



Maximizing Network Capacity, Reach and Value  
*Over land, under sea, worldwide*

# **Building Scalable, High-Performance, and Cost-Efficient Regional Submarine Systems**

Philippe A. Perrier  
Xtera Communications

22 September 2011

# Regional Submarine Cable Systems Drivers & Market

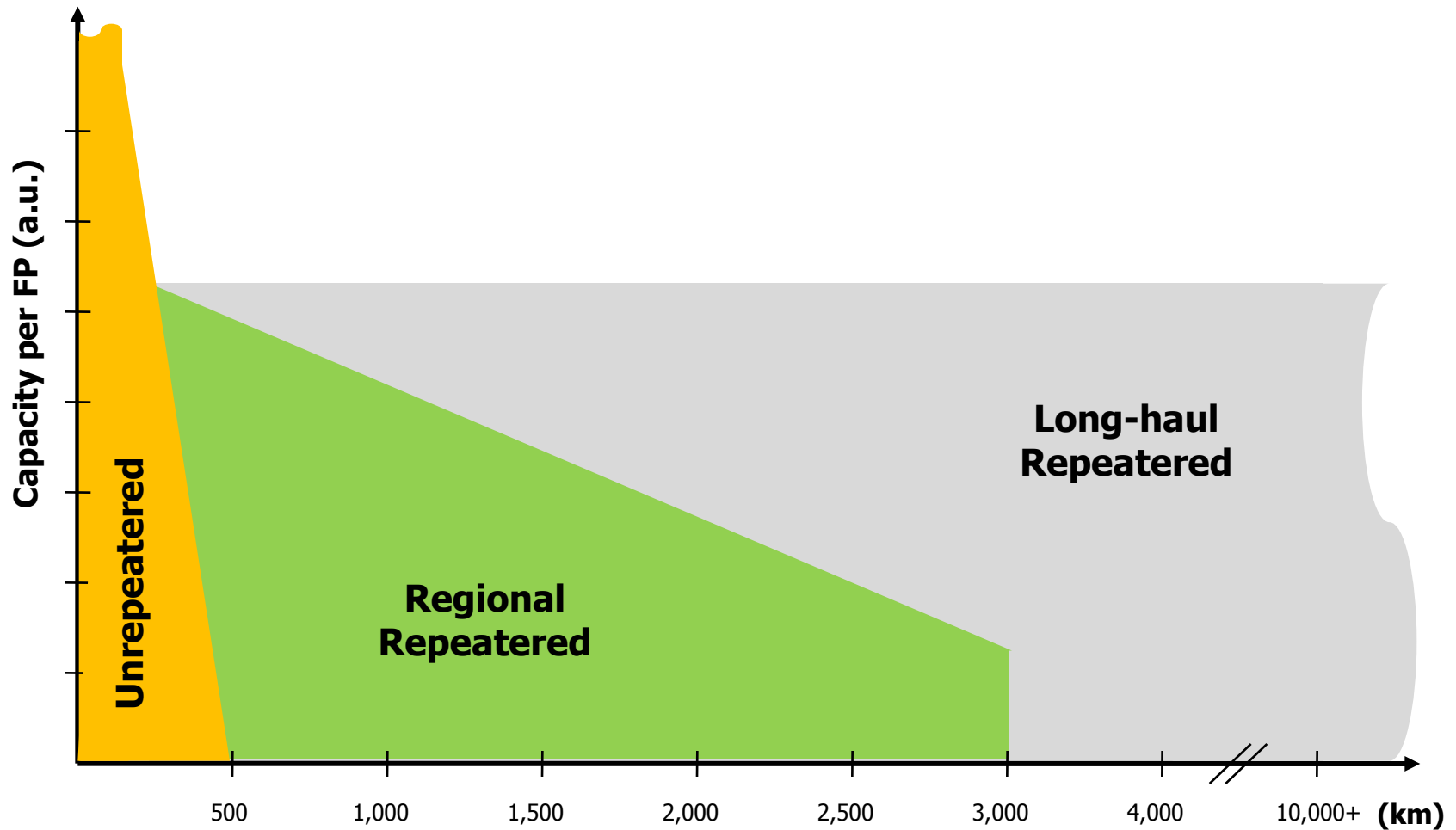


- Regional System: no segment longer than ~3,000km
- Some of the drivers
  - Bridge the digital divide
    - Provide capacity to under-served and developing markets
  - Socio-economic development of countries being connected
    - Boom in international relations (social, cultural, tourism)
  - Explosion of BB services
    - Enable new services not possible before due to BW restrictions
  - Affordable capacity
    - Competition drives price down
  - Need for redundancy
    - Limit economic impact of cable outages
- Markets
  - South-East Asia, Middle-East, Caribbean
- Private cable (single owner) or “bilateral” cables (owned by the landing parties)

# Regional Submarine Cable Systems (SCS) Unrepeated or Repeated?



- Driven by geography and system length / capacity



# Unrepeated or Repeated SCS? Example: ARCOS-1



## THE COLUMBUS NETWORKS FIBER SYSTEM *Connecting the Americas*



[www.columbus-networks.com](http://www.columbus-networks.com)

# Unrepeated or Repeated SCS?



- Driven by geography and system length / capacity

		<b>Unrepeated</b>	<b>Repeated</b>
<b>Dry plant</b>	SLTE	=	=
	LME	N/A	+
	PFE	N/A	+
<b>Wet plant</b>	Cable		>
	Repeaters	N/A	+
<b>Marine Ops</b>			>

- But other factors to consider
  - Power? Cable Landing Stations?
  - Burial
  - Landing permit
  - Backhaul

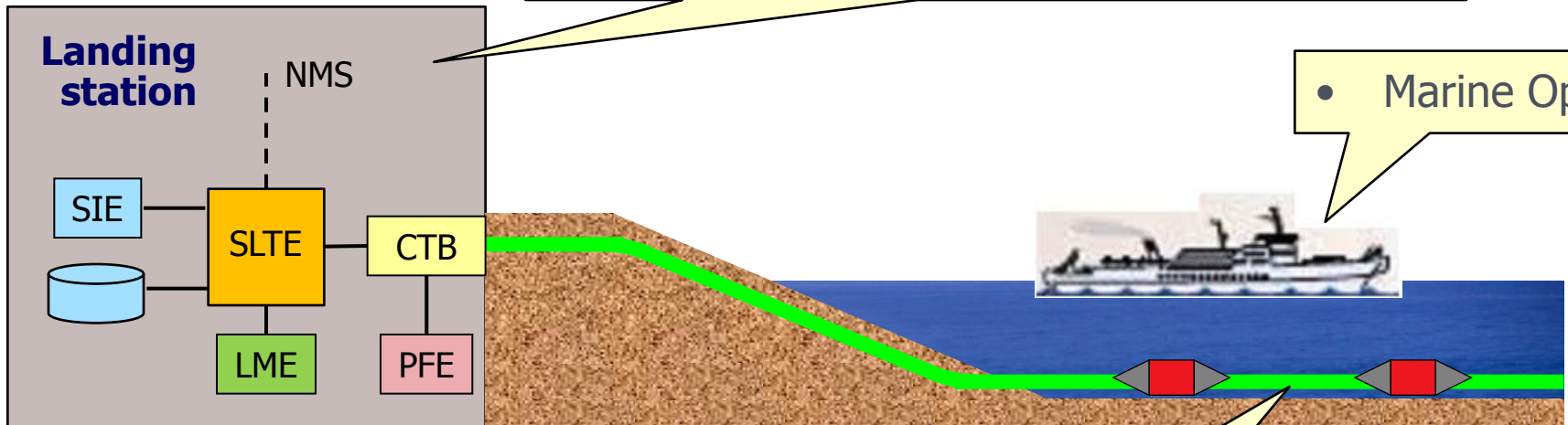
# Cost Breakdown of a New Regional SCS



	<b>Unrepeated</b>	<b>Repeated</b>	
Dry Plant	5-10%	10-15%	Includes PFE
Cable	25-40%	20-35%	Includes repeaters
Marine Ops	40-55%	40-50%	

# Where to Look for Cost Efficiencies?

- Terminal Station Equipment
  - SLTE (Submarine Line Terminal Equipment)
  - PFE (Power Feed Equipment)
  - Wet plant monitoring
- System design



- Marine Ops

- Submerged plant
  - Repeaters
  - Cable

- Don't need performance of long-haul repeatered systems

- Long-haul systems need:

- Complex dispersion compensation
- Small bands
- Per channel compensation
- Signal formats (e.g., RZ) to minimize non-linear effects
- Adaptive pre-emphasis
- High-density loading
- Limited to 10G & 20G (40G) line-rates
- Channel spacing down to 33GHz

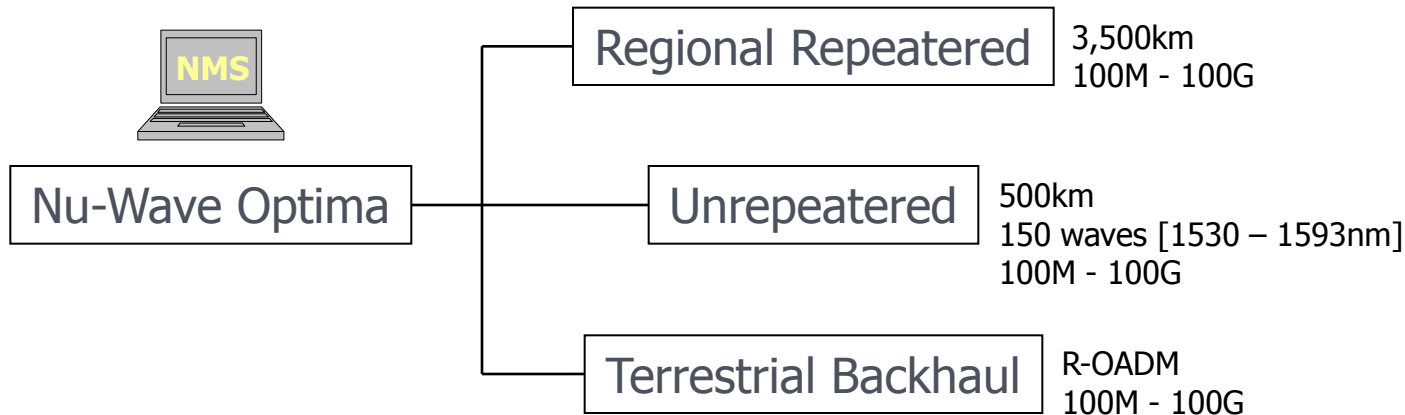


- Regional systems:

- Simple dispersion compensation
- Larger bands
- Not needed at 10G
- Use NRZ (avoids two modulators)
- Fixed pre-emphasis
- No / few loading channels
- Supports 10G, 40G, & 100G line-rates
- 50GHz channel spacing

# More Capacity, More Reach

- One platform – 3 applications



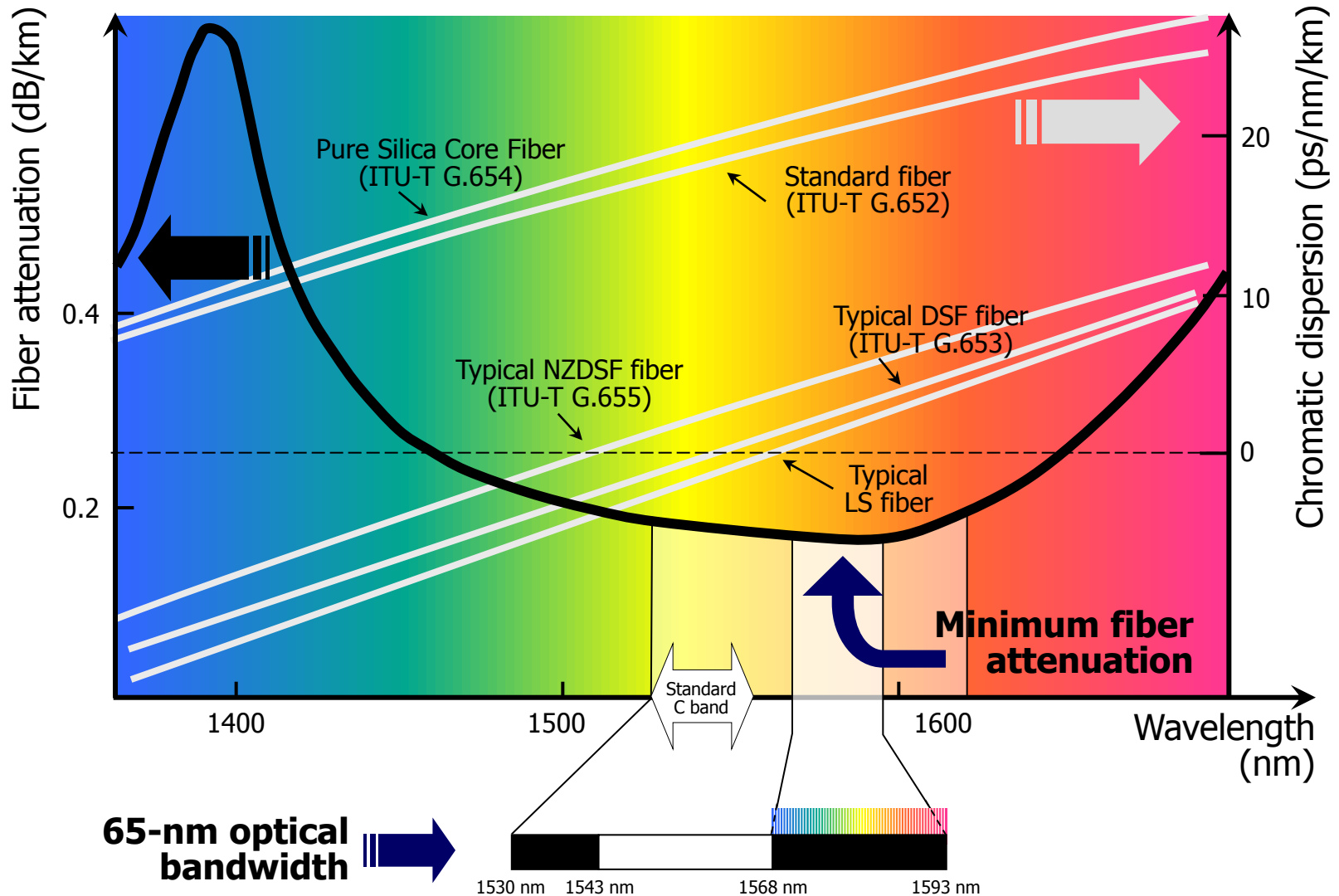
- Modular architecture
    - Tailored to specific system requirements
  - Lower operating costs
    - Smaller footprint (1 Tb / standard rack)
    - Lower power consumption (per 10G)
- ➔ Lower cost of transmission per bit



# Technology Advances



- Improved reach / capacity
  - Low loss fiber
  - Spectral window of transmission

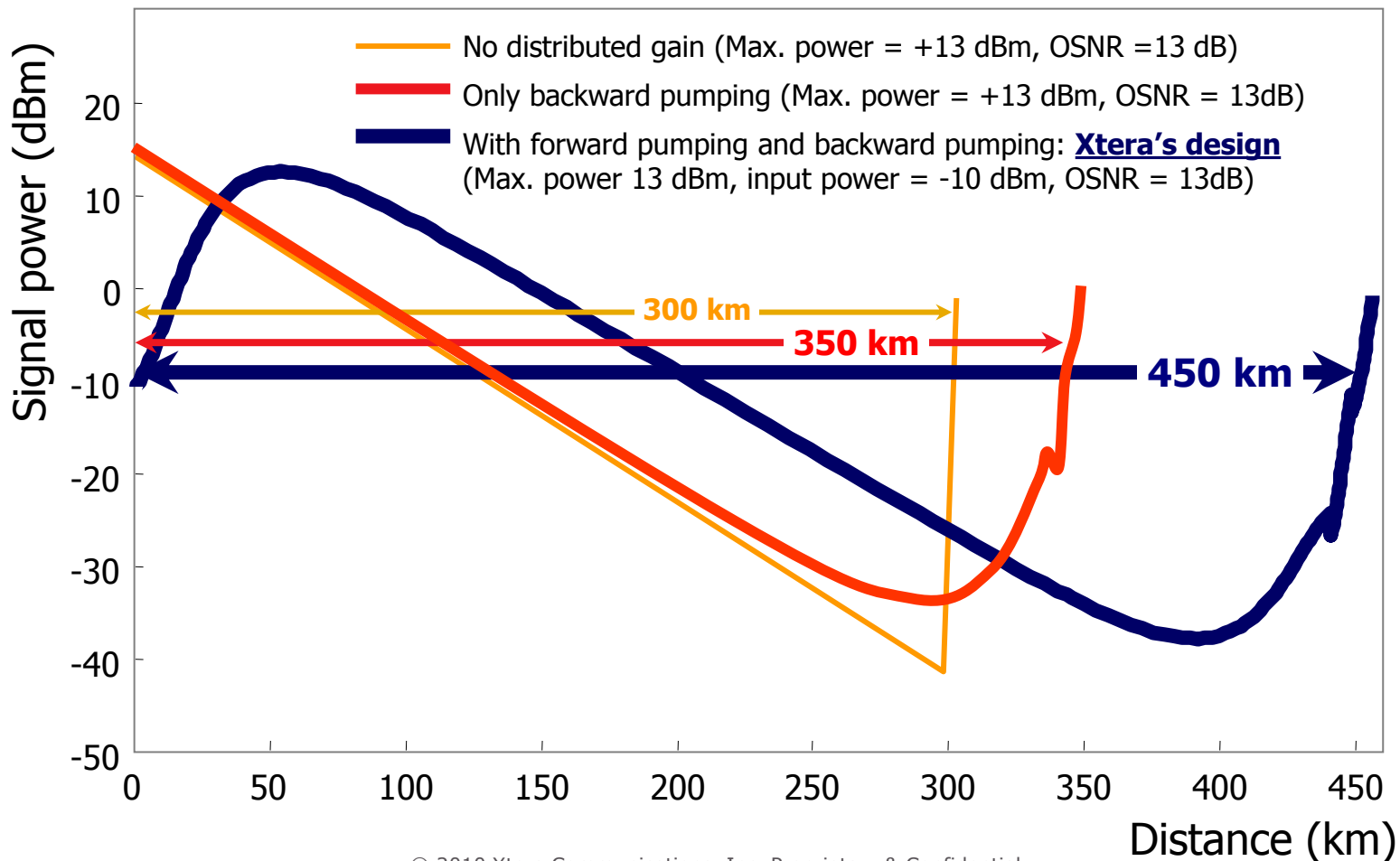


- Improved reach / capacity
  - Low loss fiber
  - Spectral window of transmission
  - Raman amplification

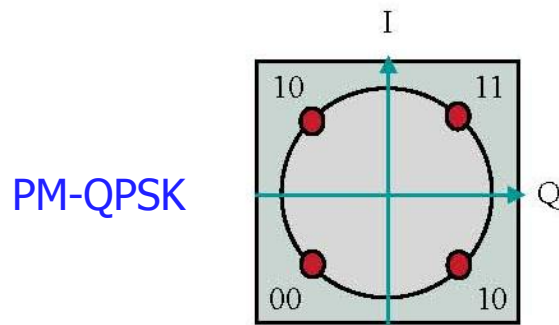
# Raman Amplification



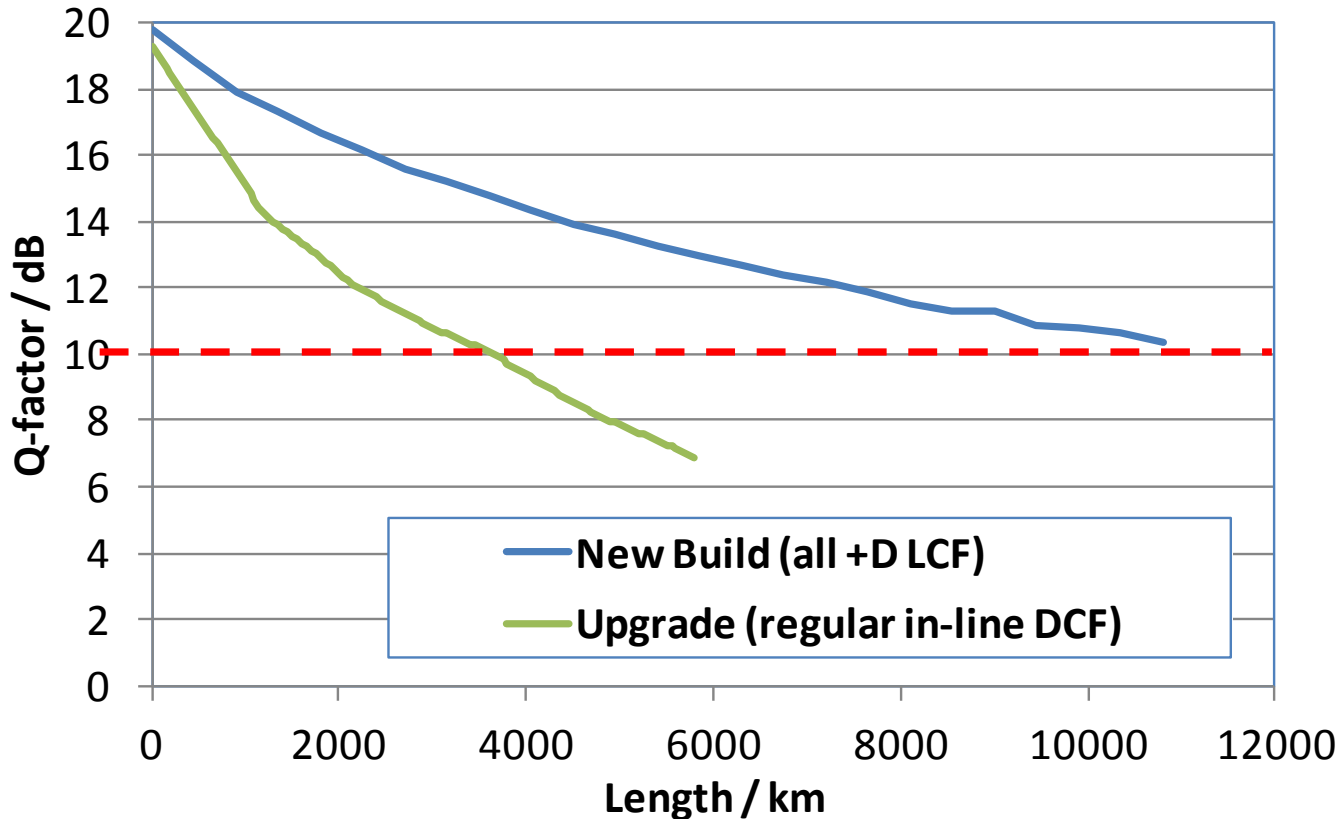
- Reduced launch power
- Reduced non-linearities
- Improved OSNR



- Improved reach / capacity
  - Low loss fiber
  - Spectral window of transmission
  - Raman amplification
  - ROPA
  - Advanced modulation formats

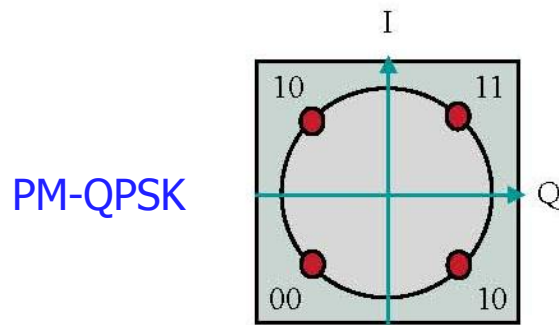


# 100G Coherent for Upgrades



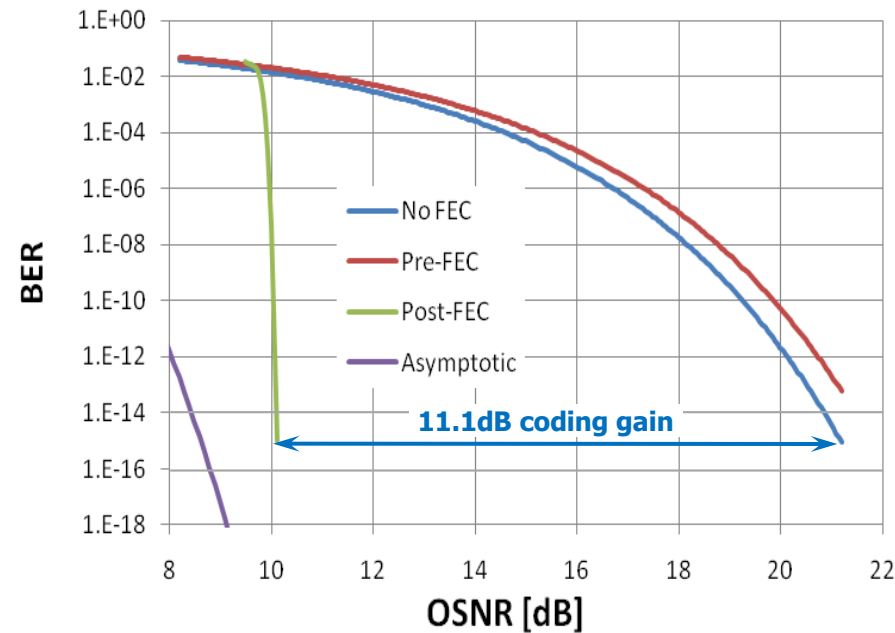
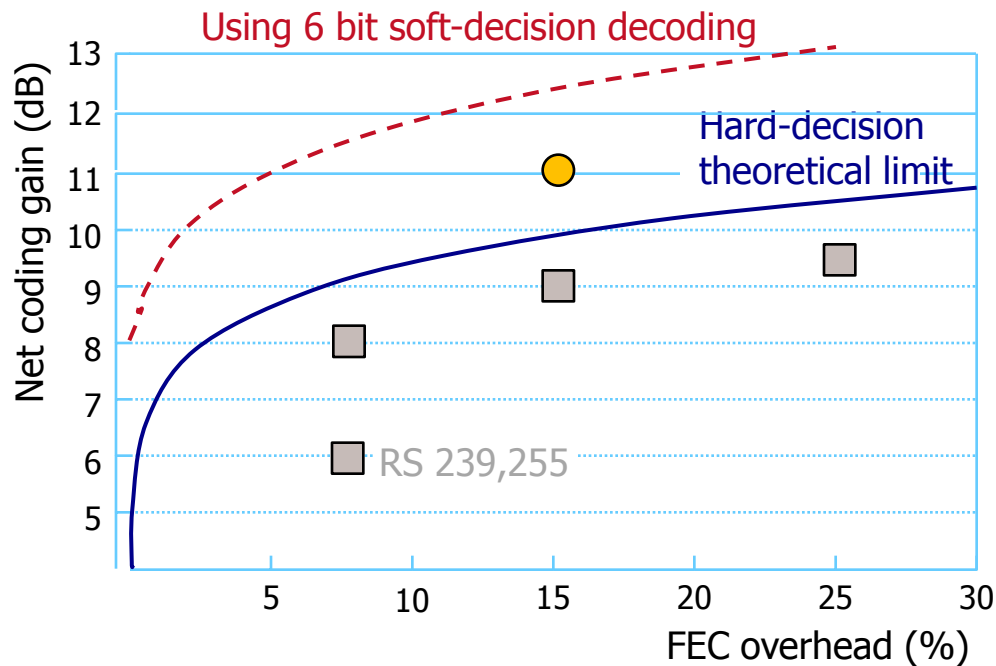
- Performance of 100G DP-QPSK on upgrades (with in-line compensation) vs. new Build (all +D fibre)
- Today's coherent products work for regional upgrades and longer new builds, but not for long repeatered upgrades

- Improved reach / capacity
  - Low loss fiber
  - Spectral window of transmission
  - Raman amplification
  - ROPA
  - Advanced modulation formats



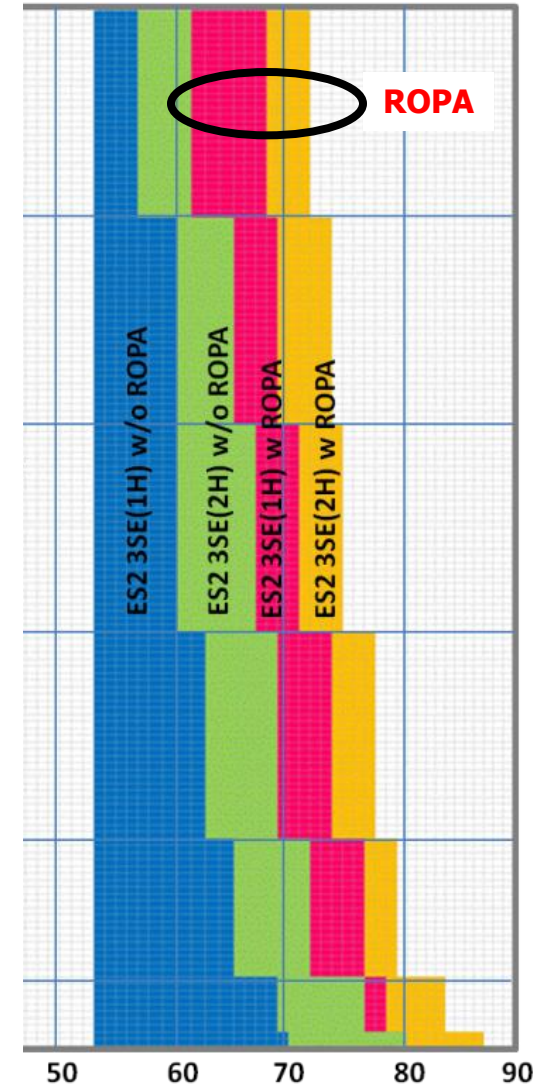
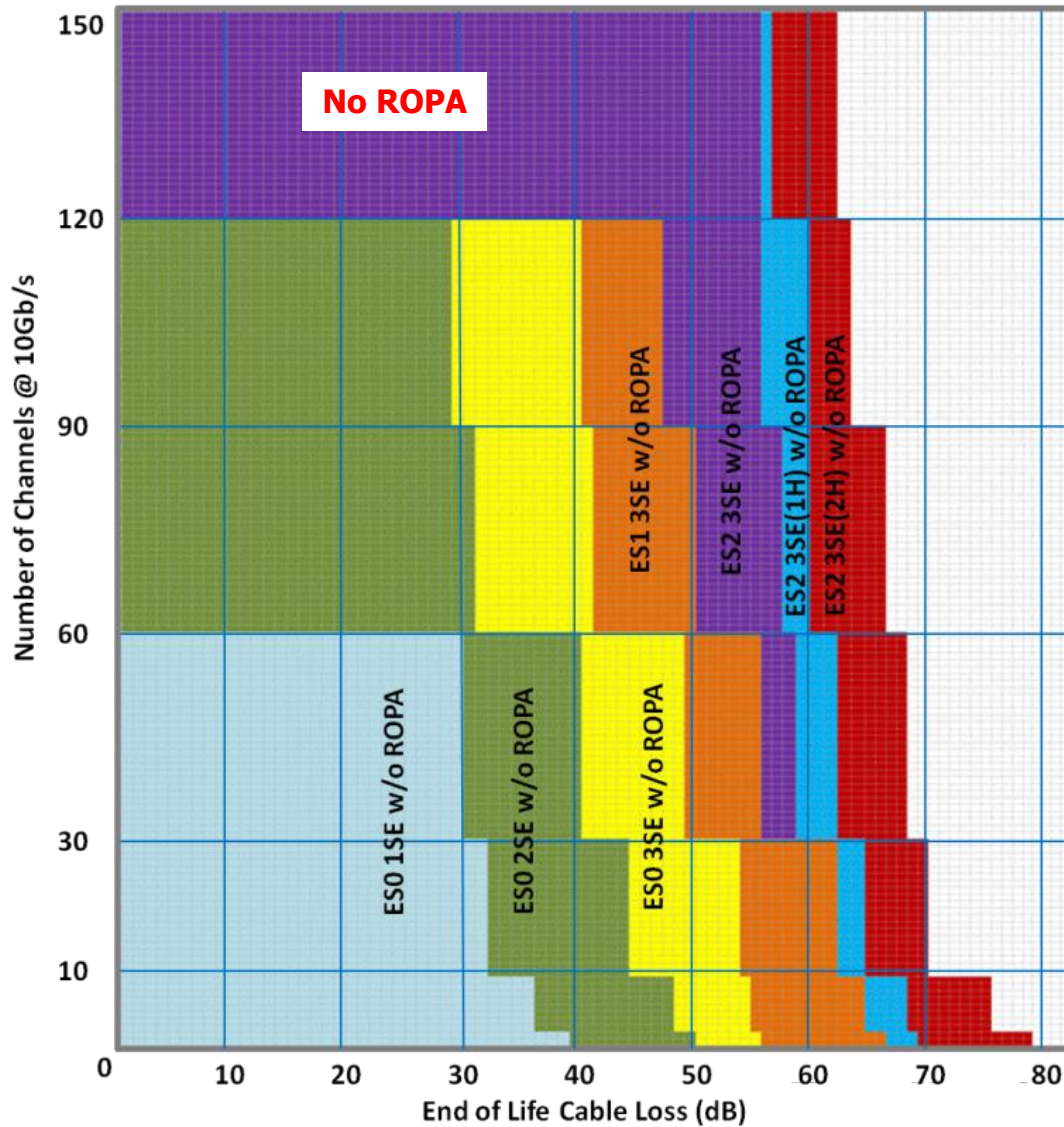
- Digital Signal Processing
- Advanced Forward Error Correction

# Forward-Error Correction

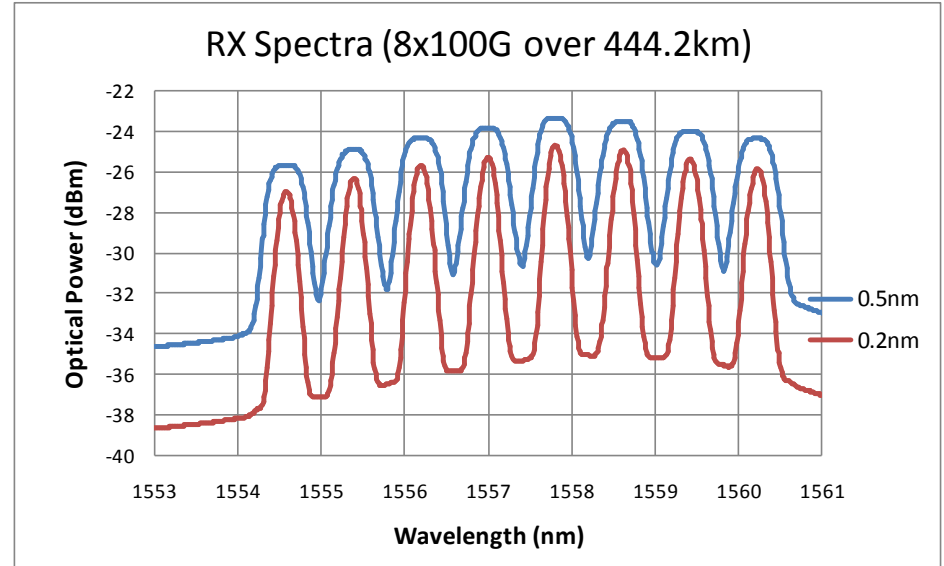
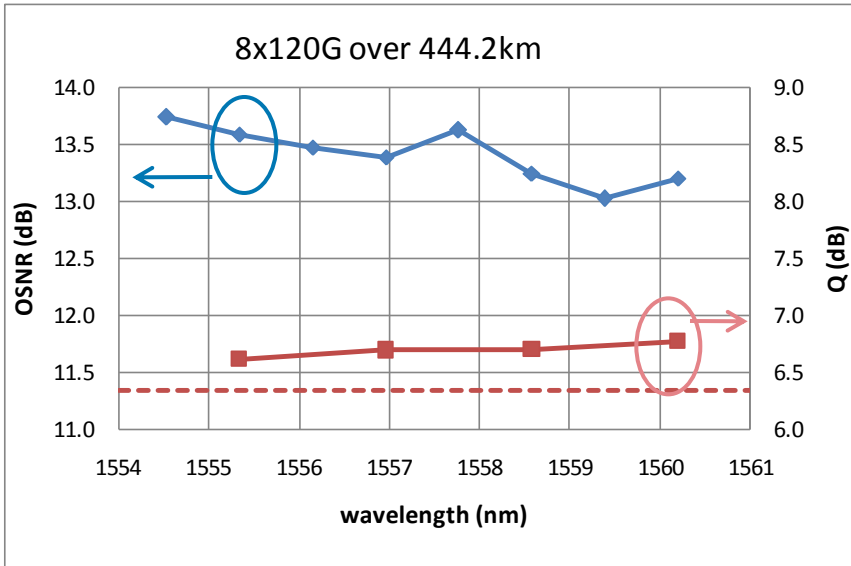
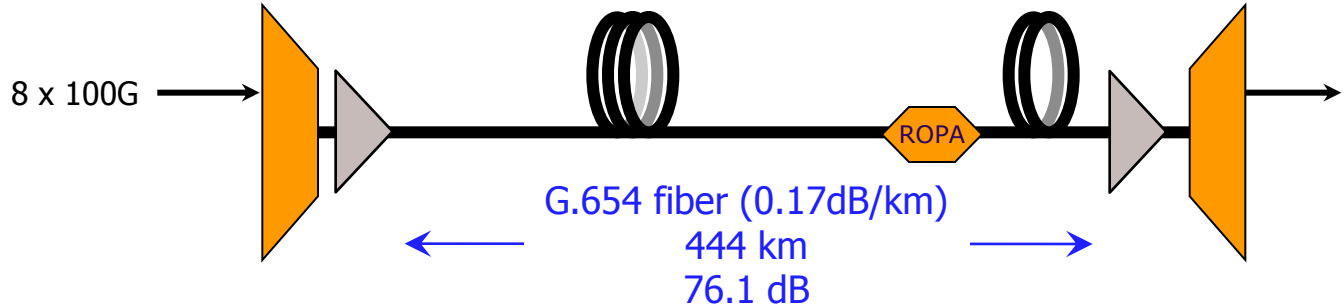


- At 15% overhead, Soft-decision FEC offers ~2 dB additional gain

# Capacity (at 10G) vs Cable Loss

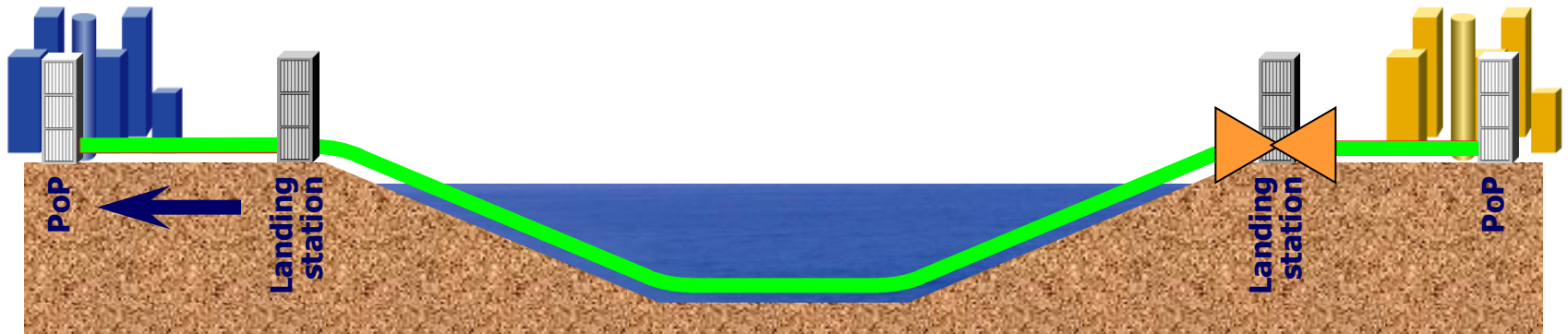


# 8 x 120 Gb/s Transmission over 444 km



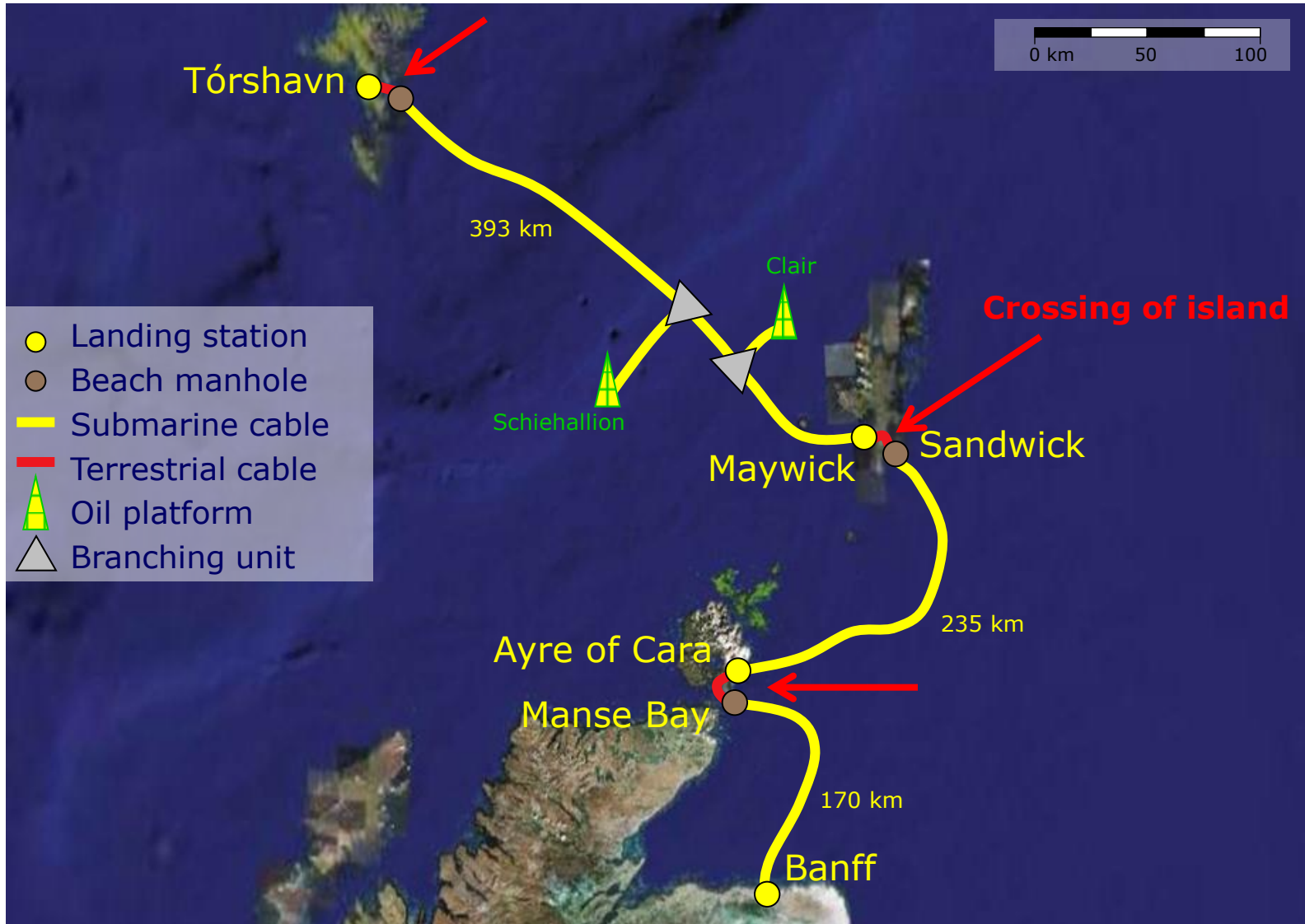
➔ Twice the capacity achievable at 10G (NRZ)

- Direct delivery to City PoP

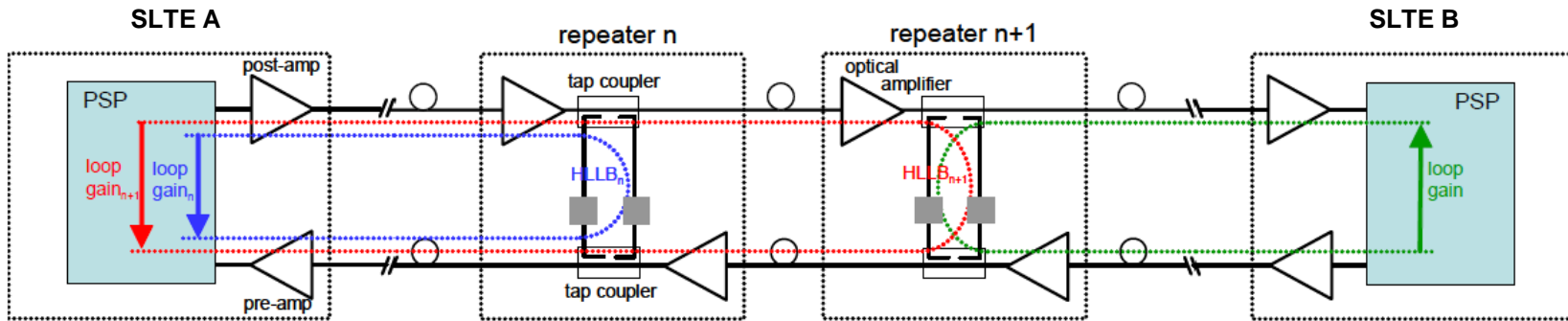


- Maximize repeater spacing
  - ↳ Future upgrade

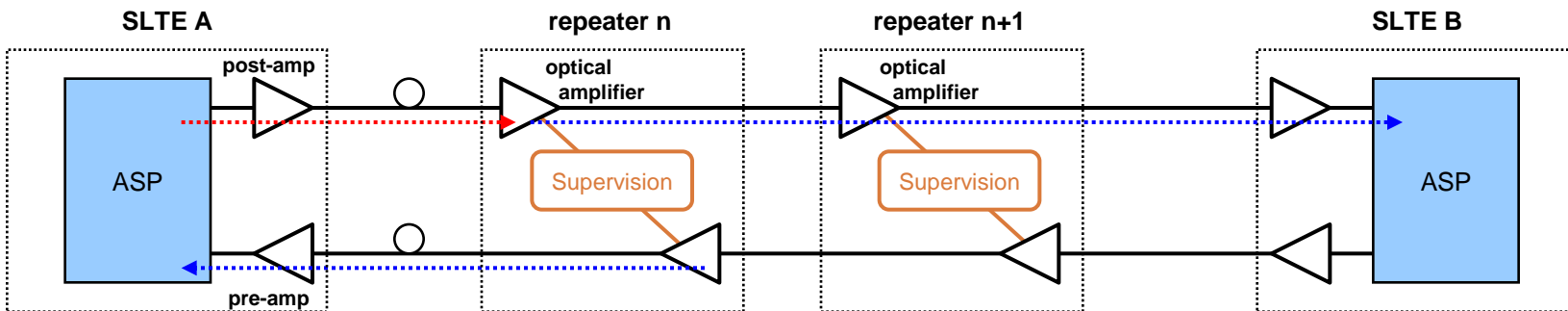
# System Design SHEFA-2



- Passive



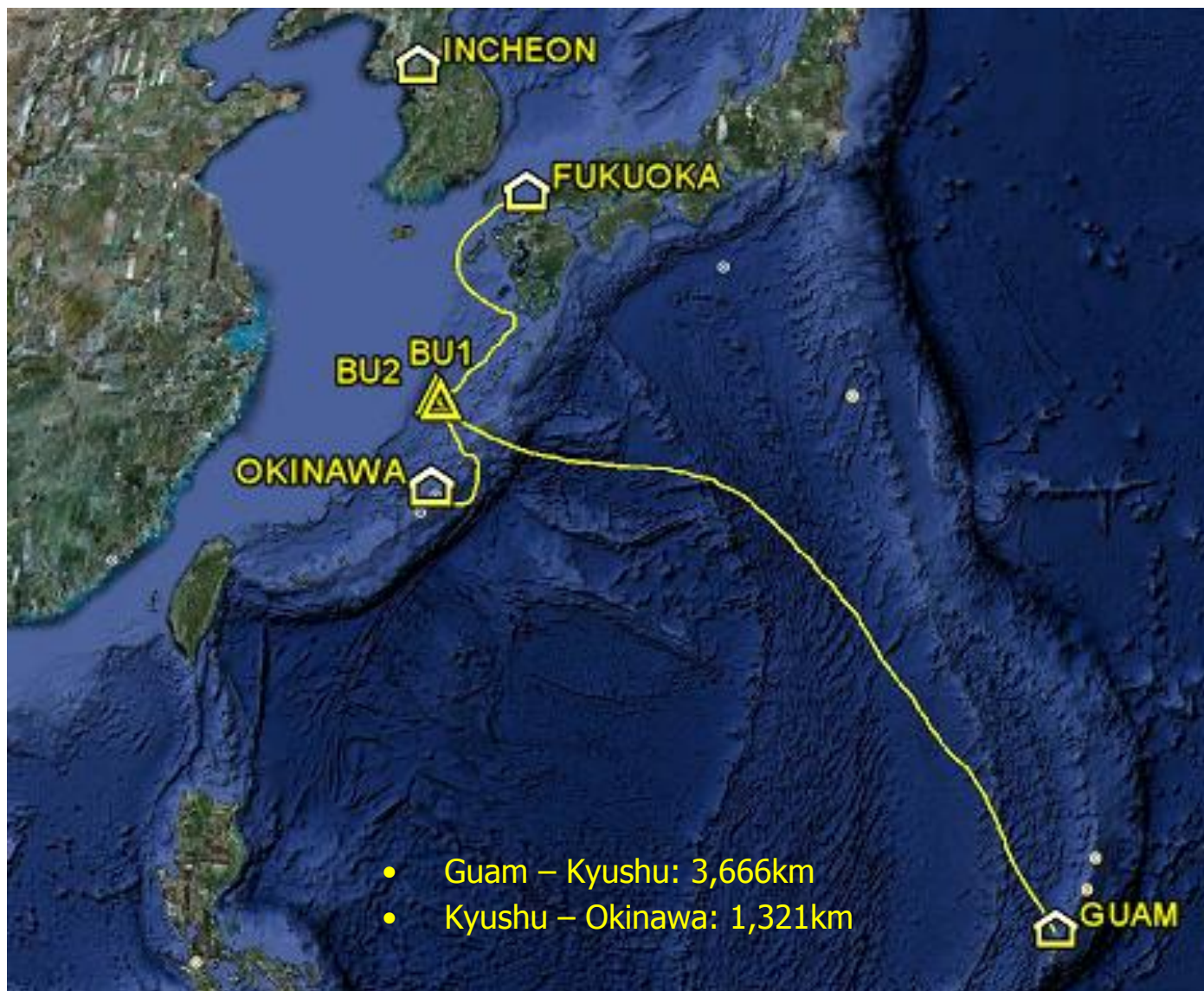
- Active – Command-response repeater monitoring



- Smaller PFE
  - For regional repeatered SCS, requirement can be as low as 1-2kV at 0.5-0.7A
- Lower operating costs
  - Smaller PFE leads to
    - Smaller footprint
    - Lower power consumption
- For low-capacity regional repeatered SCS
  - Eliminate internal filtering
  - Output power with reduced number of pumps
- Lower core count
- Development of physically smaller repeater housing not justified
  - Small quantity
  - High-cost of qualification

- Fiber type
  - Positive Chromatic Dispersion fiber (G.652, G.654)
    - Lower loss → larger repeater spacing
    - Dispersion compensation at Terminals (Coherent detection)
  - NZ-DSF
  - ➔ Results in cable savings (sparing)
- Fiber count
  - For unrepeated SCS, analyze number of cores vs use of ROPA
  - For repeated SCS, lower fiber count results in savings on repeaters and cable
- Cable
  - Smaller diameter repeated cable
    - ➔ Results in cost savings in armoring and cable laying
  - **Cable redeployment**

# Example of Cable Redeployment GOKI



- Generally, most expensive portion of any SCS deployment
- Critical step for performance and reliability of systems
- Cost efficiencies
  - Route engineering (vs burial)
  - In case of cable recovery and redeployment, on-board reconditioning of wet plant
  - ...

- The market for regional systems remains strong
- Advances in technology & tailored designs enable high-performance, cost-effective regional submarine cable systems
- In turns, this will provide the impetus for new cable system developments as countries need (more and more) capacity



**XTERA®**

**Maximizing Network Capacity, Reach and Value**  
*Over land, under sea, worldwide*