

# EFM Copper

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## Flexibility and Bandplans

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# The problem

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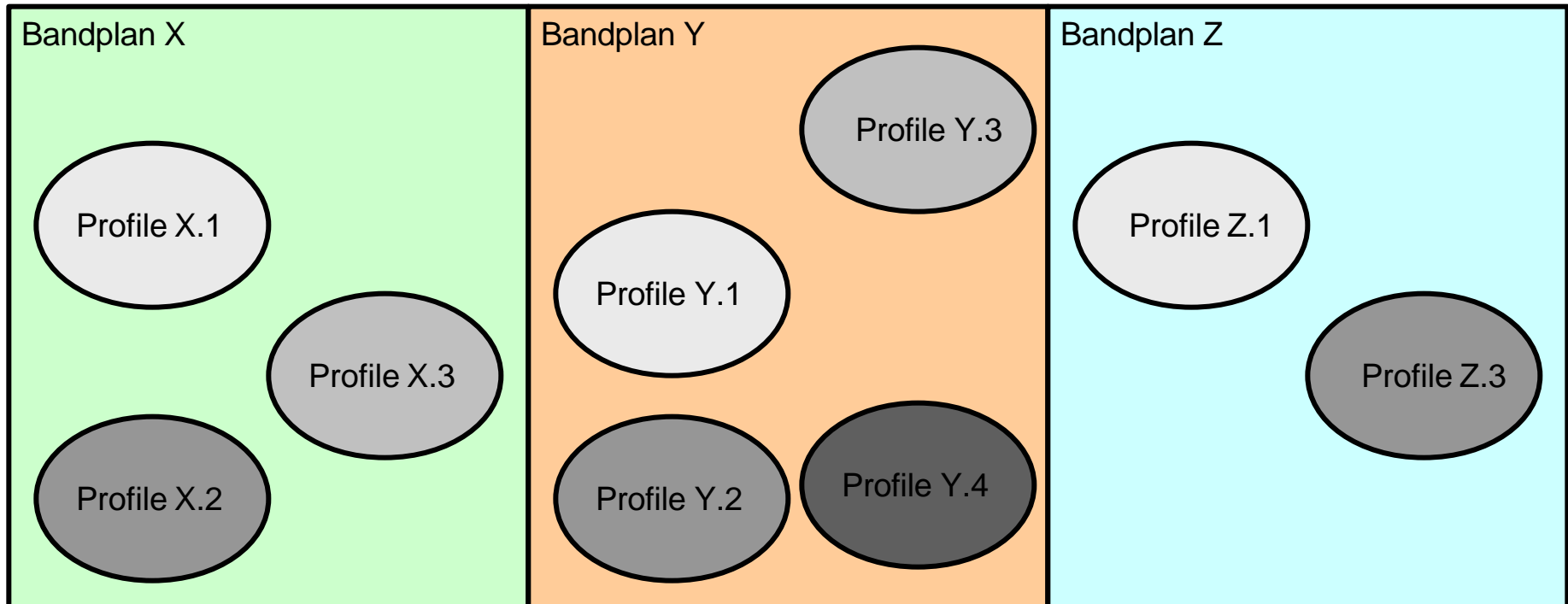
- Voice grade copper characteristics vary widely
- Local spectral regulations also vary widely
- Luckily, VDSL is a very flexible technology...

**How does this flexibility fit into the EFM<sub>Cu</sub> standard?**

- How do we specify, require and regulate this flexibility?
- This presentation will try to illuminate these questions.

# Flexibility Overview

- PHY Capabilities are determined by choice of bandplan and profile.
- Bandplans dictate the frequency PSD used for communication.
- Profiles control how the PHY uses the assigned bandplan (constellation density, interleaver depth, target bit rates, noise margin targets, etc.)

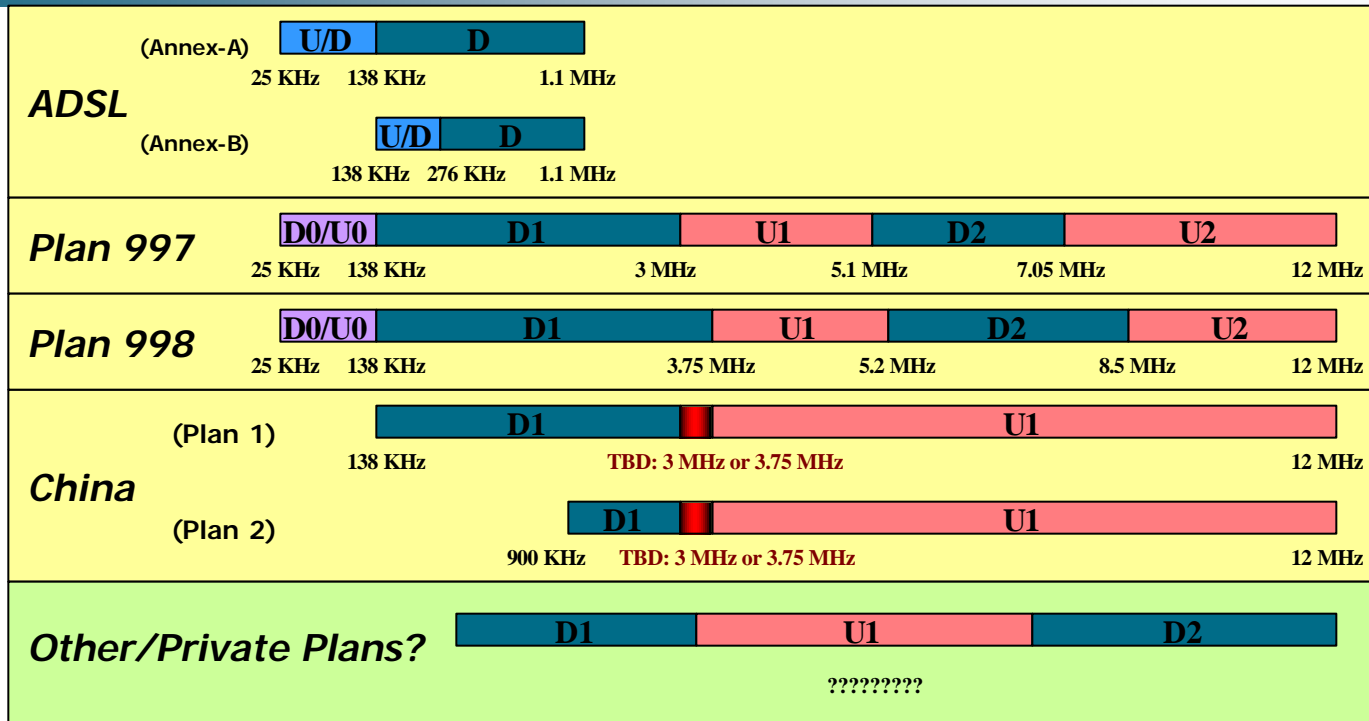


# Bandplans



- In general, a bandplan will be chosen by a regional regulator  
That bandplan will be a legal requirement in the region
- There are at least 3 different bandplans already specified worldwide
- These are **not** mutually compatible

# Bandplan Examples



- Bandplans also complicated by “method B” compliance  
     **Calculated interference instead of fixed PSD mask**
- Private bandplans may be optimized for particular applications

# How to handle bandplans?

- **Don't explicitly state any bandplans in the standard**
  - Leave hooks in PMD control to set PHY to arbitrary bandplan
  - Compliance issues relegated to system vendors and integrators
  - How do we specify compliance?
  - What degree of flexibility is required?
- **Specify each bandplan as an annex**
  - Compliance on an "annex-by-annex" basis
  - No flexibility required (but may be implemented)
- **Require compliance with all known bandplans**
  - Implies flexibility for systems
- **Some combination of the above**
  - Maybe flexible bandplans with an annex for each splitter
  - (POTS vs. ISDN vs. smartphone, etc)

# Flexibility?

- Different technologies and philosophies for bandplan implementation
- Primary requirements are echo cancellation and out of band rejection
- Several approaches exist

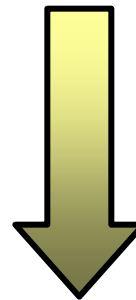
Purely discreet analog

Active / discreet analog combination

Active analog + digital

Purely active analog

Purely digital



Flexibility Increases  
Complexity Increases

# Profiles

- **Even within a bandplan, there are many variations**  
Bits/ baud, carriers used, rates and symmetry (plus interleaving)
- **MIB will define objects to control these parameters**
- **Two questions are raised:**
  - Which profiles must be tested for compliance?
  - How will MIB control these profiles?
    - What parameters will be needed?
  - How should the MIB objects be ranged? (for use beyond the standard)
- **Note that rates are coupled to reach**  
Many rate/reach curves, easy to get bogged down



# Call for Presentations

We ask that any interested parties please prepare a presentation for the EFM<sub>Cu</sub> STF, to be delivered at the July Plenary in Vancouver, BC.

Requested Topics:

Technical issues regarding the implementation of flexible bandplans

historically, state-of-the-art and the near future

Strategies for compliance testing

Rate/reach performance

Bandplan compliance

Any other topics related to bandplans, profiles and flexibility