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A Roadmap for Cable Access Reliability

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Reliability is the hot new concern

- A pilar for the 10G platform
- FCC-22-7A1 – does not include availability, but addresses other aspects
- Over the past year, at several webinars and events, Cable executives have been acknowledging the importance of reliability
- Several recent studies point toward a customer pivot from bandwidth to reliability
- Light Reading headlines as an example:
  - **Rogers will shell out billions on reliability, AI tech in wake of outage**
  - **Reliability paramount in home broadband, former Comcast CTO says**
- SCTE NOS WG8 – Service and Network Reliability
- NOS WG7, CableLabs PNM-WG – Failure Modes, Effects and Criticality Analysis linkage to repair matrix for PNM
- Flexible MAC Architecture – several reliability related work items

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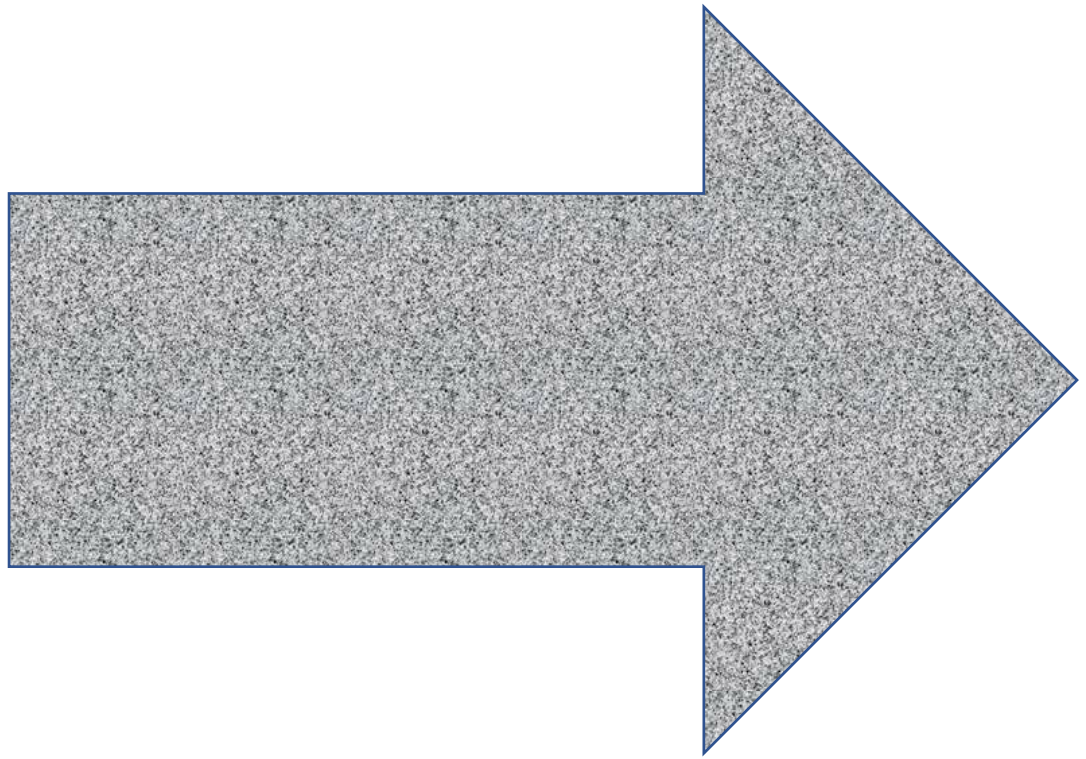
Customers are highly concerned about reliability. What do these mean to you, a customer, an operator?

- Reliability
- Availability
- Maintainability
- Repairability
- Survivability
- Resiliency
- Performability
- Friction



Service Reliability
=
Frictionless Experience

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Scenarios for discussion

A customer experiences pixilation on the screen. They are sensitive to this. Is this a failure, a fault, or outside the operator's concern? How do you know it happened?

A customer experiences slow webpage loading. They assume they need more bandwidth, so they call the operator

- The operator finds the customer needs more bandwidth – is this a fault, failure, other?
- The operator finds the customer has impaired service – is this a fault, failure, other?
- The operator finds the customer has a Wi-Fi problem – is this a fault, failure, other?

A customer slow webpage loading. But they suffer in silence. Is that a failure, fault, other? How does the operator know it happened, and how do they determine the cause?

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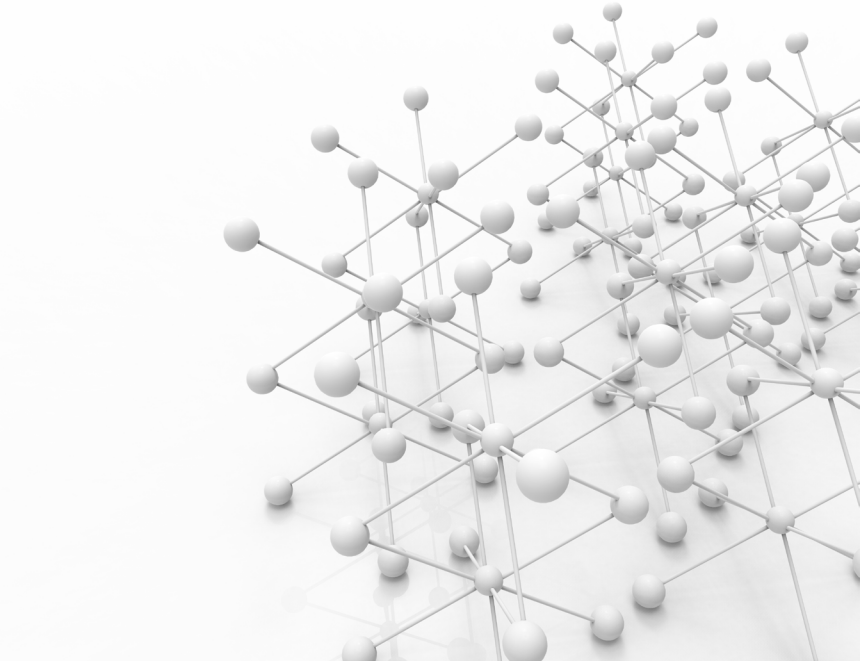
Assure reliable service

- Network, system, application, process, procedure, management, telemetry, everything
- Reliable, available, performing, effective
- Events and conditions link to customer experience and service impressions – friction
- Network operations: PNM, fault management, design, planning, engineering, life cycle
- Tools, glorious tools!
- Financial health, price stability, etc.



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Operations for reliable service

- Measures of performance combine for a measure of effectiveness, aligned with the customer's experience – when they experience friction, operators need to know.
- What can go wrong?
  - Try Failure Modes, Effects, and Criticality Analysis (FMECA)
- Set Service Level Agreements
- Assure Service - Reactive, Proactive, Predictive
- Manage Faults
- Optimize repair and supply chains
- Remove degraded and poor quality
- Manage vendors and contracts
- Design Reliable Networks
- Manage Life Cycle

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A foundation

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FMECA contained

- Define the thing and its purpose
- Break it down to sub-things and components
- Define how each can fail in its role
- Identify the effects of each failure mode
- Assign criticality to each failure mode
- keep going:
    - Probability
    - Cause – ask “why” five times
    - Purpose and effects extended
    - Detection, Localization, Mitigation

Component	Failure Mode	*	Exposure to elements	Accelerated physical damage	Accelerated corrosion	Exposure to potential electrical damage	Accelerated electrical degradation	High variability in signal levels	Intermittent impairments	impedance mismatch	echo tunnel (wave, multiple impedance mismatches)	flat loss	uneven loss (wet plant)	interval loss (adjacency, filters)	roll off	suck out	resonant peak	ingress noise	other noise	PIM+CPD noise	uneven signal	complete failure	*	Accelerated degradation	signal degradation	capacity loss	network separation	*	Signal Corrected	Signal impeded	Digital impacted	Application impacted (UDP)	Application impacted (TCP)	Application failure	Probability
Hard Line (distribution, trunk, feed	cut cable																					x				x							x		high
	cut or hole in jacket																																		
	cut or hole in jacket, shield																					?				?							?		
	cut or hole in jacket, shield, insulation																					?				?							?		
	heat damaged jacket																																		
	heat damaged insulation																																		
	degraded jacket																																		
	exposed shield, jacket pulled																																		
	dented shield																																		
	corroded shield, jacket damage																																		
	water shield, jacket damage																																		
	frozen shield, jacket damage																																		
	corroded conductor, j-s-i damaged																																		
	water conductor, j-s-i damaged																																		
	frozen conductor, j-s-i damaged																																		
	metal fatigue																																		
	stretched cable																																		
	incorrect type cable																																		
	crushed cable																																		
	bent cable, shield crease, insulation crush																																		
	pulled cable disconnect shield																																		
	pulled cable disconnect conductor																																		
	pulled cable disconnect completely																																		
	power line touch																																		
	electrical damage shield																																		
	electrical damage conductor																																		
Connector	bent																																		low
	mis-thread																																		medium
	loose																		?																high
	corroded																																		low
	crimp, poor fittings																																		high
	mechanical failure																																		medium
	wrong type, model, poor fit																																		
	open																					x				x							x		high
	EMC - poor connection quality																																		
	weatherproofing failure or missing																																		
	incorrect stinger length																																		

FMECA is usually about failure. But networks degrade, and services work under imperfect conditions. So we extend the method into all the effects impacting service.

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As the network degrades, so does performance

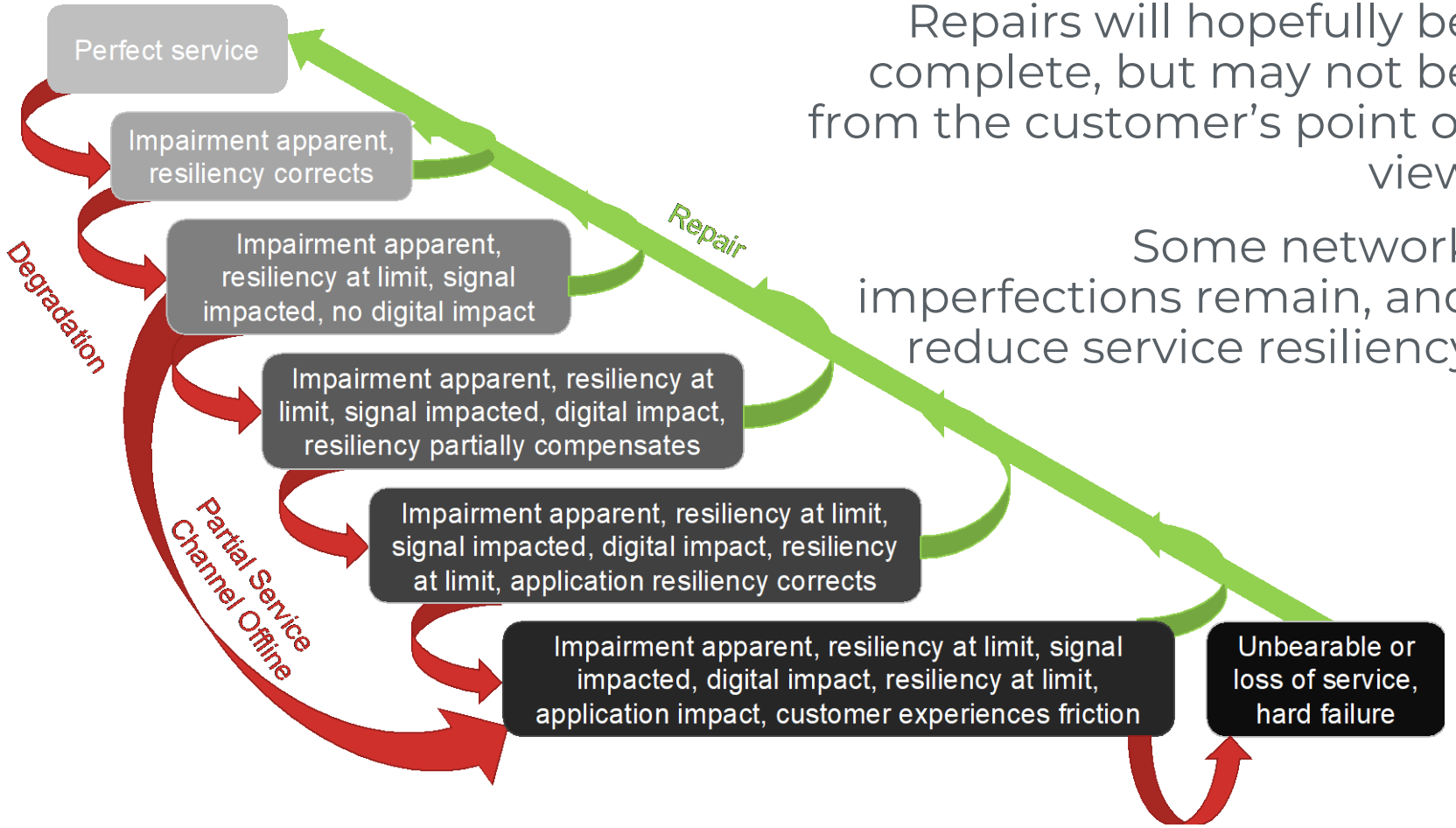
Degradation from the network components compounds and worsens

DOCSIS resiliency counteracts at the physical layer, then data layer, until it can't

Services do what they can to counteract until they can't

Customer experiences degraded service and friction

Shock failures force rapid decline



Repairs will hopefully be complete, but may not be from the customer's point of view

Some network imperfections remain, and reduce service resiliency

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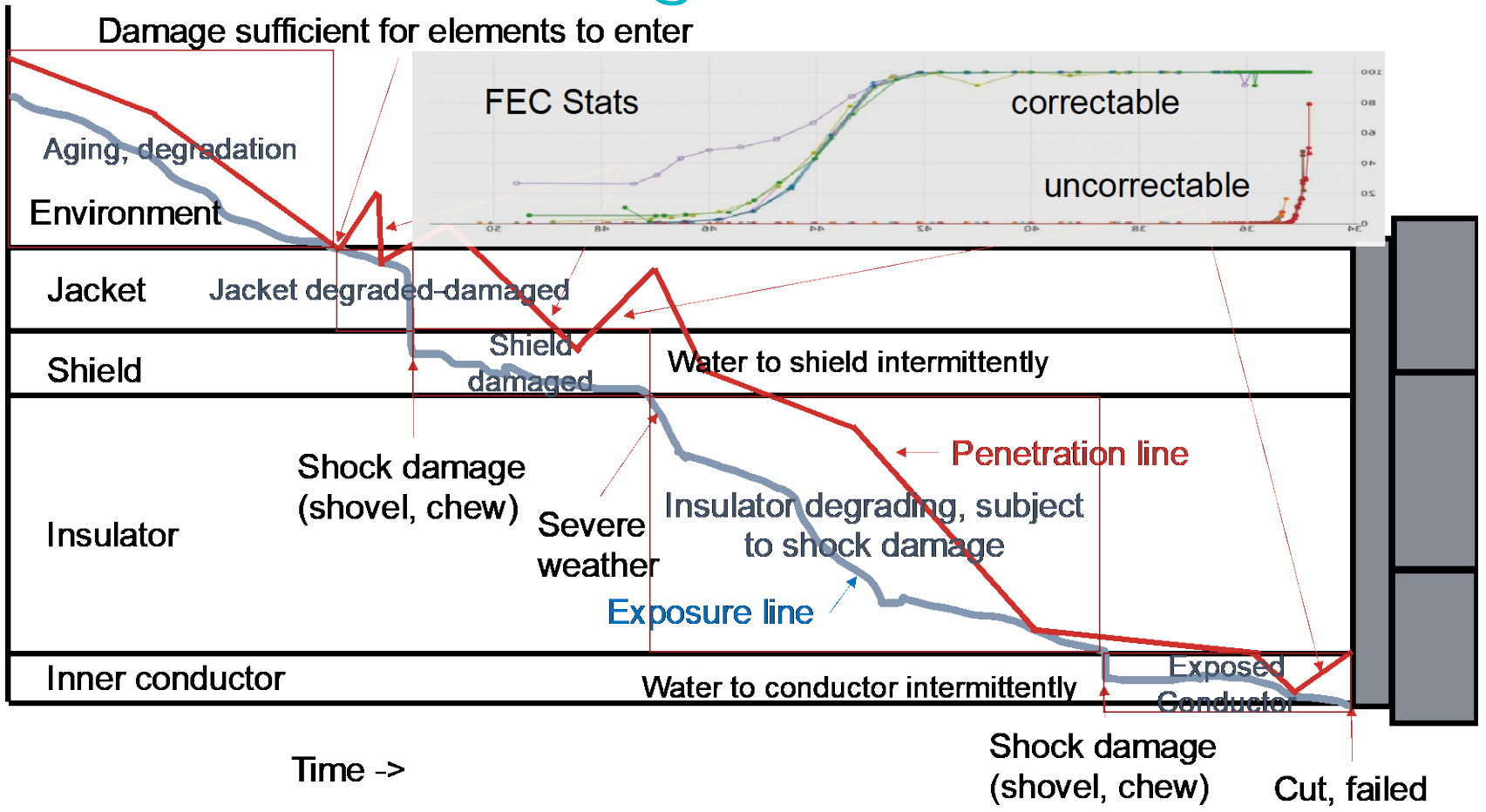
Another look at degradation in the access network



- A section of cable degrades and experiences shock damage
- At times, elements enter and can be detected by impact on signal or service
- Other times, water dries out or corrosion is reduced
- Degradation continues until addressed by replacement
- As damage continues, the network changes states and service worsens

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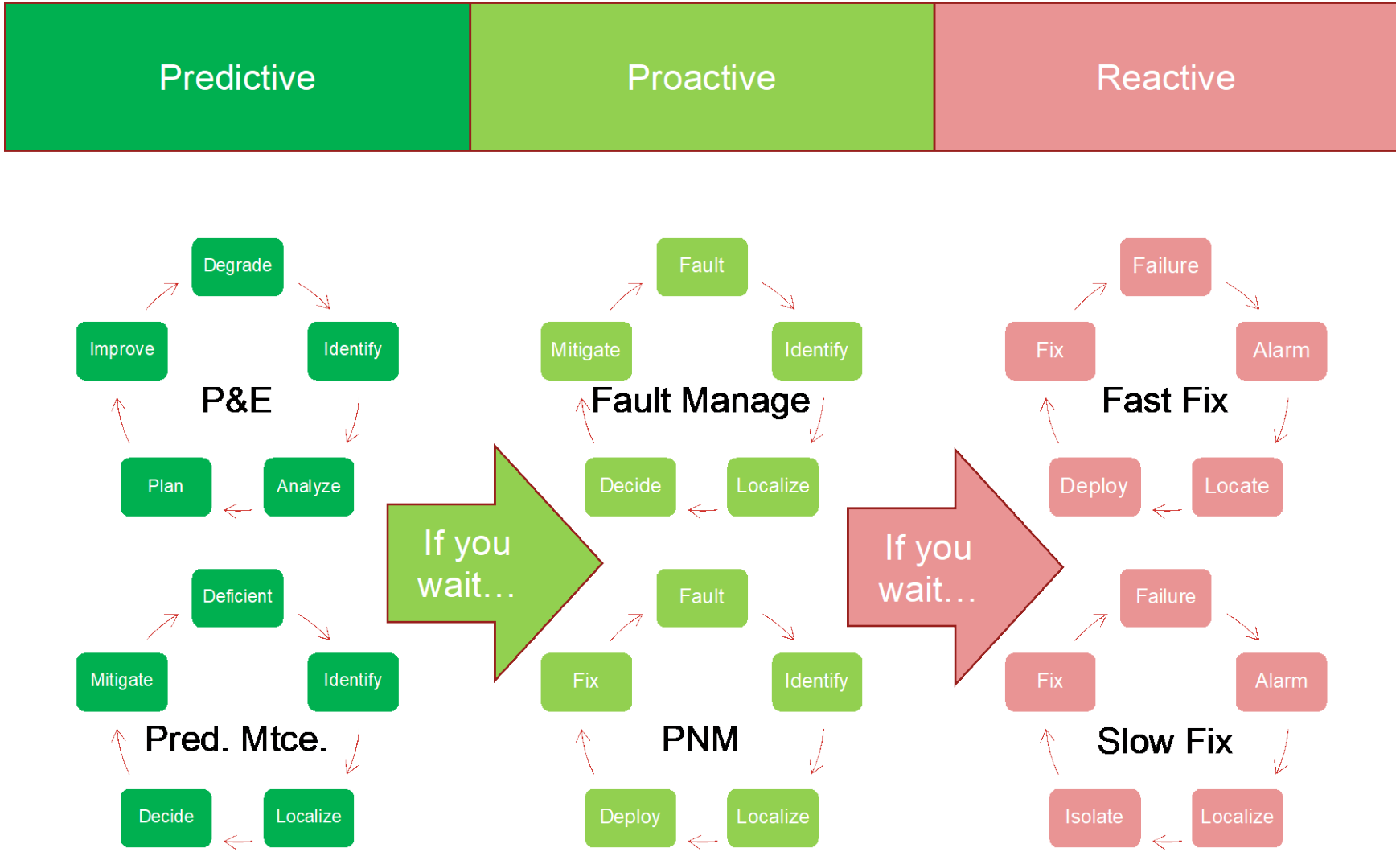
Fix it cycles

Every operations cycle is an opportunity to improve



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Why did it fail?

Water in the hard line – because water in the tap – because tap plate not secure AND too low to ground AND flooding occurred – because a damaged cable was fixed too fast – because of pressure to fix fast – because of a program to reduce repair times – because…

Customer had to reset modem – because video service gave an error on the TV – because some software process was not responding – because some software state is not monitored or not addressed when indicated – because the impact of the process is not well understood – because nobody conducted an FMECA – because…

In each of these examples, and many like them, there are multiple places where the failure mode can be addressed.

Address the failure, address the cause so the failure doesn't repeat, and address the cause elsewhere to prevent it from happening elsewhere.

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What goal do we set to assure service reliability for cable?

- Measure customer friction, and reduce it by 25% for those who experience the most
- Reduce degraded experiences by half by 2025
- Benchmark and deliver a better experience than the broadband competition
- Provide the highest service reliability with video programming
- Other
- Discussion?

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Thank You!

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Proactive Network Maintenance
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