10km and 20km budgets and optics safety

Frank Effenberger

Futurewei Technologies

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Loss budget plan

- The 100GBASE-BR10 loss range is 0 to 10 dB
- The 100GBASE-BR20 loss range is 5 to 15 dB

- This makes sense from a fiber loss perspective, in that 10 km of cabled fiber = 5 dB of loss

- The problem is that the receiver's damage threshold is only 1 dB higher than the overload level

Possible (mis)Configurations – Assuming BR10 and BR20 share wavelength plans

1. BR10 OLT – low loss – BR10 ONU — CORRECT
2. BR10 OLT – low loss – BR20 ONU — OLT burns out
3. BR10 OLT – med loss – BR10 ONU — CORRECT
4. BR10 OLT – med loss – BR20 ONU — CORRECT
5. BR10 OLT – high loss – BR10 ONU — No transmission
6. BR10 OLT – high loss – BR20 ONU — No transmission
7. BR20 OLT – low loss – BR10 ONU — ONU burns out
8. BR20 OLT – low loss – BR20 ONU — ONU burns out
9. BR20 OLT – med loss – BR10 ONU — CORRECT
10. BR20 OLT – med loss – BR20 ONU — CORRECT
11. BR20 OLT – high loss – BR10 ONU — No upstream transmission
12. BR20 OLT – high loss – BR20 ONU — CORRECT

Solution #1 to the burn out problem

- Use reverse wavelength plan for BR20
  - The mismatched optics cases then have Tx facing Tx, and the Tx is isolated
  - Cases 2 and 7 would avoid burn out – just no transmission
  - Cases 4 and 9 no longer work – just no transmission
  - Case 8 still presents a potential for burn out
- Installation personnel could also measure the field-side fiber port
  - The reverse plan makes identifying what kind of optic in on the other side very easy – all you need is a wavelength aware power meter
  - The power level could be confirmed to be within the acceptable range for the optic to be installed

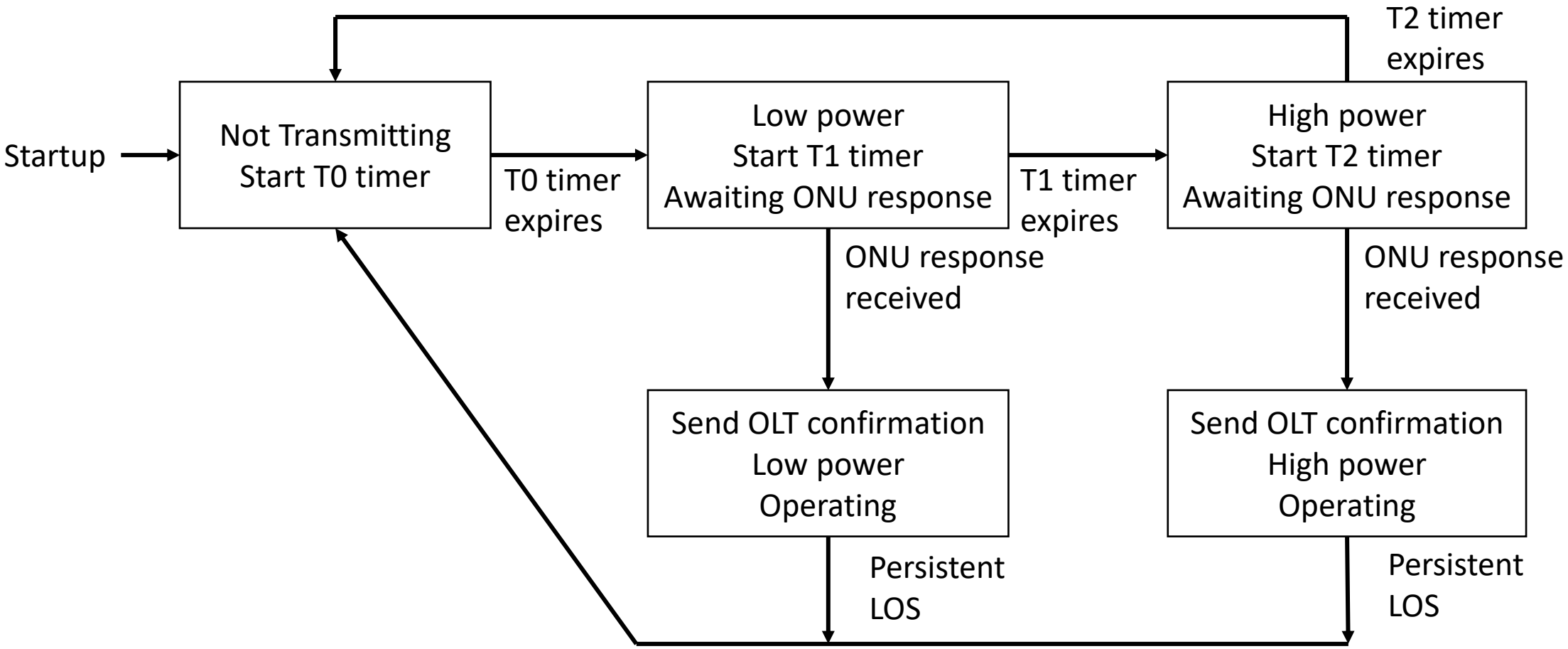
Possible (mis)Configurations – BR10 and BR20 have reverse wavelength plans

1. BR10 OLT – low loss – BR10 ONU — CORRECT
2. BR10 OLT – low loss – BR20 ONU — No transmission
3. BR10 OLT – med loss – BR10 ONU — CORRECT
4. BR10 OLT – med loss – BR20 ONU — No transmission
5. BR10 OLT – high loss – BR10 ONU — No transmission
6. BR10 OLT – high loss – BR20 ONU — No transmission
7. BR20 OLT – low loss – BR10 ONU — No transmission
8. BR20 OLT – low loss – BR20 ONU — ONU or OLT burns out
9. BR20 OLT – med loss – BR10 ONU — No transmission
10. BR20 OLT – med loss – BR20 ONU — CORRECT
11. BR20 OLT – high loss – BR10 ONU — No transmission
12. BR20 OLT – high loss – BR20 ONU — CORRECT

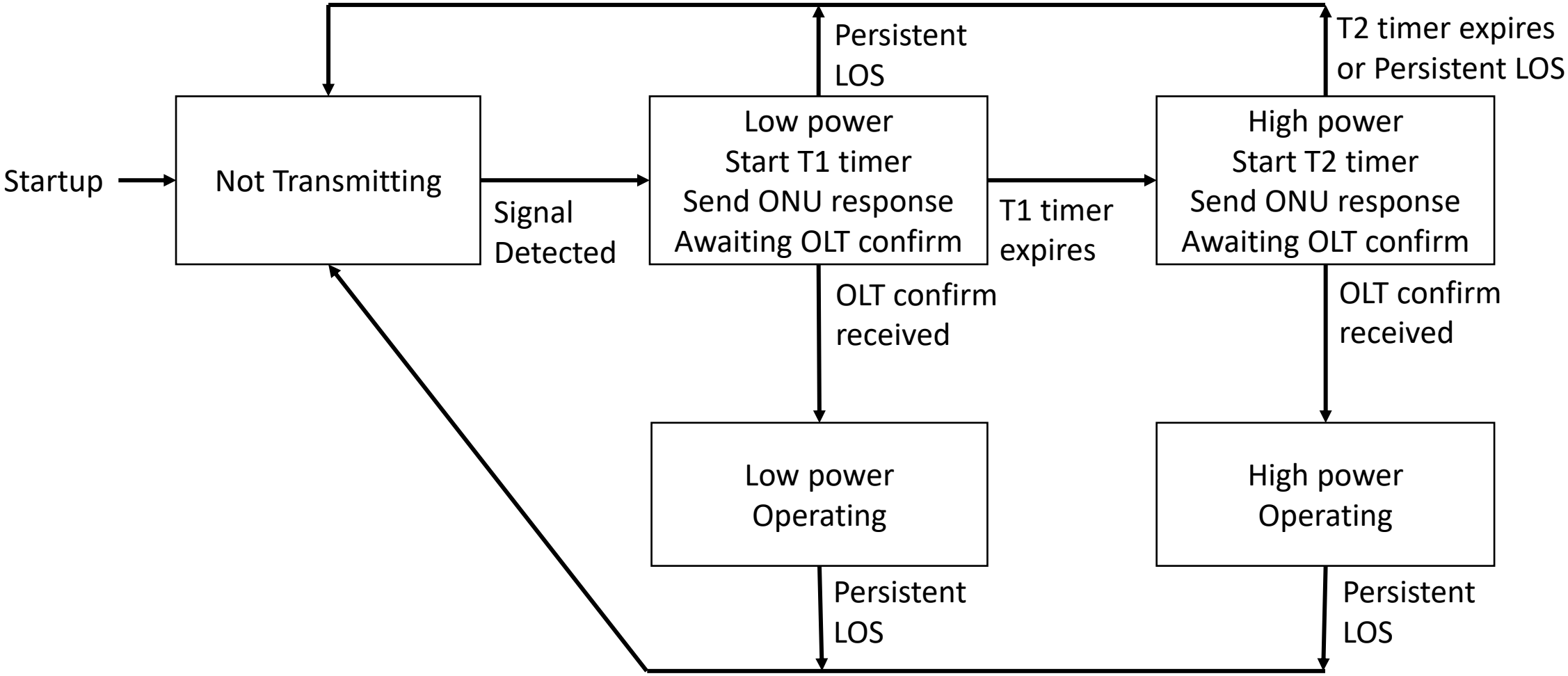
Solution #2 to the burn out problem

- “Soft start” procedure
  - Assume that transceivers can operate in either BR10 or BR20 mode, and have a common wavelength plan
- The OLT is normally off
- OLT would periodically come up in BR10 mode, and listen for ONU
  - If low or med loss fiber, then the ONU would come up in BR10 mode, the OLT would hear the ONU, send a response, and the link works
  - If high loss fiber, then the ONU won’t hear the OLT, and it remains silent
- After trying BR10 mode for a while, the OLT would try BR20 mode
  - The ONU would now hear the OLT, and it would come up in BR10 mode
  - The OLT won’t respond, so after a while, the ONU tries BR20 mode, the OLT would hear it and respond, and the link works
  - If the OLT still doesn’t hear any ONU, then it goes back to sleep
- On the plus side, this procedure is “green” and operationally easier
- However, if an ONU is plugged into a low loss fiber just as the OLT is trying out BR20, it will get burned!

Soft start OLT state transition diagram



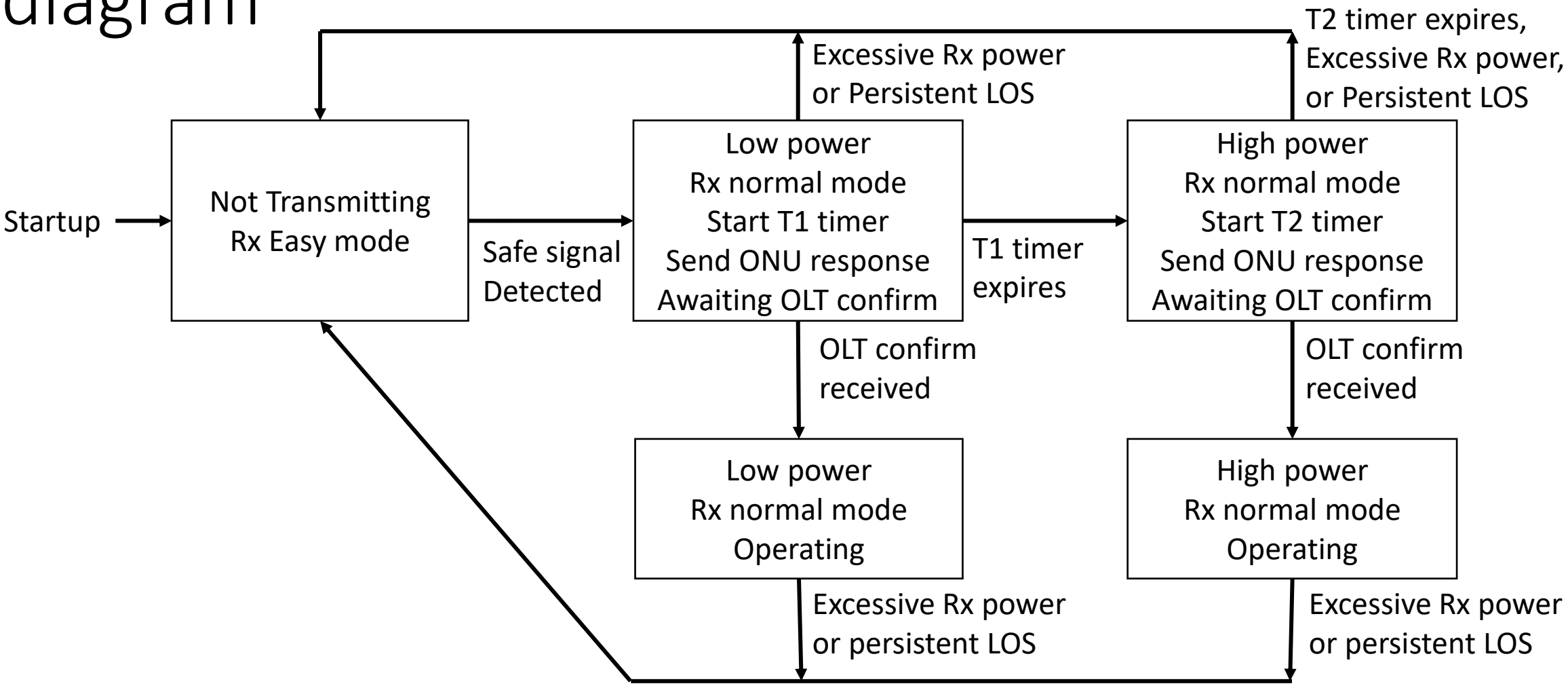
Soft start ONU state transition diagram



Solution #3 to the burn out problem

- “Easy listening” procedure
  - When an ONU receiver comes up, it is in “easy mode” with a higher damage threshold, such that direct connection to a BR20 OLT is tolerated
  - In this mode, it is essentially a power meter
- The ONU would remain in “easy mode” until it detects power
  - If the power is too strong, a warning light would be shown, and the ONU stays in easy mode, safe from damage
  - If the power is within range, the receiver would then switch to full operation, and begin receiving data
  - If the power is too weak, a different warning light would come on
- This kind of solution covers the gaps in methods 1 and 2

Soft start + Easy listening ONU state transition diagram



Conclusions for 100G BR10/20

- Solutions 1 and 2 alone don’t solve the problem in all cases
- A combination of 1 and 3 still leaves some corner cases unresolved
- A combination of solutions 2 and 3 can work in all cases
  - This hybrid option is a green solution, keeping power to a minimum
  - It also implies optics that are combined BR10 and BR20 – easier operations
- We propose to employ both “soft start“ and “easy listening” procedures for BR10/BR20 optics

Final thought: A bigger problem

- We already have quite a fleet of BiDi optical modules, with a range of wavelength plans and power levels and damage thresholds
  - And this promises to only get larger: 100G BR40 and 200G are coming
- If different speed optical modules are accidentally connected, there is a good chance of receiver burn out
- The same soft start and easy listening will help these cases, too

Thank you

Any questions?