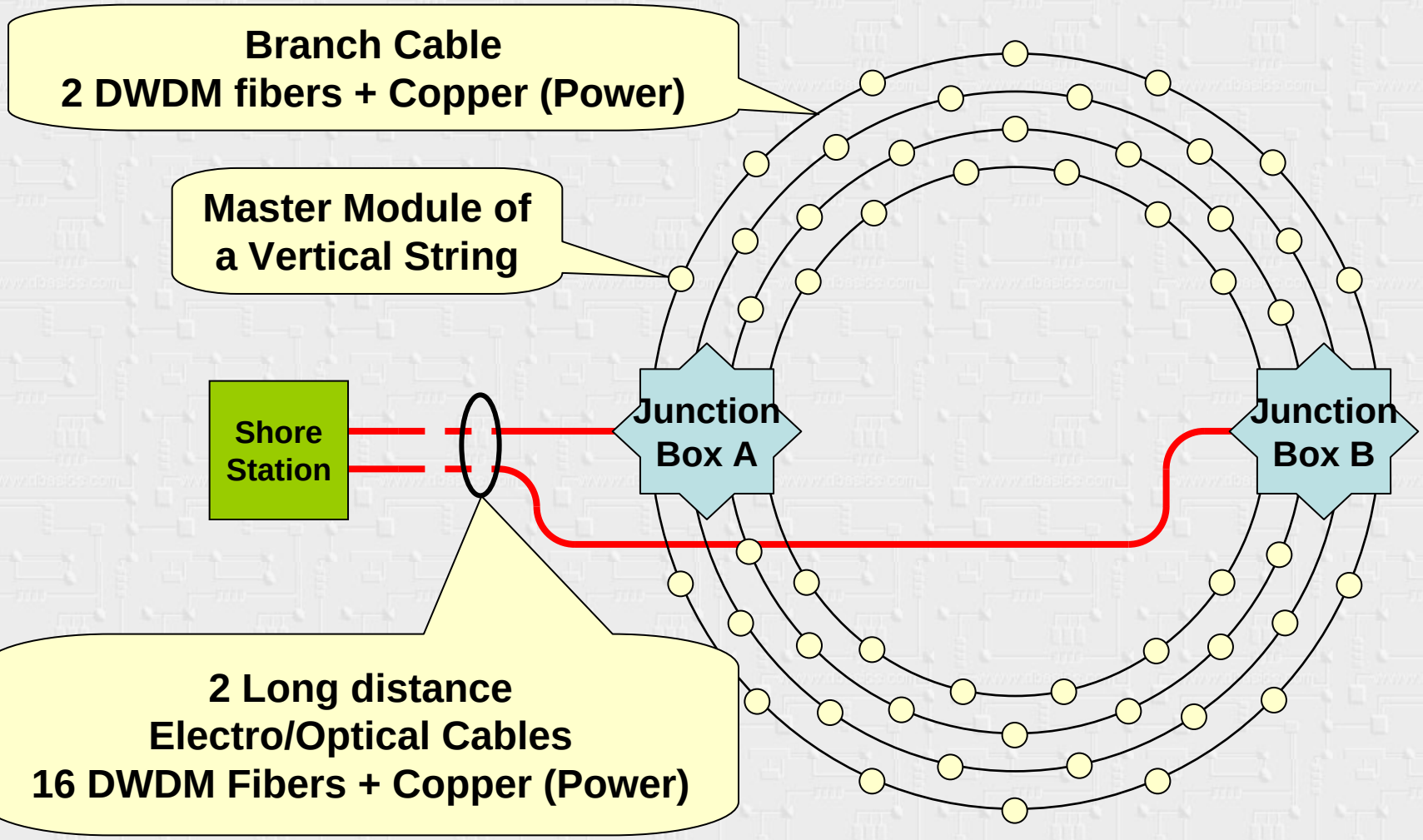


Branch Cable

Redundancy



Telescope Overview



Summary

Vertical String

VDSL2 is a cost effective, high bandwidth solution for a Vertical String

Need extra functionality to incorporate timing over Copper

Power, Data, Timing over a single twisted Pair

Just one λ / Vertical String

Telescope

Need extra functionality to couple timing calibration over Copper <-> timing over fiber

Total telescope can be read out via 16 DWDM fibers

Thank you