Single-pair channels specifications, investigation

IEEE P802.3cg 10SPE Task Force

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ISO/IEC JTC1 SC25 WG3 ad hoc: “JMTG”

- JMTG: Joint Modeling Task Group
- Officially, ISO/IEC JTC1 SC25 JPT1; it includes experts from:
  - ISO/IEC SC25, LAN cabling systems
  - IEC SC46C, balanced cable
  - IEC SC48B, electrical connectors
- JMTG scope: copper, cabling channel and cable assembly modeling
- ISO/IEC JMTG and IEEE 802.3 common members:
  - Alan Flatman
  - Dave Hess
  - Bernd Horrmeyer
  - Bob Lounsbury
  - Dieter Schicketanz
  - Masood Shariff

Overview

- Organization of JMTG and related topics.
- Summary of current results of the ISO/IEC ad hoc investigation of single-pair Ethernet channels.
- Preliminary conclusions

JMTG projects

Recently published:

- TR 11801-9902 ed1, End-to-end link configurations
  - Alternative channel definition, with end connectors included
- TR 11801-9903 ed1, Matrix modelling of channels and links,
  - 8-port, differential mode

Current projects:

- TR 11801-9903 ed2, Matrix modelling of channels and links,
  - 16-port, mixed mode (differential mode and common mode)
- “TR 11801-9906 ed1”, “One pair channels up to 600 MHz”
  - Single-pair channels specifications, investigation

SC25 WG3, similar TR projects, not in JMTG

Published:

- TR 11801-9901 ed1,
  - Balanced cabling in support of at least 40 Gbit/s data transmission
- TR 11801-9904 ed1, Channel model alternatives,
  - Assessment and mitigation of installed balanced cabling channels to support 2,5GBASE-T and 5GBASE-T

Current projects:

- TR 11801-9905 ed1, Channel model alternatives,
  - Guidelines for the use of installed cabling to support 25GBASE-T application

Other JMTG coordinated projects

- IEC SC46C
  - IEC TR 61156-1-3/AMD1 ED1
    - Multicore and symmetrical pair/quad cables for digital communications - Part 1-3: Electrical transmission parameters for modelling cable assemblies using symmetrical pair/quad cables
- IEC SC48B
  - IEC 60512-28-100 ED2
    - Connectors for electronic equipment - Tests and measurements - Part 28-100: Signal integrity tests up to 2 000 MHz …

ISO/IEC TR 11801-9906
One pair channels up to 600 MHz

Draft scope:

- Channel descriptions, for channels constructed from single-pair cabling, to be used primarily for general purpose industrial process control applications and Industrial IoT applications.
- For supporting IEEE 802.3 single-pair Ethernet (SPE) applications:
  - 802.3 bp, 1000BASE-T1;
  - 802.3 bw, 100BASE-T1;
  - 802.3 cg, 10BASE-T1.
  - 802.3 bu, 1-pair PoDL
- Functional space ranges:
  - Rate: 10 Mb/s to 1000 Mb/s
  - Reach: 10 m to 1000 m
  - BW range: 1 MHz to 1000 MHz
  - Cable size: including AWG 24, 22, 20, 18; others TBD
- Environmental specifications, particularly EMC related, are referenced from the ISO/IEC MICE classification scheme based on the severity of the environment interfering with the signal integrity.
- The channel descriptions include guidelines for IL, RL, TCL, aC, parameters specifications, comparisons to the 4-twisted-pair cabling specifications, and respective estimates of channel capacity.

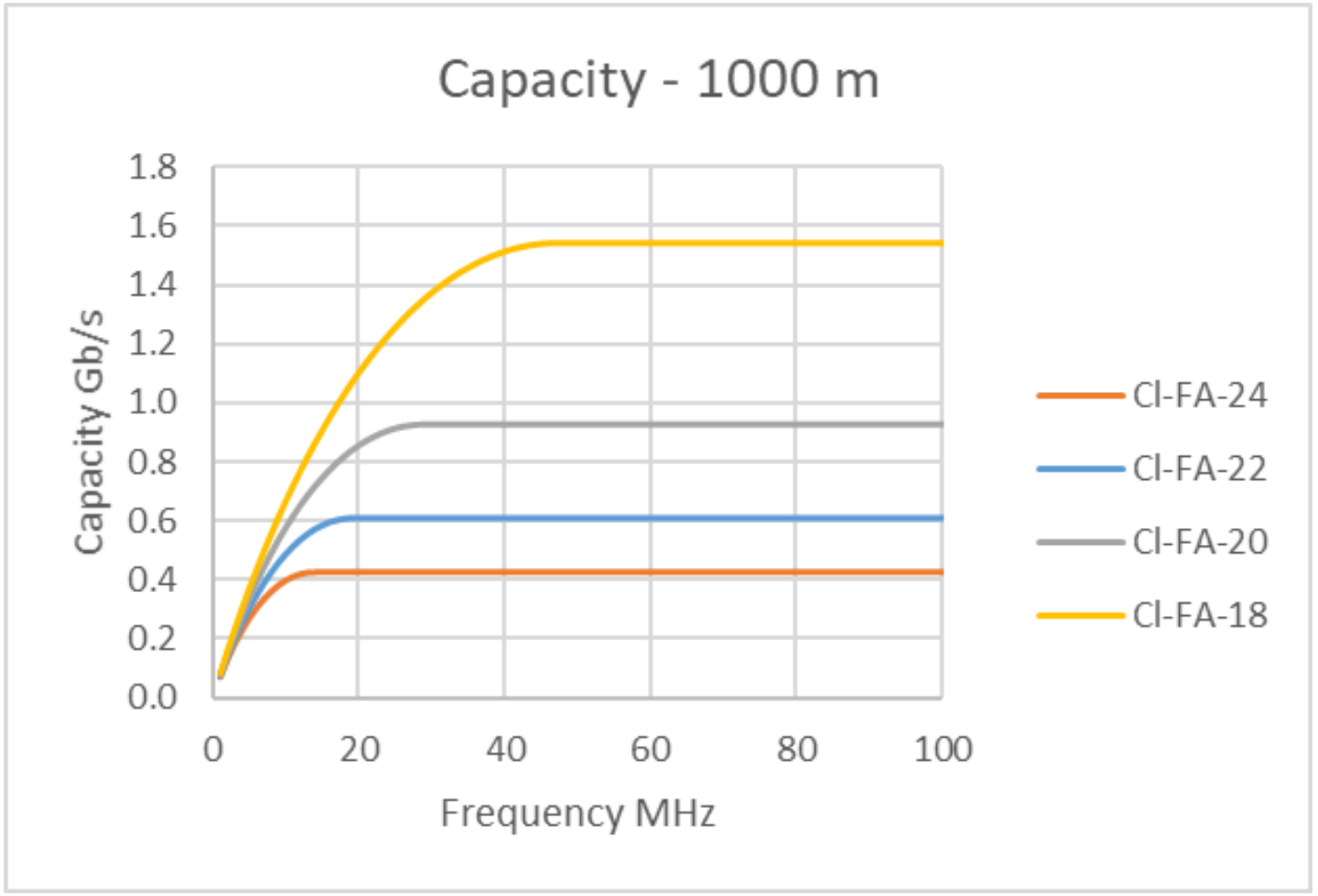
Results

- Channel capacity calculations
  - Cable sizes
    - 24 AWG
    - 22 AWG
    - 20 AWG
    - 18 AWG
- Alien crosstalk considerations for 4-pair and other bundled implementations
  - “Cable sharing” and bundle, modeling considerations
- Connector return loss summation model considerations for links having multiple connectors with various spacing.

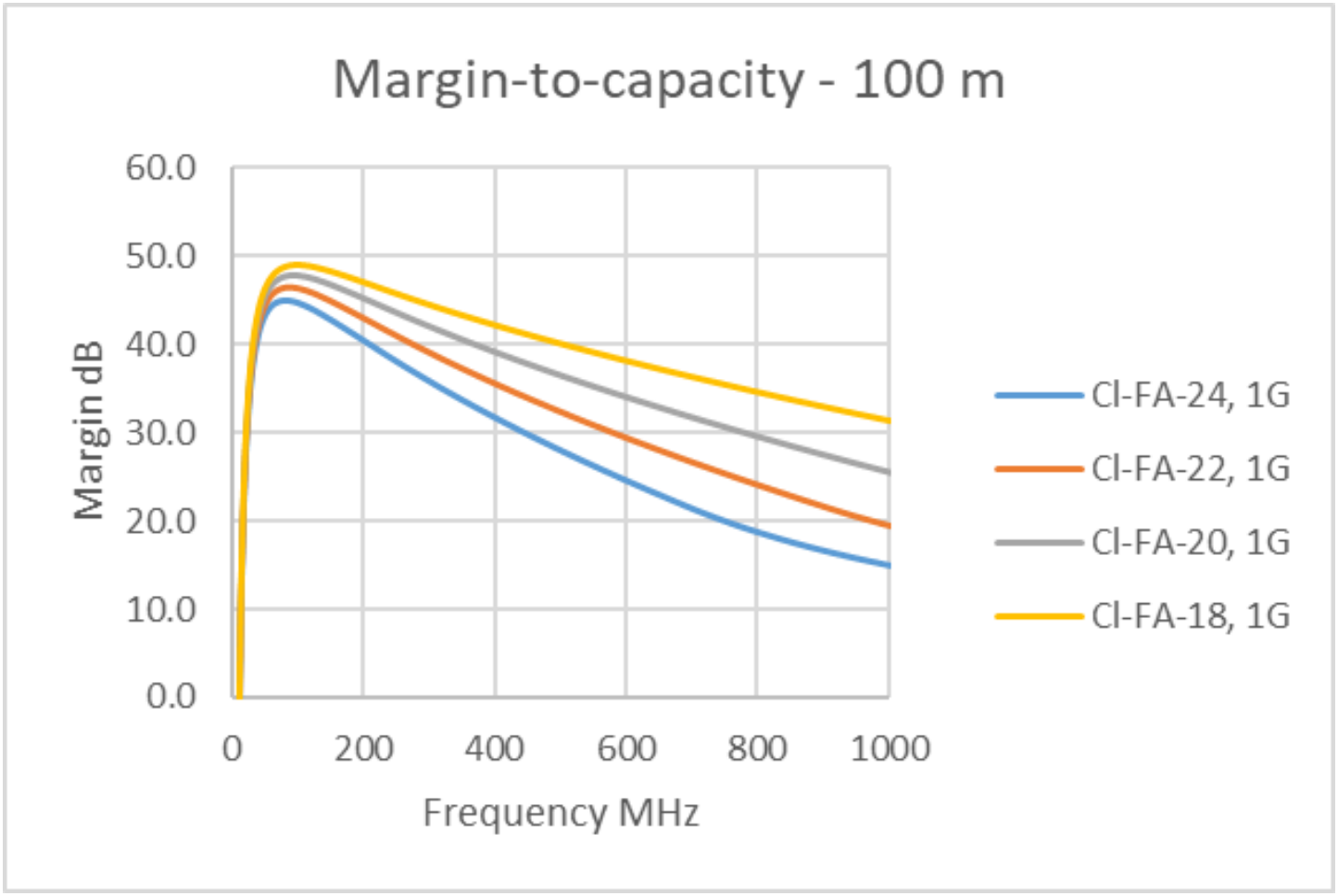
Channel capacity estimates

- Based on 802.3bz “ALSNR” equivalent calculation.
  - Using CAT7A (Class-FA) 4-connector channel parameters.
  - Cable sizes: vary attenuation according to AWG diameter.
    - 24 AWG
    - 22 AWG
    - 20 AWG
    - 18 AWG
- Using -145 dBm/Hz noise figure
  - Equates to 85-10log(f) dB coupling attenuation
- Notation:
  - aC = coupling attenuation
  - Cl-FA = Class-FA

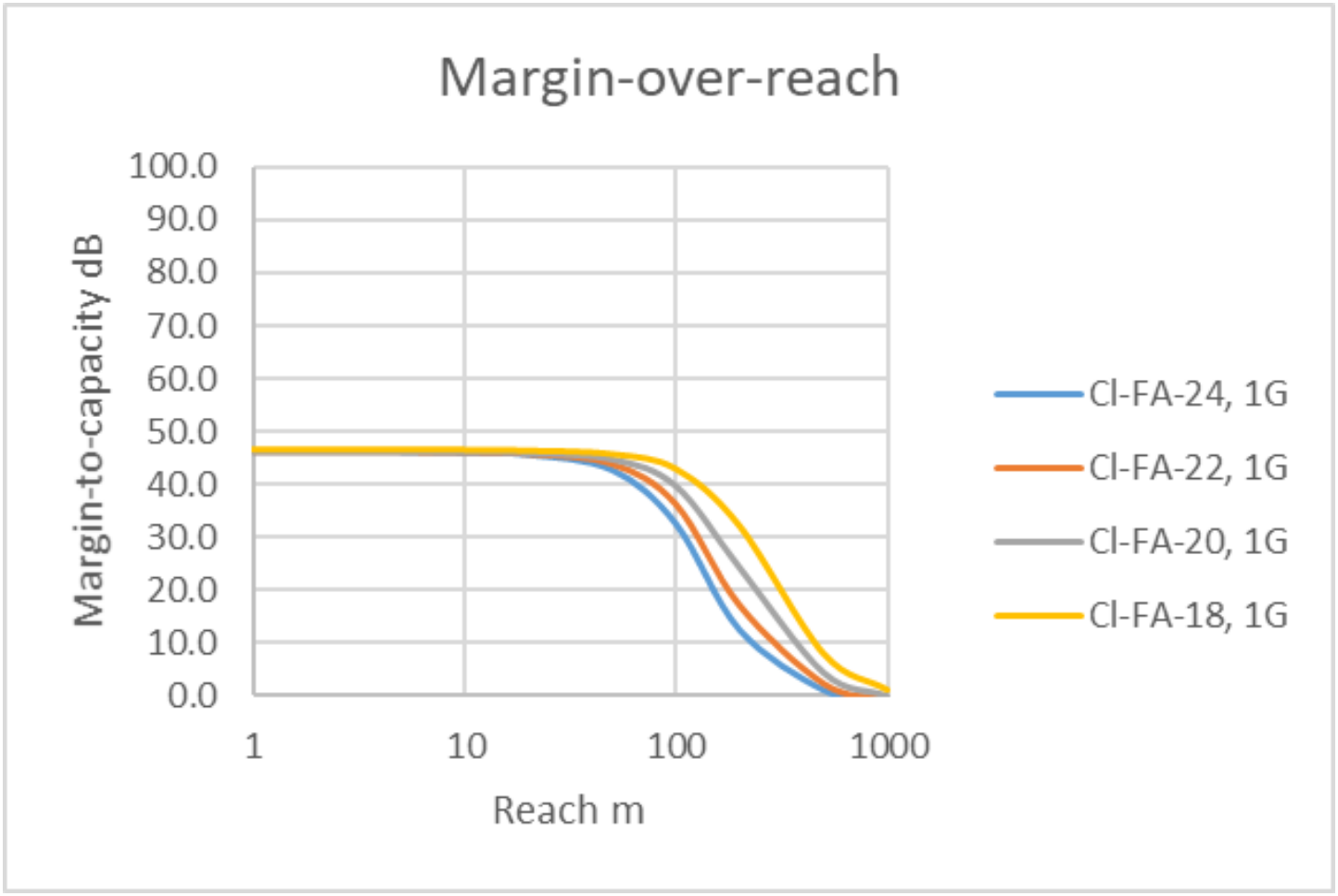
1000BASE-T1, Capacity, 1000 m



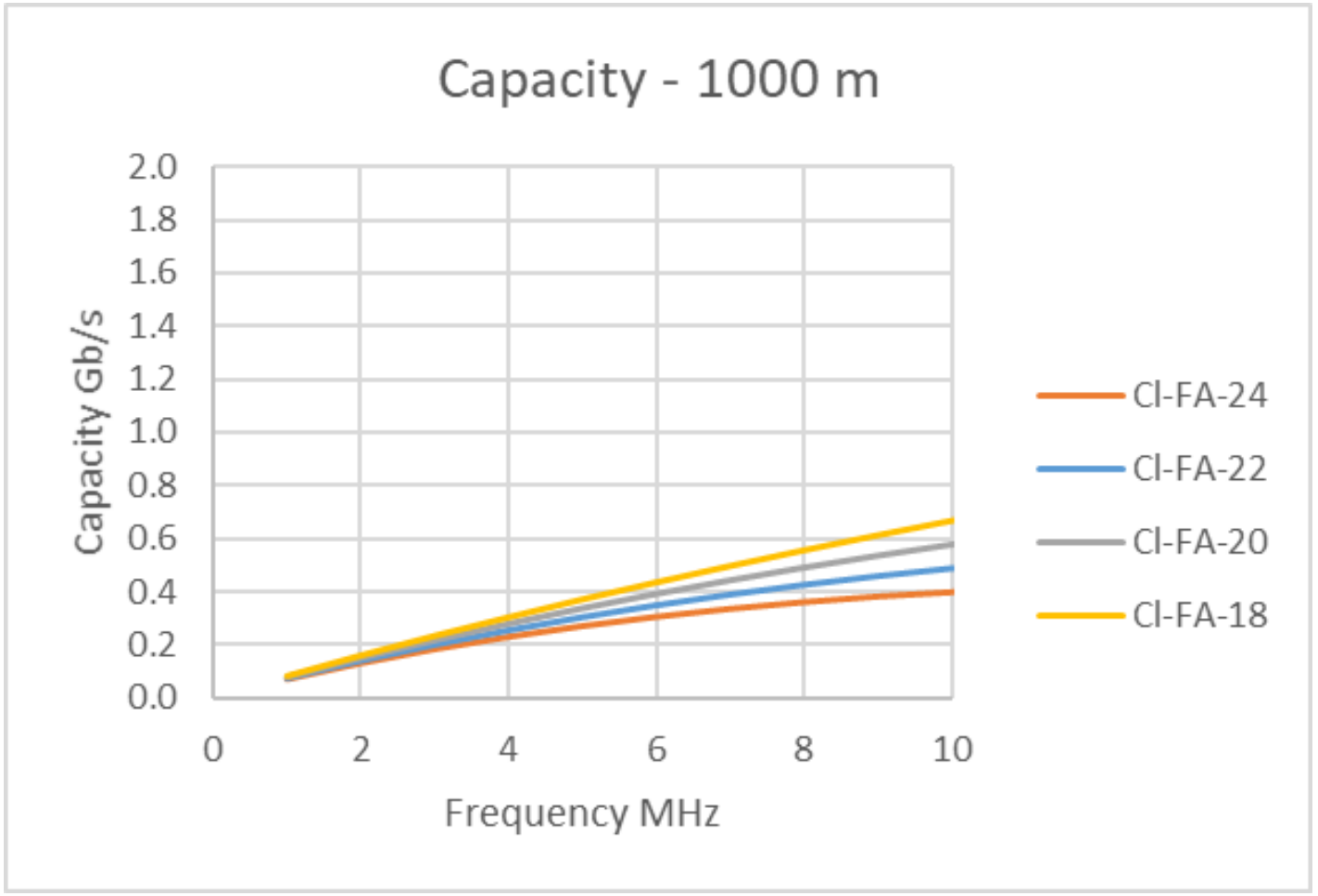
1000BASE-T1, Margin-to-capacity, 100 m



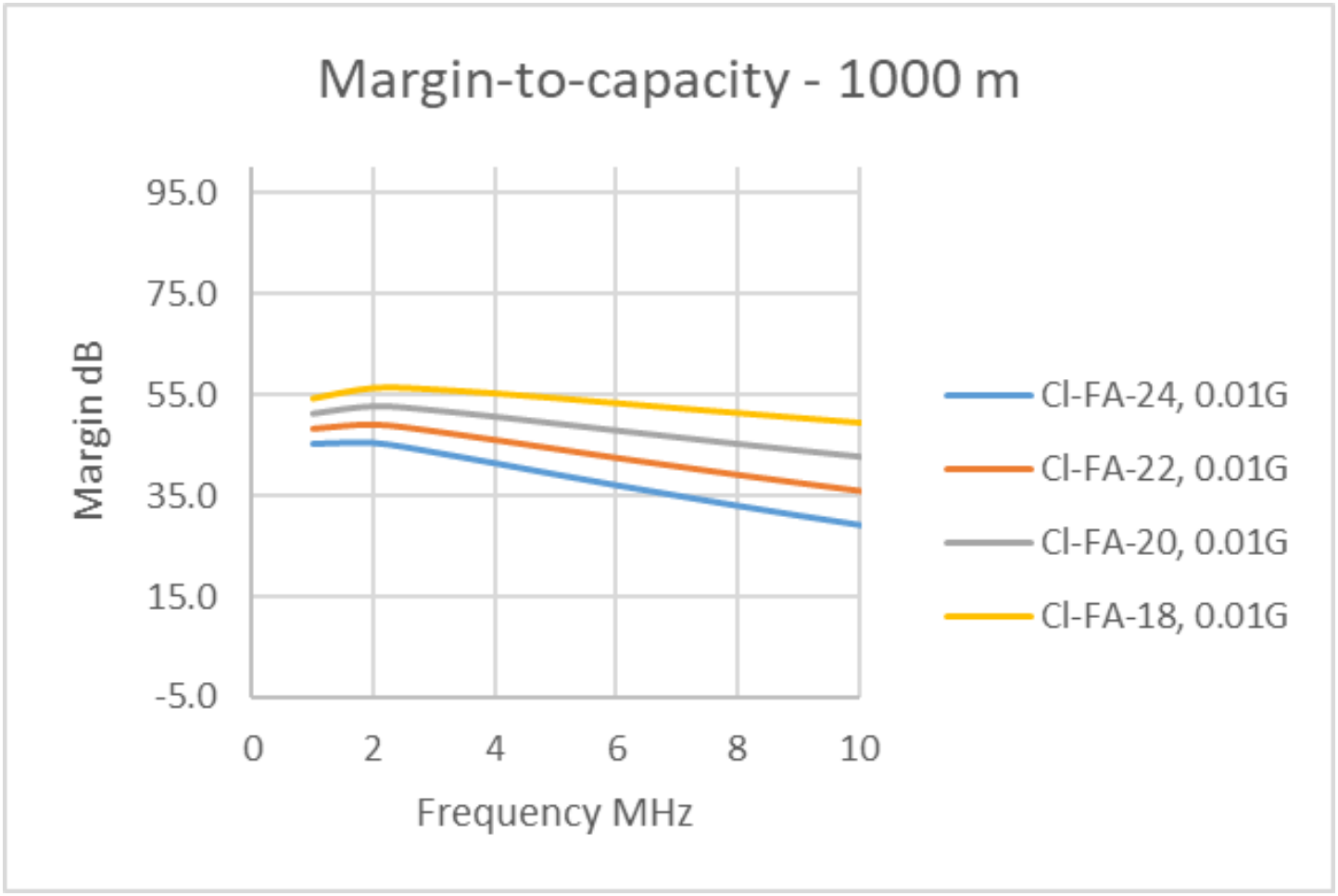
1000BASE-T1, Margin-over-reach



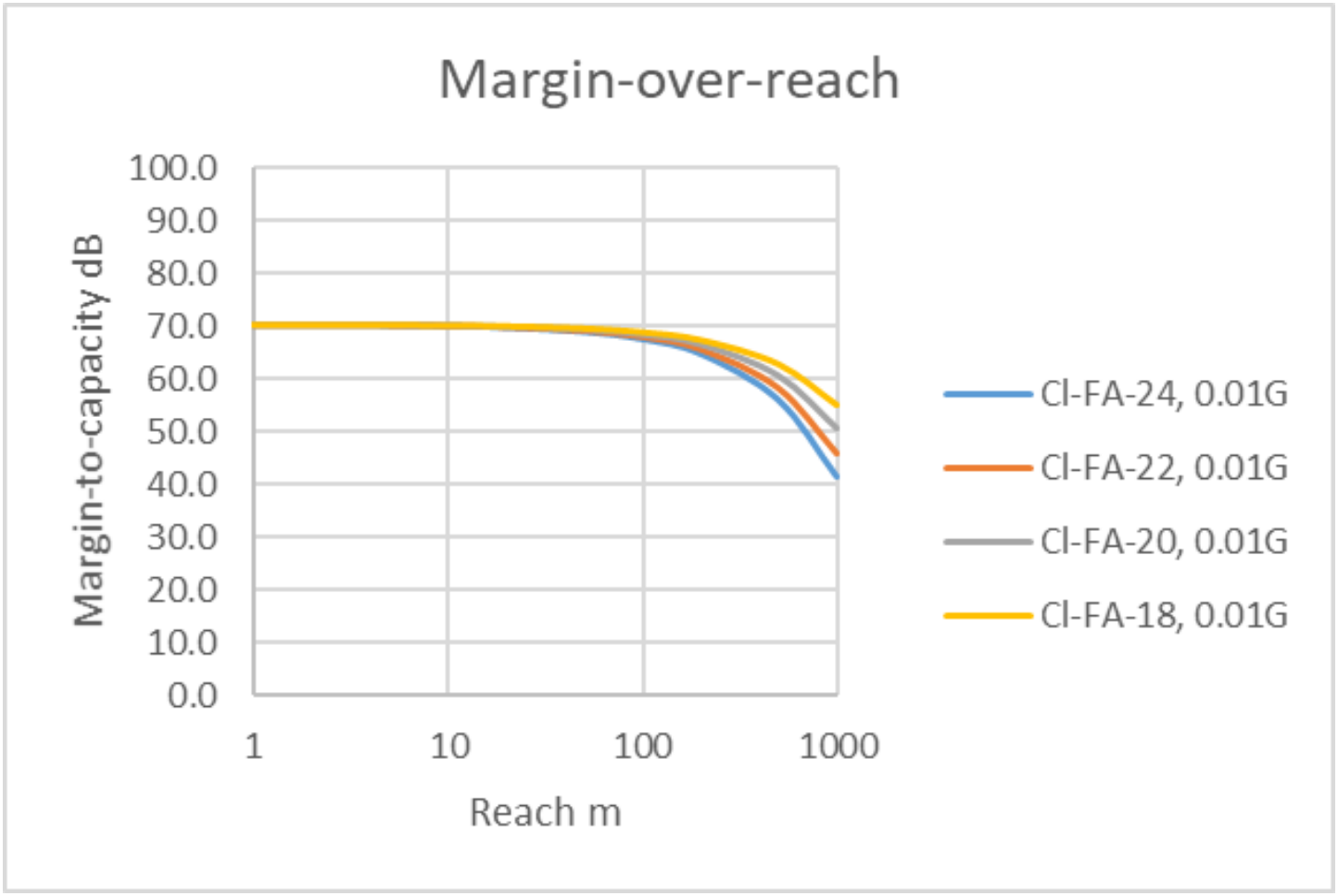
10BASE-T1, Capacity, 1000 m



10BASE-T1, Margin-to-capacity, 1000 m



10BASE-T1, Margin-over-reach



Preliminary conclusions

- Regarding AWG size, larger cable appears to has a greater effect on Power delivery, than its effect on Data capacity.
- Recommend U/UTP for supporting E1, using CAT6A components; recommend S/FTP for supporting E3, using CAT7A components.
- Considering a few performance levels according to BW, each varied by several sizes, according to use cases' reach needs.
- Considering three-way, EMC conformance verification by coupling attenuation, unbalance attenuation, or enhanced alien crosstalk loss; all according to component requirements, TBD.