

Attendee Announcements

- ✓ **Seminar Raffle** – Be sure to drop your raffle ticket in the drum at today's Keynote located in the Tangerine Ballroom. You have a chance to win a \$250 American Express Gift Card. One winner will be drawn at the Opening Keynote and the Closing Keynote. **You must be present to win.**
- ✓ **Seminar Evaluations** – All attendees will be receiving an email with regards to the seminar and we encourage you to respond to the surveys. The survey results will be compiled by ISE EXPO team members, summarized, and will be shared with the seminar speakers. *The seminar feedback is an important aspect of continually improving ISE EXPO.*
- ✓ **Seminar Certificates** – Attendees will be able to log into the Attendee Resource Center (ARC) using their first name, last name, and their Badge ID (this number will appear on the badge and also on any registration confirmations) to view/print their seminar certificates. If a certificate is needed on-site, the attendee may visit the ISE EXPO registration counter between the hours of 1 PM – 3 PM September 13 & September 14 and ask for a certificate to be printed. Attendees will be able to access the ARC website up to 2 – 3 months after the event to print CEC certificates.
- ✓ **Subscribe** – ISE magazine is the most trusted educational and solutions resource for 21,000 professionals across the ICT industry. Each month, ISE delivers 20+ educational articles and showcases leading technology solutions in an approachable and interesting format, available in both print and digital. Visit <http://www.isemag.com/subscriptions/> to begin or renew your subscription.

Agenda

BICSI – 1 CEC

This talk was recently presented by Mike Dazio at the IEEE Workshop on Communications, Quality and Reliability (May, 2016 and May, 2017) and focused on the issues facing service providers as they struggle to maintain legacy telecom networks. The goal is to extend the life of your legacy telecom investment by fighting obsolescence. This talk focuses on issues and solutions that are relevant to service providers:

Market Trends

- * Aging telecom network
- * Subscribers decreasing 10% per year
- * Wireline maintenance costs increasing
- * Vendors exiting legacy business
- * Lack of technical support and repair capability threaten major service disruption
- * Cost to Migrate to next generation is too expensive

Solutions to Extend the life of Legacy Systems

- * Assess the network for legacy products
- * Manage OEM vendors (Determine End of Life dates)
- * Assess Technical Support Issues
- * Assess Repair Issues



Slide Presentation

- Slide Presentation can be found at <http://zttechsol.com/events-news/ise-expo-2018-techtalks/ise-expo-2018-presentation/>
- IEEE CQR May, 2017 <http://zttechsol.com/events-news/ieee-cqr-2017/ieee-cqr-2017-presentations-videos/>
- IEEE CQR May, 2016 <http://zttechsol.com/events-news/ieee-cqr-2016/>



IEEE ComSoc International Communications Quality and Reliability Workshop

9-12 May 2016 – Stevenson, Washington, USA

Agenda

This year's workshop will be at Skamania Lodge in Stevenson, WA in the Columbia River Gorge about 45 minutes east of Portland. More details at <http://cqr2016.ieee-cqr.org/program.html>

Session 8 - Legacy Network Reliability Risks

Mike Dazio, ZT Technology Solutions - Fight Obsolescence: Extend the Life of Legacy Telecom Networks

Mike Plumb, Precision ERS - Repair Solutions for Legacy Networks

Carmine Chase, Century Link - Challenges Facing Transport

Spilios Makris, Palindrome Technologies - World Games and Olympics reliability lessons learned for large networks and venues



IEEE ComSoc International Communications Quality and Reliability Workshop

16-18 May 2017 – Naples, Florida, USA

Agenda

Operations Panel – Science and Statistics of Better Legacy Network Reliability

Chair: Martin Guldborg, Verizon Wireless - <http://cqr2017.ieee-cqr.org/program/day-2-speakers/>

Abstract – Mission critical services including emergency communications services are provided by wireline and mobile carrier networks containing large quantities of aging equipment. Some of this equipment has been in service 25 years, and in some instances as much as 40 years.

Time has marched on, technology has evolved, development teams have been reassigned, budgets have been reduced and spare parts are becoming very scarce. These factors combine to make service reliability very challenging with a difficult goal of keeping customer-impacting outages to an absolute minimum.

This panel will present and discuss some of the advanced scientific and statistical methods being constructively used to narrow the root causes of reliability risk and put in place cost-effective maintenance actions which improve long-term network reliability. Communications use cases will be compared with analogous improvements in military platform reliability.

Speakers include

Mike Dazio, ZT Technology Solutions

Mike Pohland, Lead, Physics-of-Failure Program at U.S. Army Materiel Systems Analysis Activity

Mike Plumb, Precision Electronic Repair Systems



IEEE ComSoc International Communications Quality and Reliability Workshop

15-17 May 2018 – Austin, Texas, USA

- CQR 2018 will be held at [AT&T Hotel and Conference Center](#), Austin, Texas, May 15-17, 2018
- My Focus is to develop a Community of interest for Life Cycle management of Legacy products

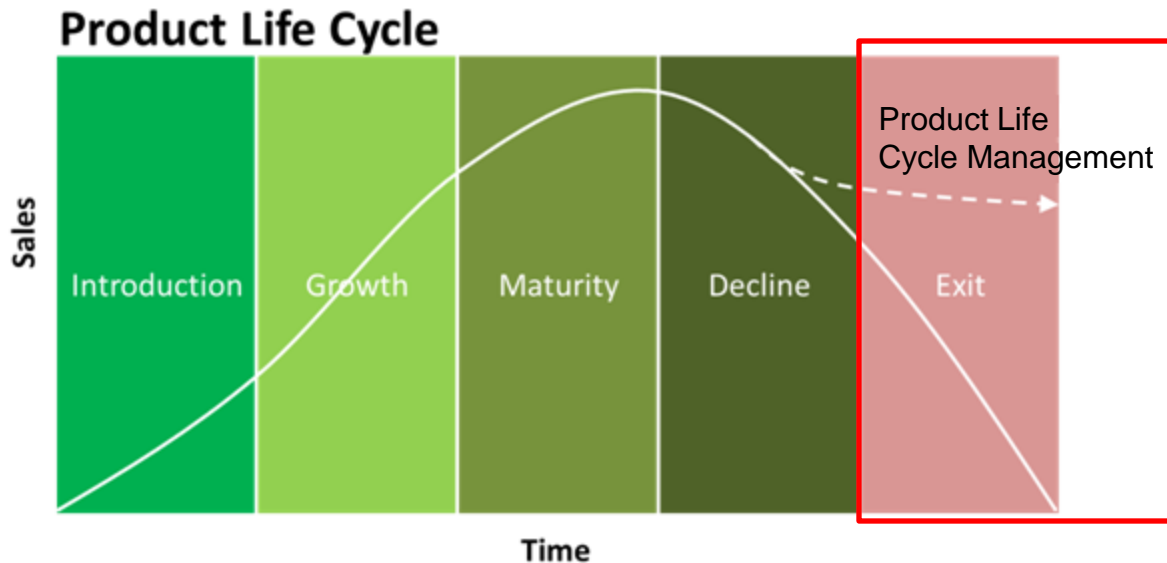
Fight Obsolescence

ZT Technology Solutions' mission is to extend the life of your legacy telecom investment by fighting obsolescence

Mike Dazio



Extend the life of your legacy telecom equipment

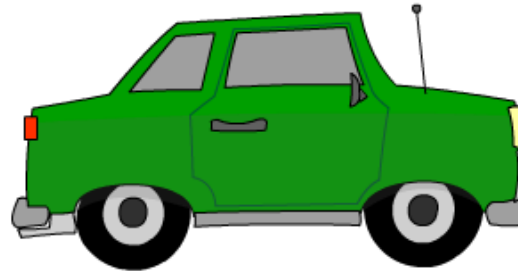


- Network Equipment, Cars, B-52 Bombers and People have a Life Cycle
- Good news..... That life cycle can be extended

Extend the life of legacy telecom equipment



The B-52 was introduced in 1952, over 60 years ago. During that time, it has undergone many updates and upgrades that have allowed it to continue to be a critical part of the U.S. Air Force. It is expected to serve into the 2040s.

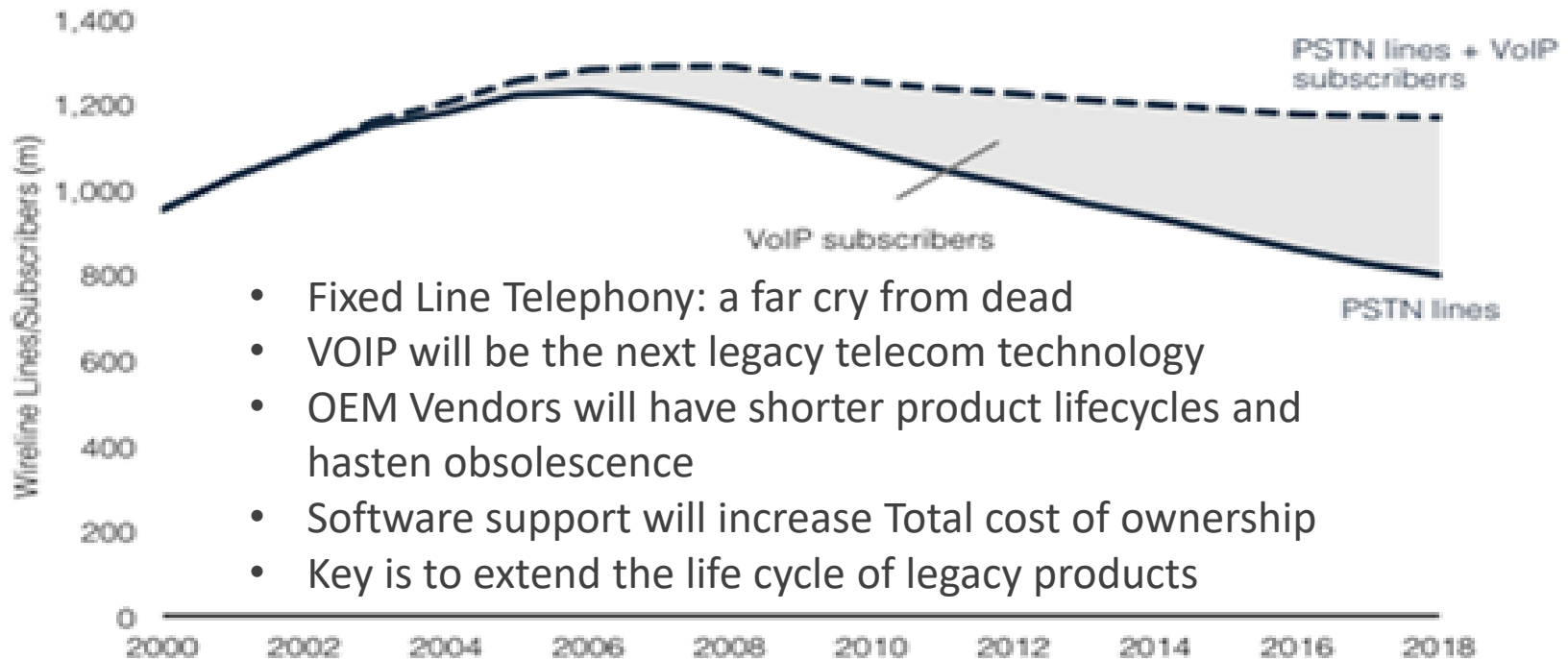


Market Trends

- Aging telecom network
- Subscribers decreasing 10% per year
- Wireline maintenance costs increasing
- Vendors exiting legacy business
- Lack of technical support and repair capability threaten major service disruption
- Cost to Migrate to next generation is too expensive
- Service Providers and OEM's are consolidating thru M&A
- CAPEX is focused on Fiber/5G
- NFV/SDN is the ultimate answer

Global Wirelines PSTN vs. VoIP

Global Wirelines, PSTN vs. VoIP, 2000-2018



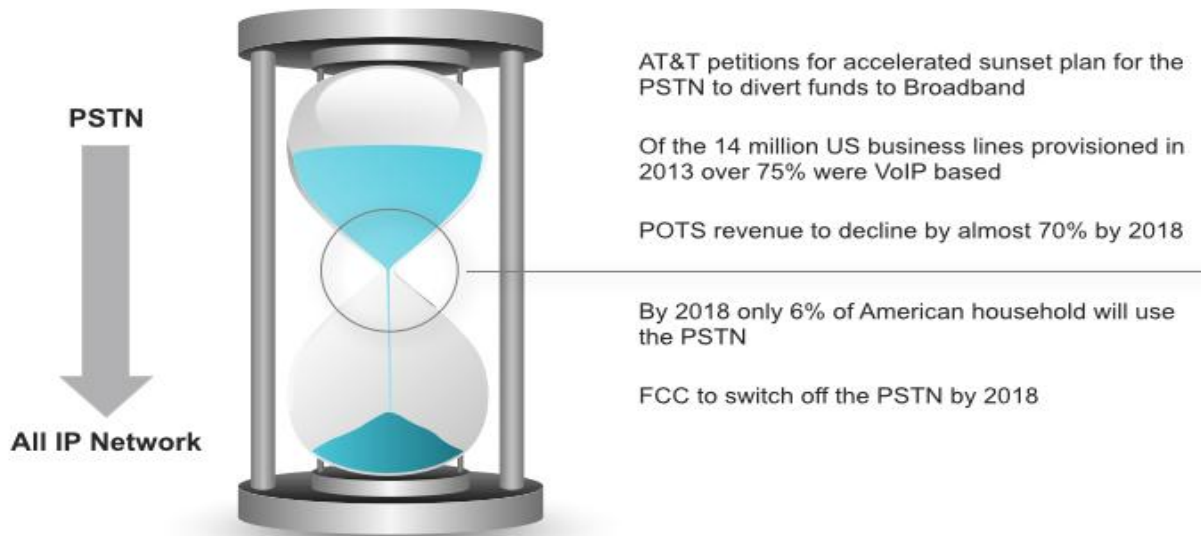
- Fixed Line Telephony: a far cry from dead
- VOIP will be the next legacy telecom technology
- OEM Vendors will have shorter product lifecycles and hasten obsolescence
- Software support will increase Total cost of ownership
- Key is to extend the life cycle of legacy products

FCC Ponders Death of PSTN

By [Karl Bode](#)

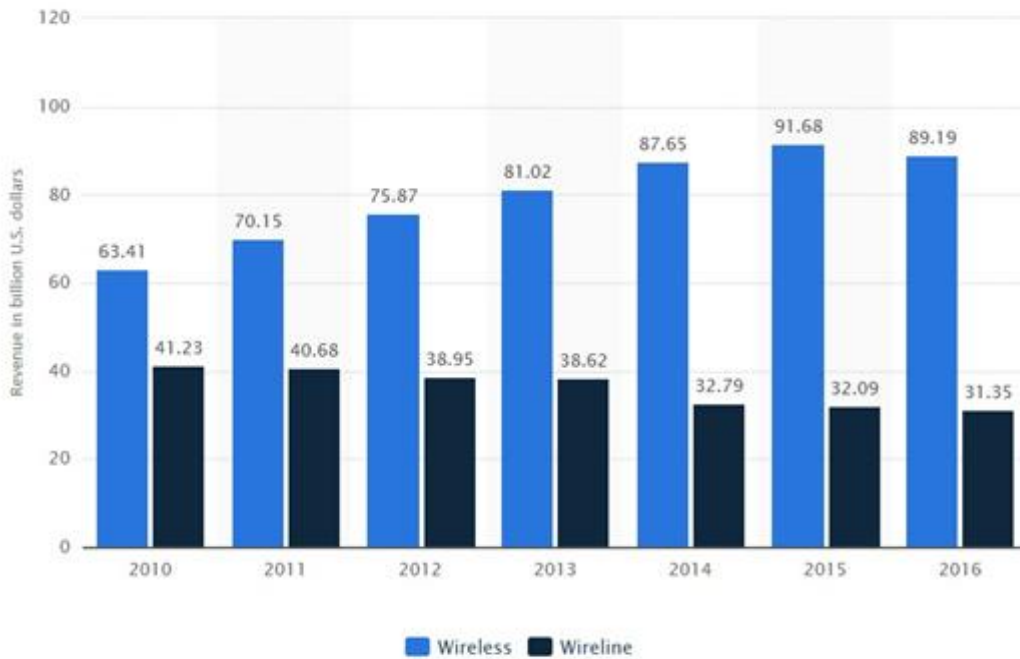
Thursday Jul 07 2011 08:48 EDT

The Technical Advisory Council (TAC) to the Federal Communication Commission suggested in a [June 29 presentation](#) (pdf) to the FCC that the agency impose a "date certain" for the sunset of the public switched telephone network (PSTN). [Telecompetitor](#) directs our attention to an interesting discussion of the move over at the [Fractals of Change blog](#), where TAC member Tom Evslin notes that while only 6% of the US population will still be served by the public switched telephone network by the end of 2018 -- there still needs to be some government plan in place to migrate these mostly-rural users (who don't have broadband and may not have wireless access) lest they lose things like 911 service. Eager to eliminate the costs of operating these lines, AT&T has been [pushing for the death of the PSTN for several years already](#).



Verizon Wireline and Wireless Services

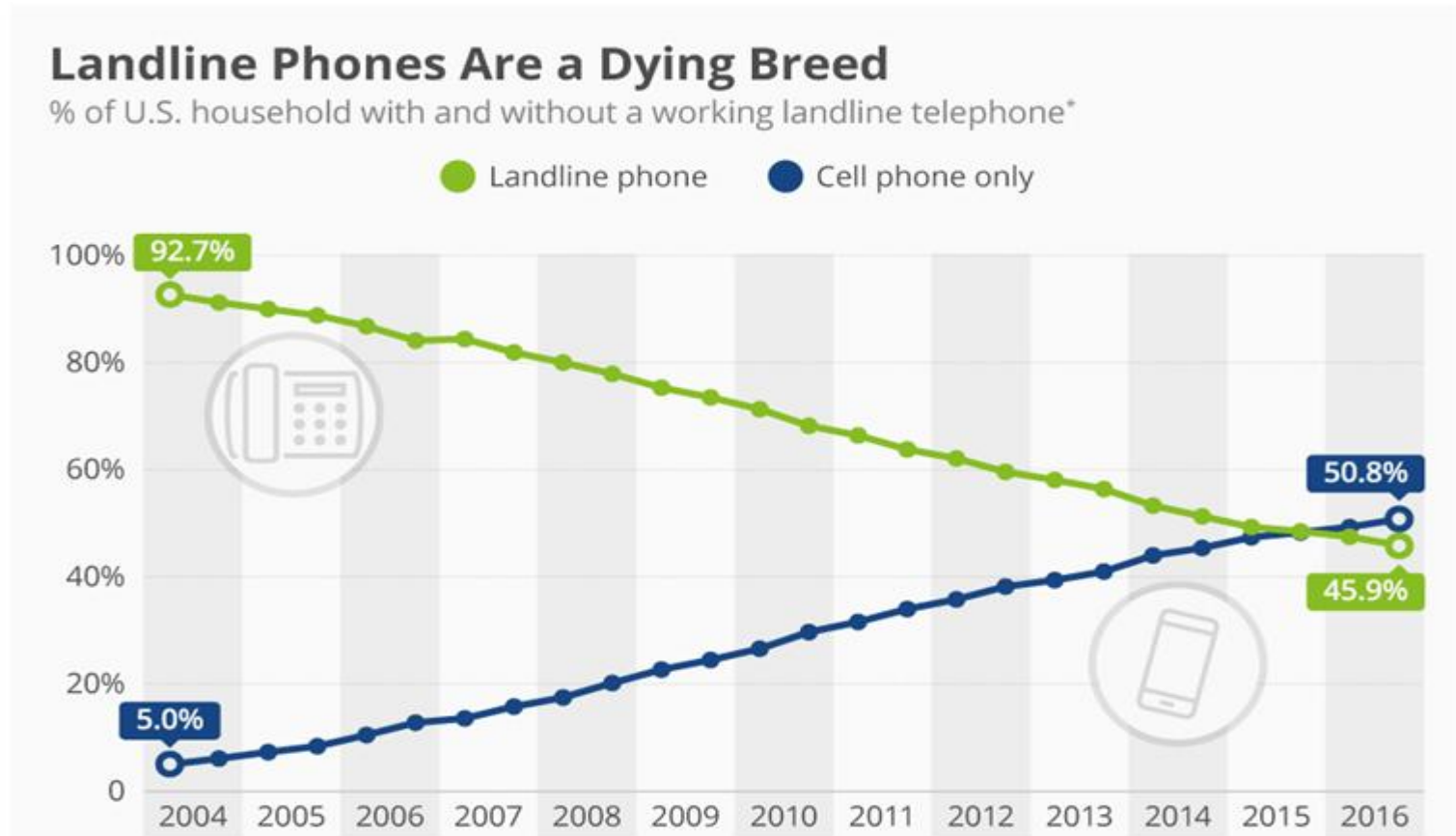
Verizon Communications' revenue from wireline and wireless services from 2010 to 2016 (in billion U.S. dollars)



ABOUT THIS STATISTIC

The statistic shows the wireline and wireless revenue of Verizon Communications from 2010 to 2016. In 2015, Verizon's revenue from its wireless segment amounted to 91.68 billion U.S. dollars.

Landline Phones are a Dying Breed

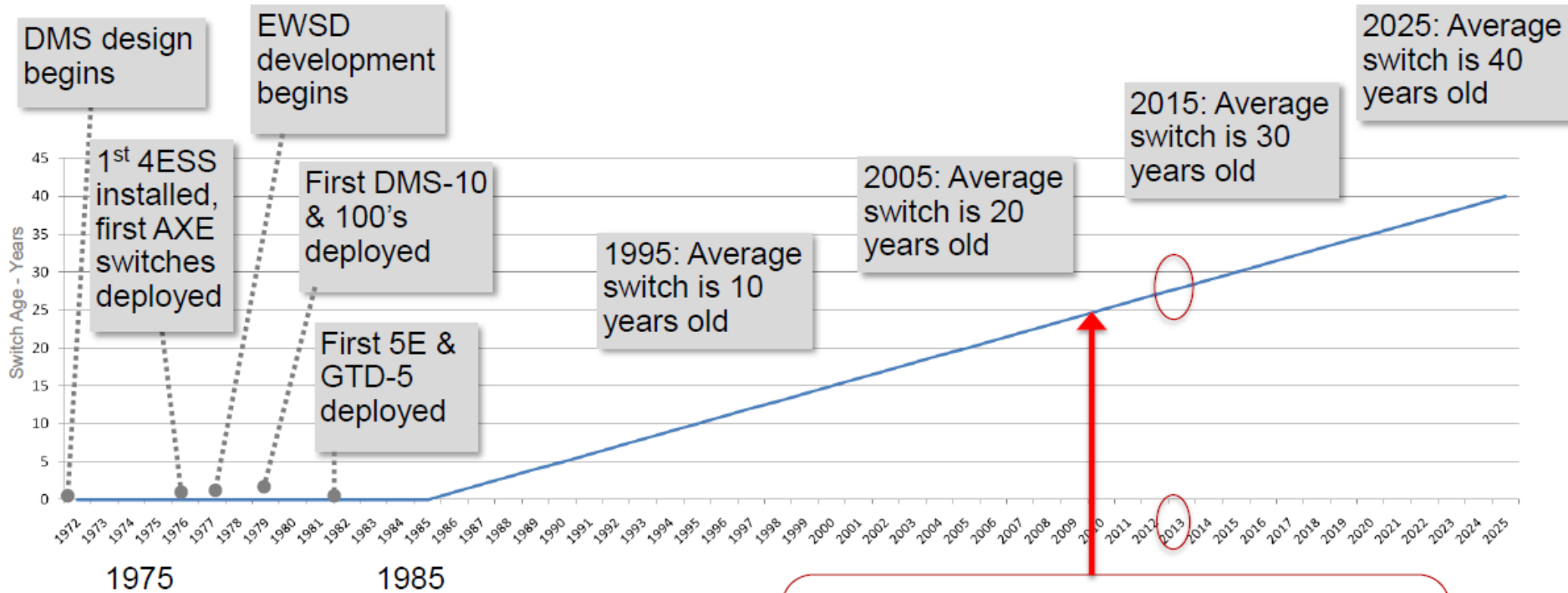


What's the mileage reading on Telecom Network Switches?



Integral parts of the average Telecom network are almost 30 years old.

TDM Switch Timeline



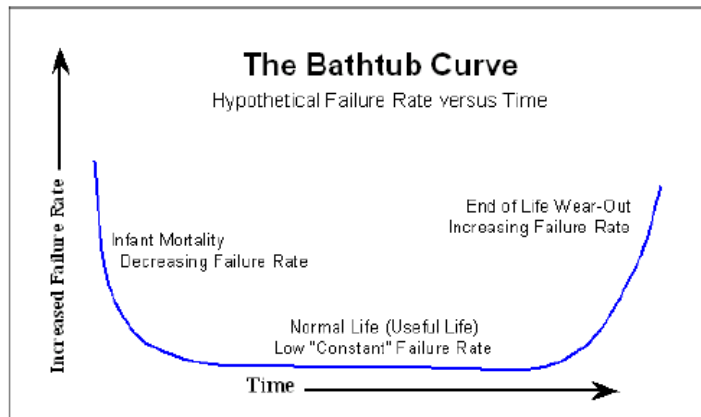
TDM switches were designed to be replaced before the end of their 25 year design life (Bellcore spec)

Note: Reference from Genband



Will Switches last?

Bathtub Curve Failure Model



• The Bathtub Curve and Product Failure Behavior
Dennis J. Wilkins, Dec. 2002

“For many electronic components, wear-out is not a practical failure mode. The time that the product is in use is significantly shorter than the time it takes to reach wear-out.”

Note: Reference from Genband



Assumption:

Switches have performed well in past decades and will continue to so.

Test:

- Bathtub Curve models are commonly used in reliability engineering
- “End of Life” or Bathtub curve wear-out for electronics is typically never challenged -- due to regular field replacement
- Many switch components are Manufacturer Discontinued (MD) or End-of-Life (EOL), and have exceeded predicted lives
- For assets with hundreds of thousands of hours in operation, ***past reliability is NOT a predictor of future performance.***

Legacy Network Equipment Primary Cause of Equipment Failure

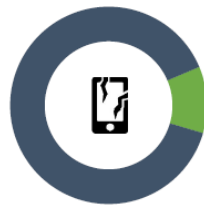
LEGACY NETWORK EQUIPMENT: PRIMARY CAUSES OF EQUIPMENT FAILURE

A review of over 11,000 repair transactions performed on legacy network equipment determined the top 5 factors leading to equipment failure to better understand proactive and reactive steps service providers can take to reduce service outages and extend the life of legacy network equipment



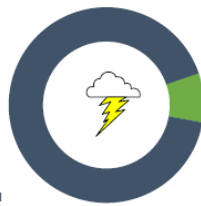
ELECTROLYTIC
CAPACITOR
38%

CHECK CAPACITORS FOR DISCOLORATION, BULGING, FOUL ODOR, OR SIGNS OF ELECTROLYTIC FLUID ON PCB.



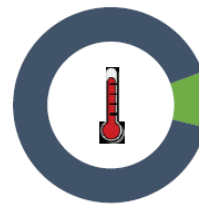
PHYSICAL/
MECHANICAL
11%

INSPECT FOR SIGNS OF WEAR INCLUDING EXCESSIVE NOISE, VIBRATION, AND HEAT CAUSED BY FRICTION.



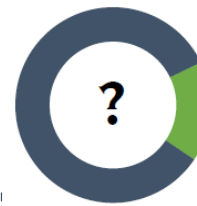
ELECTRICAL
OVER STRESS
9%

ADEQUATE CIRCUIT PROTECTION AND PROPER GROUNDING ARE THE ONLY LINES OF DEFENSE AGAINST POWER SURGES.



ENVIRONMENTAL
CONDITIONS
7%

MAINTAIN A COOL ENVIRONMENT, MINIMIZE MOISTURE, CLEAN AIR FILTERS, AND INSPECT OSP EQUIPMENT FOR INFESTATION.



NO FAULT FOUND
17%

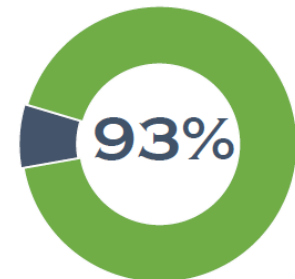
IN SOME CASES RE-BOOTING THE EQUIPMENT WILL SOLVE THE PROBLEM

THE PROBLEM OF NFF

Test labs have historically struggled simulating all types of conditions that cause equipment to fail in the "real world" leading to a high level of frustration for service providers and their repair partners.

TYPES OF TEST LAB SIMULATIONS NEEDED TO ENSURE TEST COVERAGE AND COMBAT NFF:

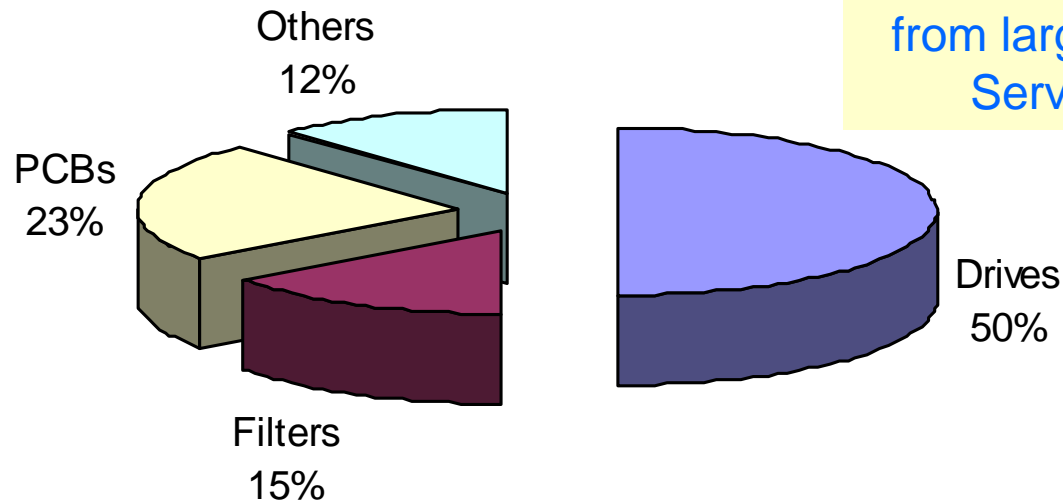
- HIGH TEMP • LOW TEMP
- DISTANCE • REAL TRAFFIC



OF NFF IN 2016 DID NOT BOUNCE BACK

VOICE MAIL SWITCH PART RETURN PROFILE

Biggest Issue



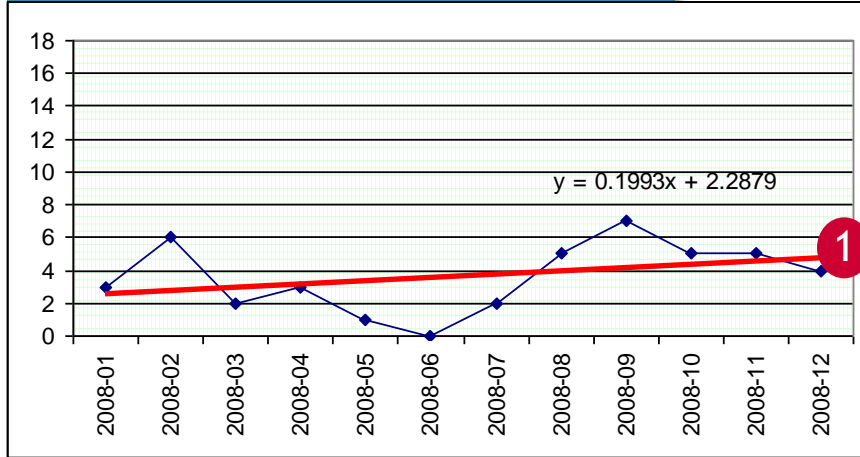
** Based on 3 years of data from large North American Service Provider **

- An analysis of the repair data shows that approximately 50% of the RMAs are scsi disk drives.
- 15% of the RMAs are fan filters.
- 12% of the RMAs are Others components (including fan assembly, interface card, switching cpu, terminal, tape drive, etc.)
- **The biggest issue are the custom PCBs, which make up 23% of the RMA's.**

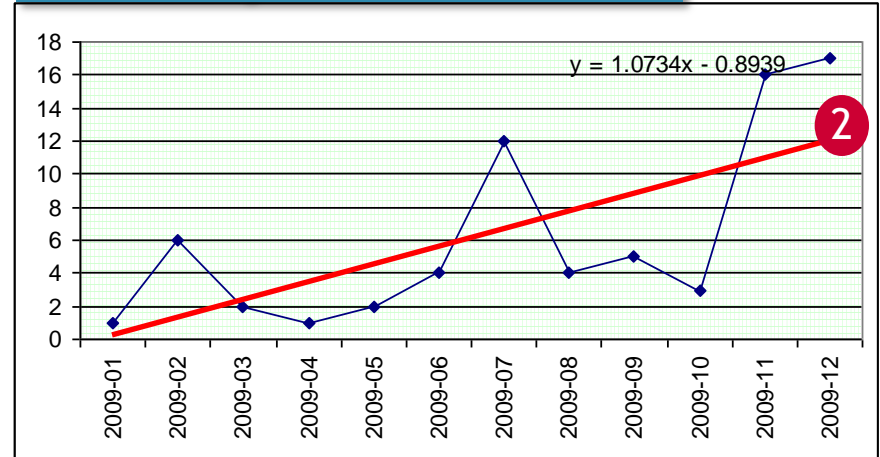
FAILURE TRENDING

Comverse Access NP, 101-3227-01, AT-210/F PCB Kit, AVALON T1/166MHz 64MB

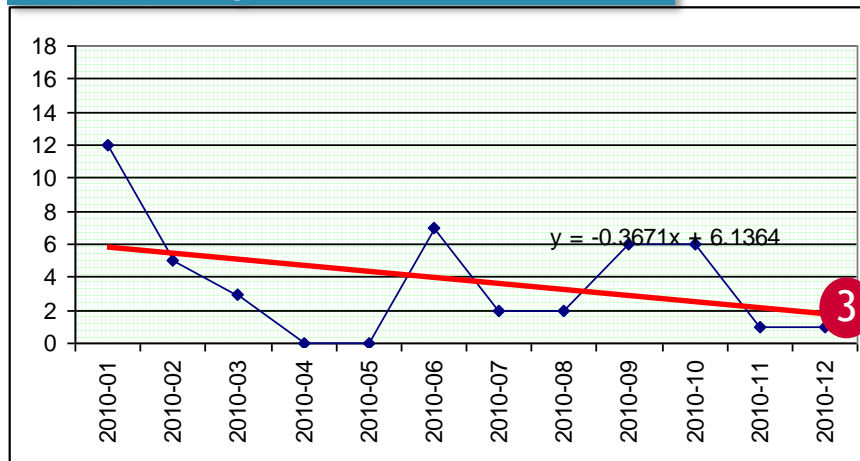
2008 Trending



2009 Trending



2010 Trending



Heuristic Algorithm

- Estimate monthly failure rate for each year (=MAX(regression value at the end of year, average monthly failure rate))
- Predict monthly failure rate at the end of 2010 (=AVERAGE(2008's, 2009's, 2010's)) (6.81 per month or 82 per year)
- Validate the estimation with 1Q2011 data (20 in 1Q2011 or 80 per year)
- Develop a proxy prediction for VZ's (need to know the installed base information of AT&T and VZ)

Solutions to Extend the life of Legacy Systems

- Assess the network for legacy products
- Manage OEM vendors (Determine End of Life dates)
- Assess Technical Support Issues
- Assess Repair Issues

Solutions to Extend the life of Legacy Systems

- ❑ Assess the network for legacy products
- ❑ Manage OEM vendors (Determine End of Life dates)
- ❑ Assess Technical Support Issues
 - Most problems are simple in nature and are man-made:
 - No back-ups of most recent software, documentation or database
 - Can't locate password of back up servers
 - Basic troubleshooting skills and preventative maintenance techniques need to be addressed
 - Be proactive - monitor the network, look for patterns of failure (e.g. excessive repairs of certain codes)
 - Inexperienced technicians can be trained
 - Technical Support Competence must be maintained
 - Highly skilled technical people do exist
 - Tier 1/2/3 can be outsourced

Solutions to Extend the life of Legacy Systems (cont.)

□ Assess Repair Issues

- Manage spares inventory
- Most repairs are due to heat and electromechanical failures and lack of preventive maintenance (disk drives, power supplies, fans, filters, cables)
- Repair Capability must be maintained
 - Repair companies that specialize in legacy products do exist (Precision ERS)
 - Parts do exist
 - Migration, consolidation of platforms, harvesting of spares
 - Replacement parts can be reverse engineered

End of Life Checklist

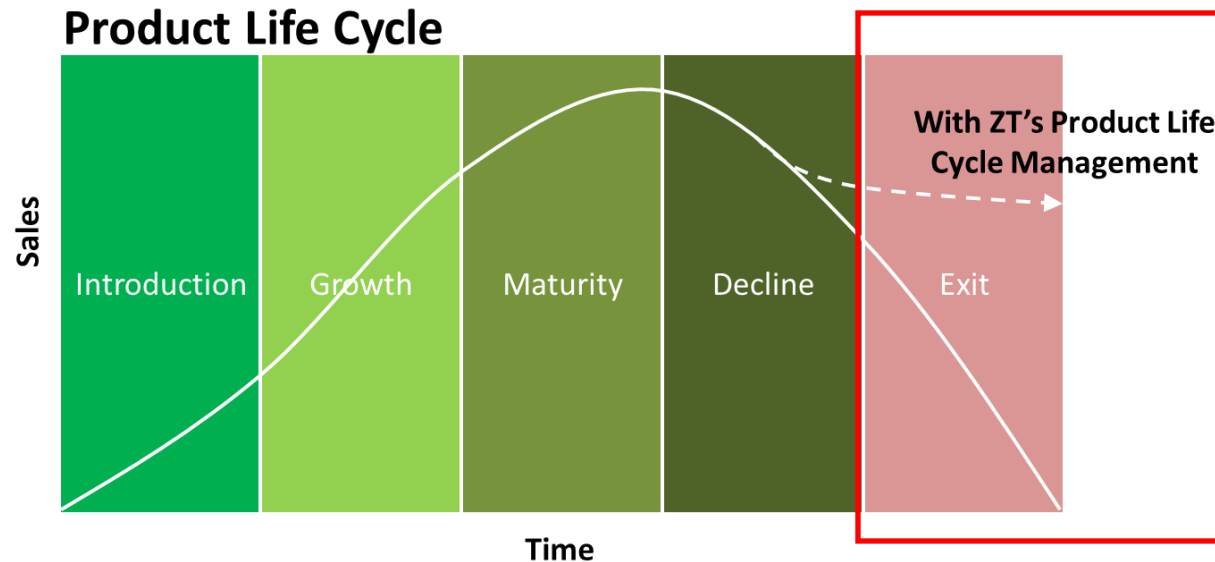
Activity Checklist	
Done	Activity
✓	Evaluate life cycle parameters for all legacy products in the network (EoL, EoS, MD/DA status) and support and repair impact on your company.
✓	Analyze your internal support capabilities. Work with your Operations Team to review all Maintenance capabilities.
✓	Identify critical legacy products by analyzing historical AR/PR patterns (Pareto analysis of ARs/PRs) and size of embedded base.
✓	Identify OEM vendor responsiveness based on contractual SLA requirements and maintenance contract pricing.
✓	Develop consolidation and migration plans for legacy products and contingency plans. Develop decommissioning plans to assist in cost reduction efforts of all maintenance costs.
✓	Calculate End of Life Date for all products when repair/replace capability will not be sufficient to support product.
✓	Analyze OEM vendors' obsolescence/life-cycle management/component substitution/repair/software support plans. Require OEM vendors to document life cycle repair strategy. Scrutinize repair vendors FMA's, Root Cause Analysis on selected products. Visit and audit vendor repair locations.
✓	Develop comprehensive repair strategies/capabilities with third parties and OEMs to insure supply of refurbished parts/repair capabilities.
✓	Develop Vendor Management report cards to continually monitor vendor performance/quality and life cycle strategies as part of a comprehensive OEM vendor management program and pricing per AR/PR.
✓	Develop maintenance cost reduction proposals through in-sourcing (internal) and outsourcing.
✓	Develop contract strategy to convince OEMs to reduce maintenance pricing and leverage your size and purchasing power.
✓	Analyze your current internal technical support capabilities and make recommendations to improve support readiness and cost effectiveness thru partnership with ZT.
✓	Develop comprehensive SLA agreements that define Remote Technical Support metrics and Repair and Exchange.



End of Life Checklist (Cont.)

Potential Legacy OEM Issues	
✓	OEM has small embedded base
✓	OEM will merge/be acquired by another vendor
✓	OEM started as a start up in the 1990's and was later acquired by Ciena, Ericsson, Nokia (ALU), and Genband
✓	OEM Product has inordinate amount of Severity 1s and 2's relative to size of the embedded base
✓	OEM has a very small support staff
✓	OEM is outsourcing technical support to non-US country
✓	OEM Product hardware has higher failure rates relative to similar technologies
✓	OEM can provide repair/replace and technical support services
✓	OEM Product has very little spares available in secondary market
✓	OEM vendors bundle repair/support of legacy products with upgrades to next generation products
✓	OEM vendors use Fear, Uncertainty and Doubt (FUD) to convince you that you can't self-maintain or only OEM can access to certain debugging diagnostics
✓	OEM product does not meet originally advertised performance specs; typical technical answer is to reboot system
✓	OEM has long standing relationship with Operations team
✓	OEM cannot provide End of Life/Support/Repair dates
✓	OEM will not provide an end of life /obsolescence life cycle management plan
✓	OEM does not provide repair statistics for disk drives, power supplies, fans, and filters and key hardware

Extend the life of your legacy telecom equipment



- By providing experienced technical resources
- By developing repair/replace/spare parts strategies
- By developing consolidation and migration strategies

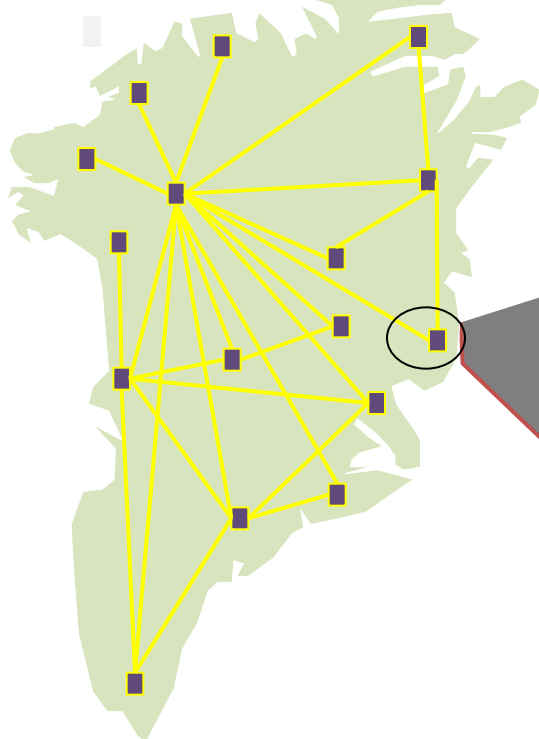
End of Life Next Steps

- Develop Life Cycle Management plan for all legacy products
- Gather data!!
- Implement plan and business case for critical products

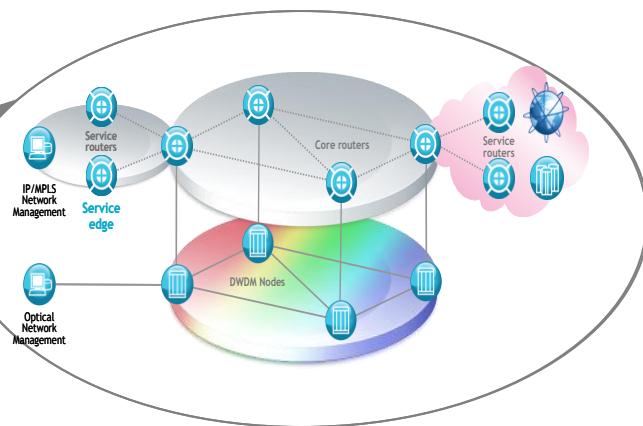
TYPICAL CUSTOMER QUESTIONS ADDRESSED BY NETWORK RESILIENCY OFFER

“My legacy SDH network is failing. Can it be managed? How? How long?”

National Network

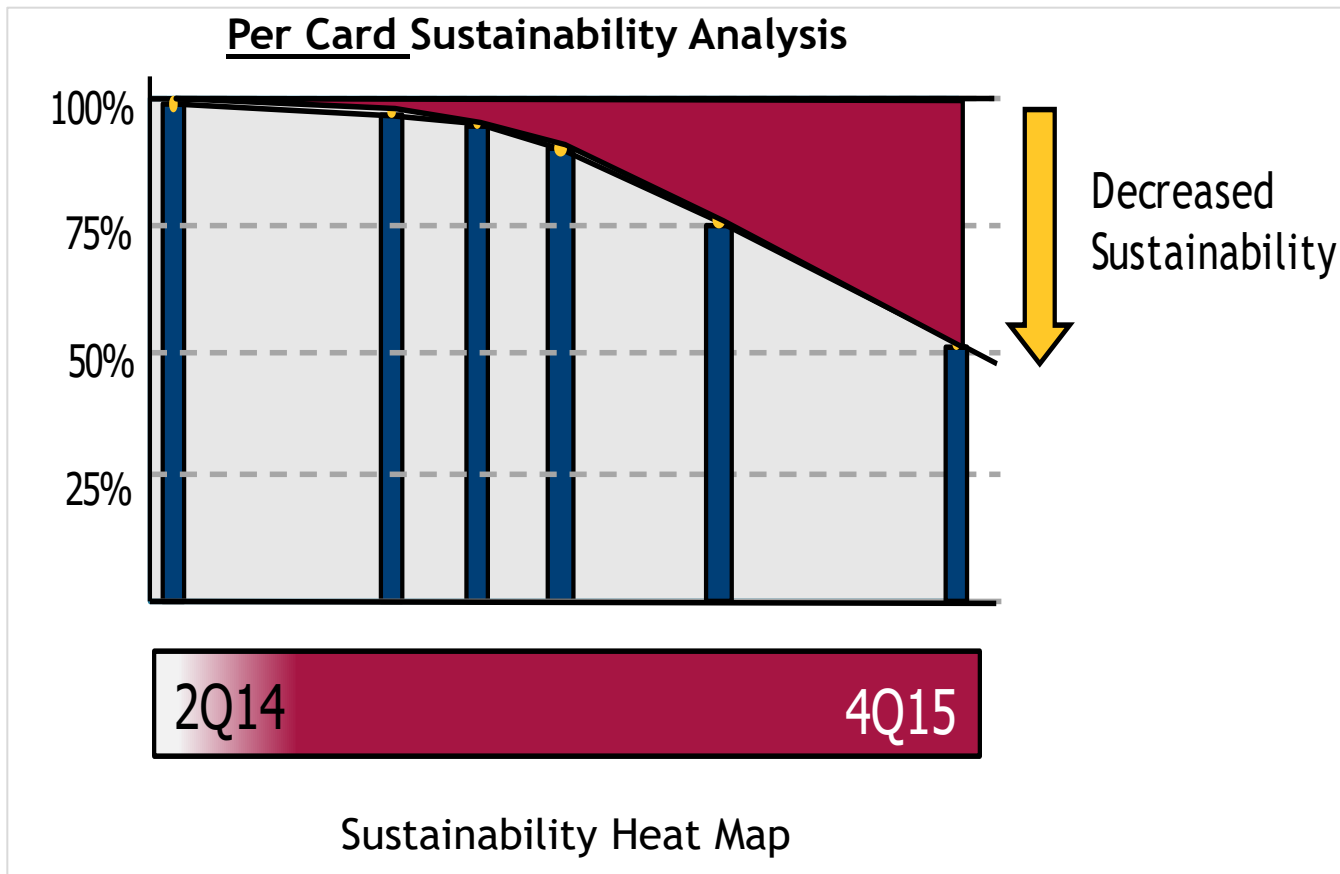


Access / Metro Offices



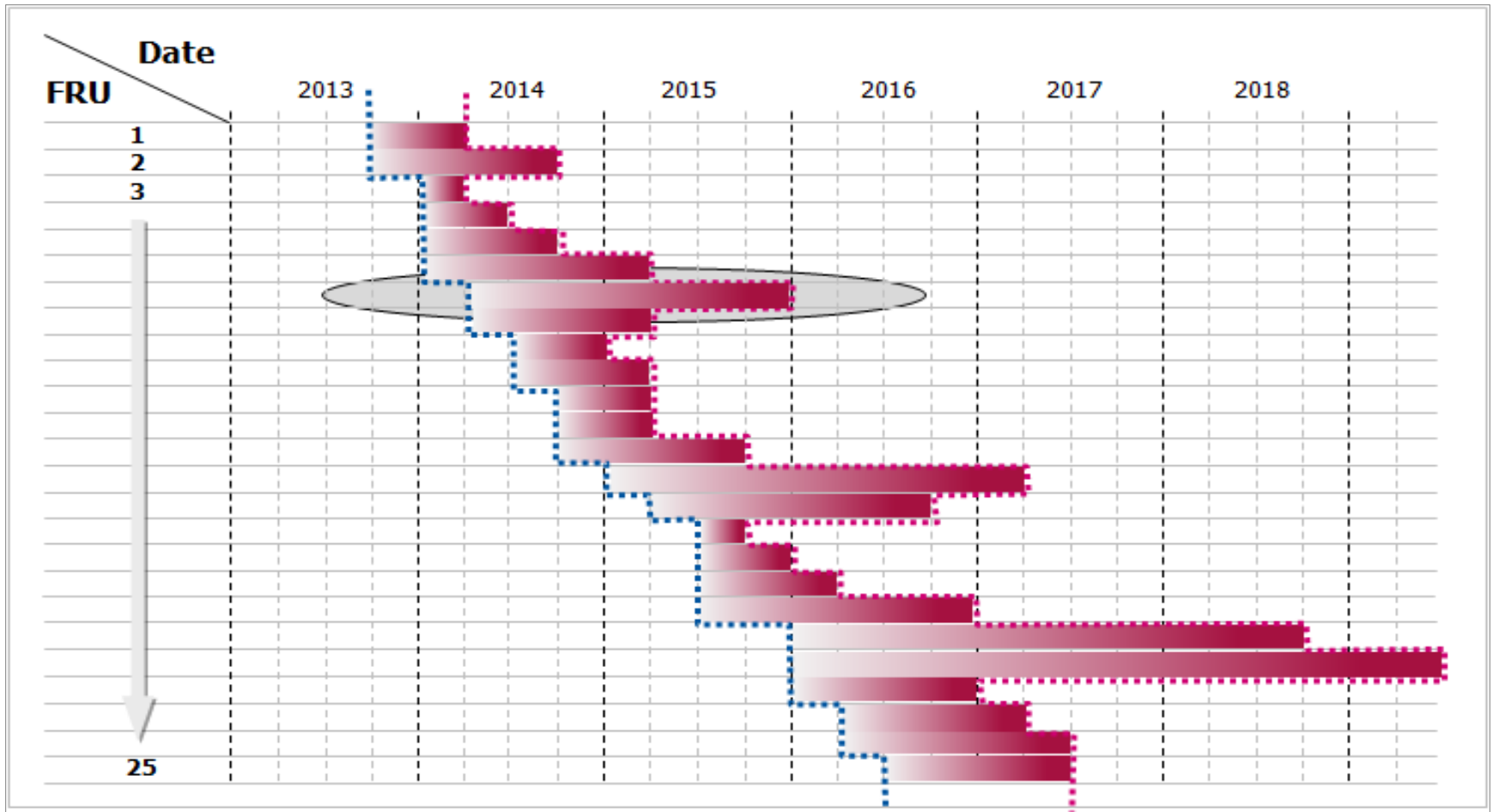
“We have had a significant outage. Regulators are breathing down our necks. Can you help us?”

WHAT DOES A LIFE CYCLE MANAGEMENT (LCM) ANALYSIS LOOK LIKE?



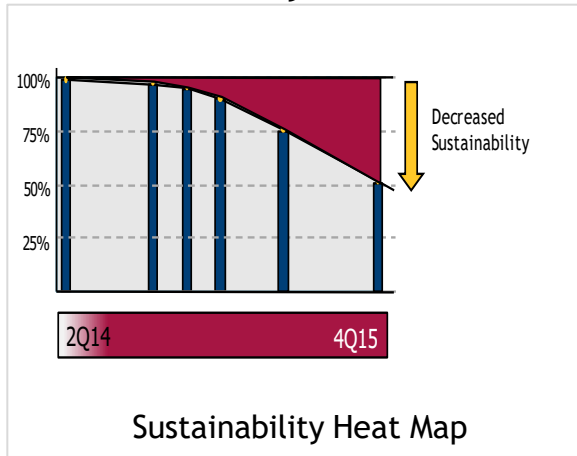
- Identifies, based on projected failure rates, when key components will reach an End-of-Stock condition
- Uses a stand-alone, smart data acquisition template which contains historical network data including return counts and installed base
- Prediction module provides failure rate trending information required for network outage prediction modeling.

Sustainability Heat Map

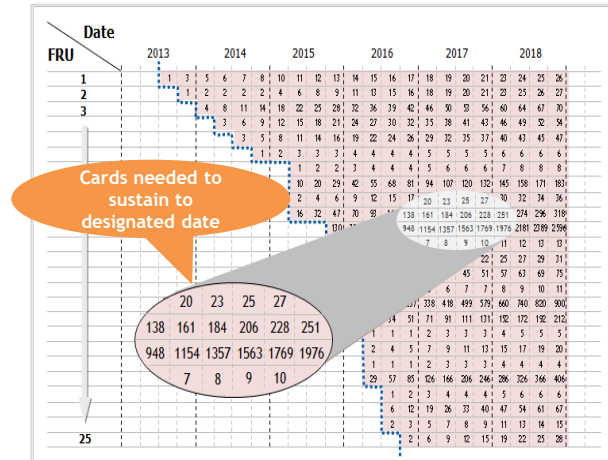


WHAT DOES A LIFE CYCLE MANAGEMENT (LCM) ANALYSIS LOOK LIKE?

Per Card Sustainability Analysis



Spares Gap Analysis - All Cards in a Network



Warning Flags - All Cards in a Network

Page of Warning Flags							
ITCA Input Data 2014-05-18-10042.stm							
Card	WF1 (Recent)	WF2 (Lines)	WF3 (Rate)	WF4 (Frequency)	WF5 (Spares)	WF6 (EB)	Overall
3AL07011 BC	No	No	0.00000	No	651	130	No
3AL07011 EC	Yes	No	0.00125	No	1096	192	No
3AL07013 BB	Yes	No	0.01657	No	308	167	No
3AL07013 EB	Yes	No	0.00480	Yes	191	2556	No
3AL07017 BA	No	No	0.00000	No	341	259	No
3AL07017 EA	No	No	0.00000	No	28	58	No
3AL07022 AC	No	No	0.00000	No	1461	18	No
3AL07022 BD	Yes	No	0.21902	Yes	405	88	Yes
3AL07022 EZ	Yes	Yes	0.12222	No	151	13	Yes
3AL07023 BA	No	No	0.00000	No	1571	23	No
3AL07023 EA	Yes	Yes	0.003145	No	661	91	Yes
3AL07034 BA	Yes	No	0.03623	No	835	36	No
3AL07225 BD	No	No	0.00472	No	0	1	No
3AL07385 BA	Yes	No	0.066195	Yes	71	187	Yes
3AL07385 EB	No	No	0.01492	Yes	351	2695	No
3AL07386 HB	Yes	No	0.315166	Yes	1531	40	Yes
3AL07453 BA	No	No	0.00000	No	1000	23	No
3AL07453 EA	Yes	No	0.00401	No	711	89	No
3AL07584 BB	Yes	No	0.068750	Yes	341	132	Yes
3AL07584 BC	Yes	No	0.32589	Yes	261	96	Yes
3AL07731 BC	No	No	0.00000	No	21	60	No
3AL07731 EC	No	No	0.00000	No	0	60	No
3AL07732 BA	No	No	0.00000	No	0	704	No
3AL07732 BC	No	No	0.00000	No	0	58	No
3AL07732 BD	No	No	0.00180	No	9	58	No
3AL07784 BC	Yes	No	0.023914	No	951	111	No
3AL07784 EC	Yes	No	0.00462	No	45	3359	No
3AL07784 ED	Yes	No	0.015221	Yes	65	1590	No
3AL07877 BA	Yes	Yes	0.003936	No	661	211	No
3AL07878 BB	No	No	0.00000	No	691	52	No

- Identifies, based on projected failure rates, when key components will reach an End-of-Stock condition
- Uses a stand-alone, smart data acquisition template which contains historical network data including return counts and installed base
- Prediction module provides failure rate trending information required for network outage prediction modeling.

- Applies statistical analyses to capture trending and predict failure rates
- Calculates additional spares required to mitigate any out-of-stock threat
- Additional parameters such as repair contract duration, vendor performance, and on-hand inventory are analyzed
- Capacity to address up to 1000 cards (at a time) and accommodate up to 20 mitigation scenarios.

- Consistent and proven technique to identify risk across all cards and enable clear, effective and transparent communication
- Algorithms and thresholds proactively identify high risk cards in advance
- Identifies and quantifies risk indicators in multiple dimensions.



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Science and Statistics of Better Legacy Network Reliability



Michael Dazio

Leading Operators: Resiliency (Life Cycle Management)

Tier 1 European Fixed / Mobile Operator

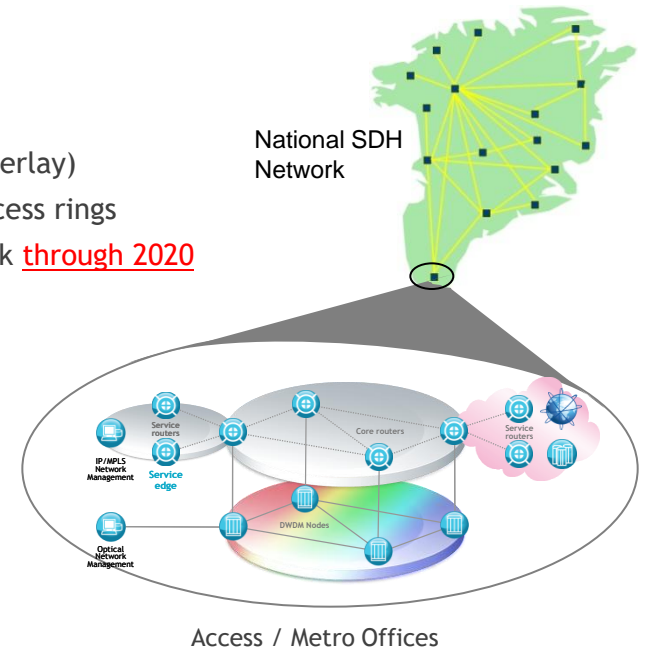
Type: National SDH network

Services: All legacy traffic - PSTN, ATM, Mobile, Private Lines (IP/Eth on next gen overlay)

Resiliency Highlights: Fully redundant core with dual-homed, self-healing metro/access rings

Comprehensive program in place to fully manage the Life Cycle of the legacy network through 2020

- All cards in the network are actively managed
 - Installed base (**transformation is ongoing**)
 - Field returns
 - Repair activities
- Spares managed to insure 12-18 months inventory on-hand
- Harvesting from transformation modeled to conserve OPEX (repair avoidance)
- Problematic products targeted for detailed Outage Prediction modeling
 - Drives targeted, accelerated decommissioning.

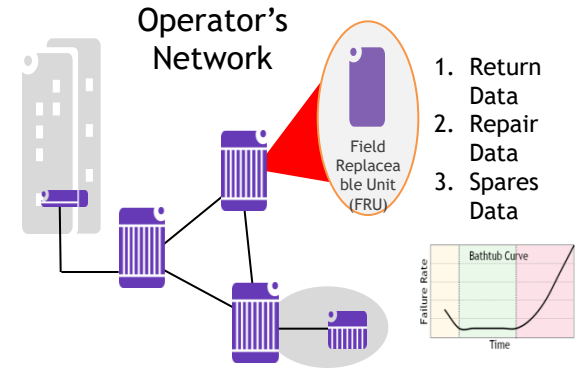


“(Operator) is in a fortunate position of being able to develop its quad-play strategy how it wants, at its own pace, because it is the dominant fixed and mobile operator. The huge customer bases in which to cross-sell has meant that (Operator) has been able to tactically move into quad play at its own pace.” Ovum

Case Study: Life Cycle Management

Tier 1 European Fixed / Mobile Operator

- Background** In order to sustain a PSTN to 2020, develop a comprehensive plan to manage the legacy transport network to the highest quality, maintaining the Operators reputation – and profitability – during their next gen transformation
- Scope** Major transformation project of a problematic DXC was underway. Remaining network stays in place. Harvesting benefits to be modeled; decommissioning speed of DXCs to be analyzed (outage probability calc)

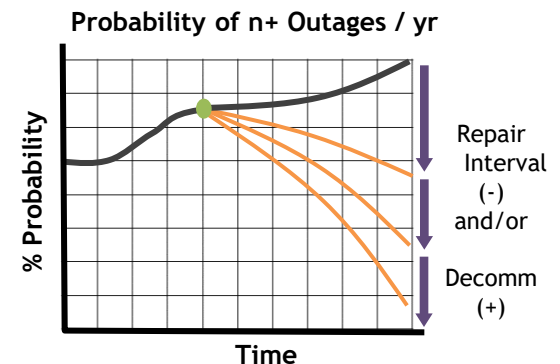
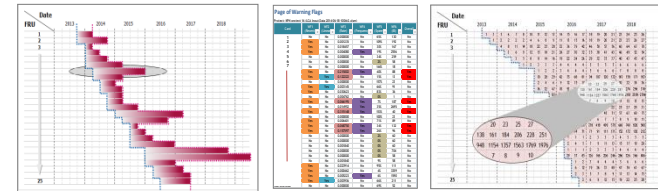


1. Return Data
2. Repair Data
3. Spares Data

Original network deployed in early 90's; 12 product families from multiple vendors; 19K total NEs; approx 350 unique cards to analyze

- Results** Developed custom program for automated, validated customer data input to Proprietary Bell Labs Life Cycle Analytics tools
- **Sustainability Heat Maps** showed that harvesting program benefits will run out in 2018 (repair avoidance must cease)
 - **Warning Flags** identified next problematic product and mitigation required
 - **Spares Gap Analysis** developed plan for the recommended 18 mo inventory on hand
 - **Outage Prediction** showed that, for the DXC, decommissioning must accelerate and repair interval must be significantly reduced to avoid increasing probability of outages in the near term.

Sustainability Heat Map Warning Flags Spares Gap Calc

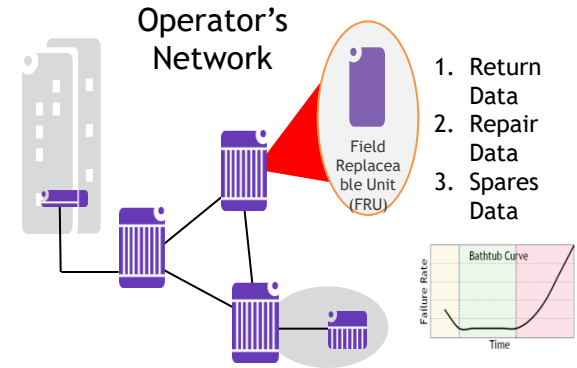


Case Study: Life Cycle Management Tier 1 European Fixed / Mobile Operator

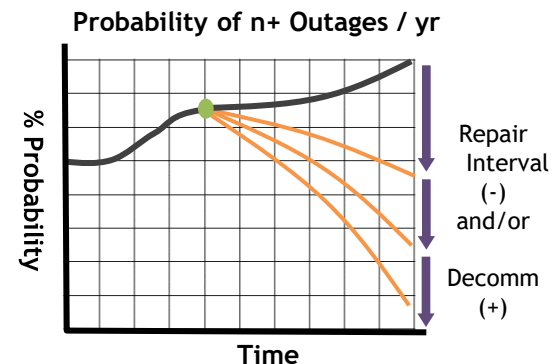
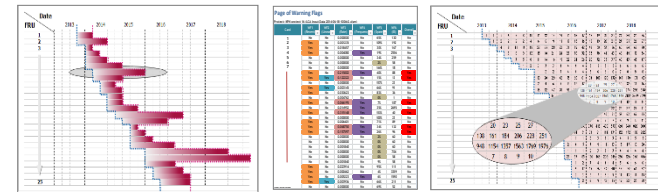
Results

Developed custom program for automated, validated customer data input to Proprietary Bell Labs Life Cycle Analytics tools

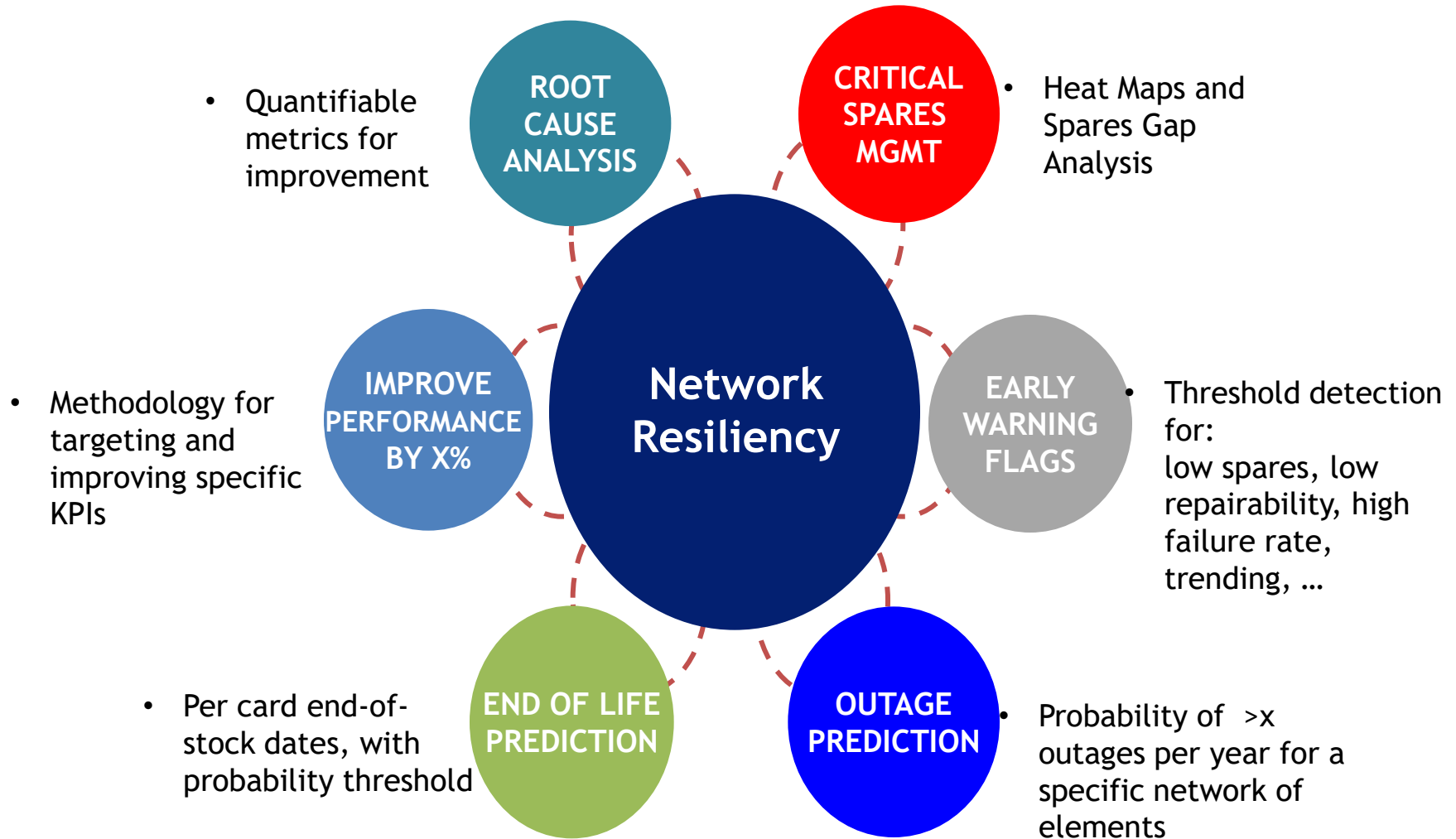
- **Sustainability Heat Maps** showed that harvesting program benefits will run out in 2018 (repair avoidance must cease)
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Sustainability Heat Map Warning Flags Spares Gap Calc

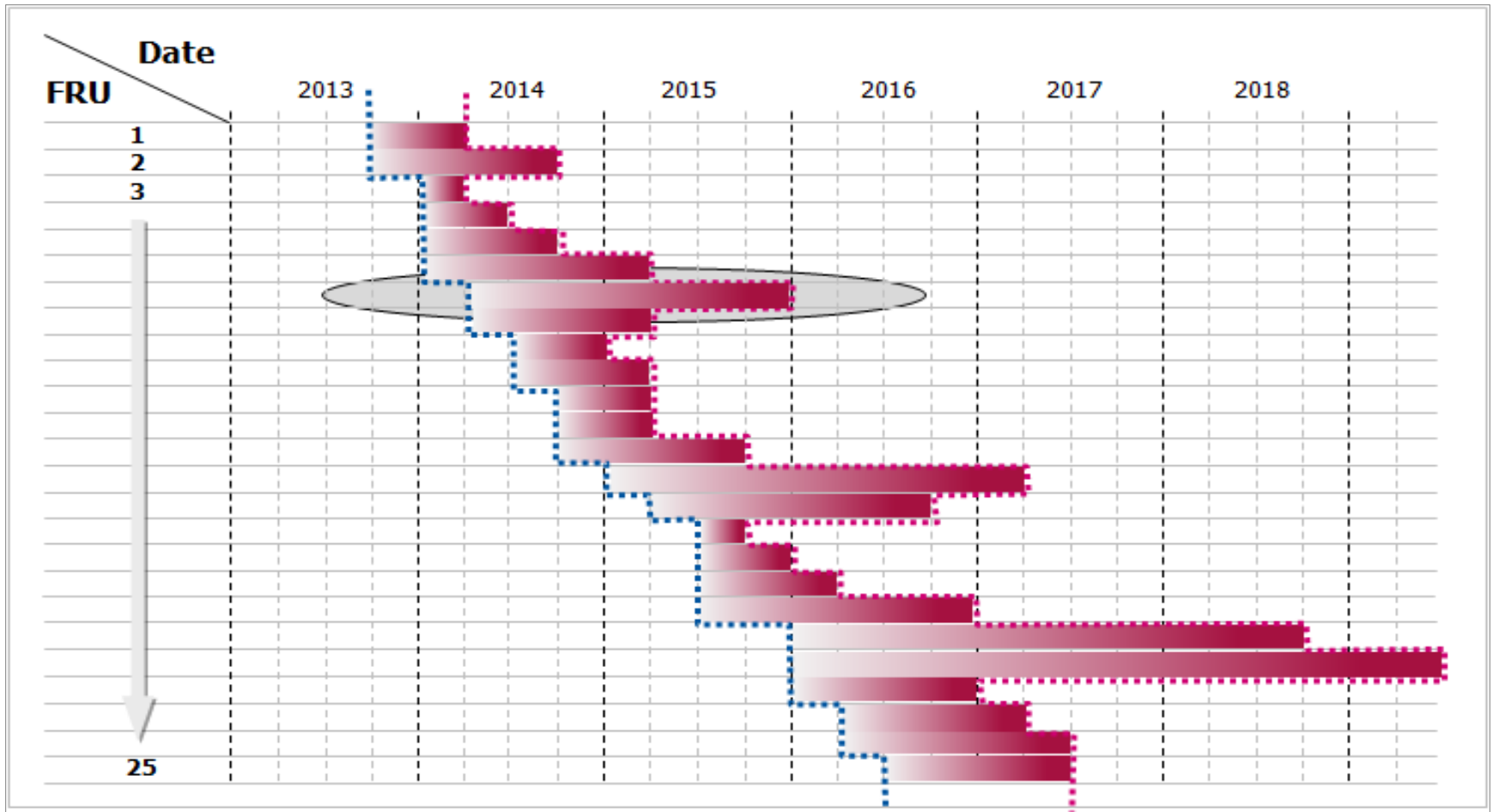


OFFER CAPABILITIES



Six Key Capabilities that can be Combined to Address Complex Customers' Questions

Sustainability Heat Map



Spares Gap Calc

FRU	Date																													
	2013					2014					2015					2016					2017					2018				
1			1	3	5	6	7	8	10	11	12	13	14	15	16	17	18	19	20	21	23	24	25	26						
2				1	2	2	2	2	4	6	8	9	11	13	15	16	18	19	20	21	23	25	26	27						
3					4	8	11	14	18	22	25	28	32	36	39	42	46	50	53	56	60	64	67	70						
						3	6	9	12	15	18	21	24	27	30	32	35	38	41	43	46	49	52	54						
							3	5	8	11	14	16	19	22	24	26	29	32	35	37	40	43	45	47						
								1	2	3	3	3	4	4	4	4	5	5	5	5	6	6	6	6						
									1	2	2	3	4	4	4	4	5	6	6	6	7	8	8	8						
										10	20	29	42	55	68	81	94	107	120	132	145	158	171	183						
										2	4	6	9	12	15	17	20	23	25	27	30	32	34	36						
											16	32	47	70	93	116	139	162	185	208	231	254	277	300						
												130	259	389	518	648	777	906	1035	1164	1293	1422	1551	1680						
																	138	161	184	206	228	251	274	296	318					
																		948	1154	1357	1563	1769	1976	2181	2389	2596				
																			7	8	9	10	11	12	13	13				
																					22	25	27	29	31					
																					45	51	57	63	69	75				
																					6	7	7	8	9	10	11			
																						20	23	25	27					
																					138	161	184	206	228	251				
																					948	1154	1357	1563	1769	1976				
																						7	8	9	10					
25																														



EOL ANALYSIS

CRITICAL SPARES DECISION SUPPORT TOOL → FIND / ELIMINATE STOCK-OUTS

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Circuit Card 1	0	2	4	6	9	10	13	15	19	25
Circuit Card 2	0	0	21	22	24	27	29	33	35	42
	0	0	0	5	8	12	15	17	23	33
	0	0	0	7	9	11	13	15	19	28
	0	0	0	19	23	28	33	43	51	55
	0	0	0	1	1	3	7	11	17	21
	0	0	0	0	1	1	1	2	3	3
	0	0	0	0	2	4	5	7	9	9
	0	0	0	0	2	9	15	21	23	27
	0	0	0	0	0	2	4	5	7	9
	0	0	0	0	0	65	129	198	257	338
	0	0	0	0	0	2	3	4	5	7
	0	0	0	0	0	0	2	6	9	12
	0	0	0	0	0	0	29	57	85	126
	0	0	0	0	0	0	16	32	47	70
	0	0	0	0	0	0	4	8	11	14
	0	0	0	0	0	0	10	20	29	42
	0	0	0	0	0	0	0	12	22	37
	0	0	0	0	0	0	0	4	23	35
	0	0	0	0	0	0	0	20	39	53
	0	0	0	0	0	0	0	1	3	7
	0	0	0	0	0	0	0	2	5	9
	0	0	0	0	0	0	0	5	34	56
Circuit Card 25	0	0	0	0	0	0	0	0	3	5
	0	0	0	0	0	0	0	0	6	7

Example Output

Frontier Curve Indicating Potential Outages

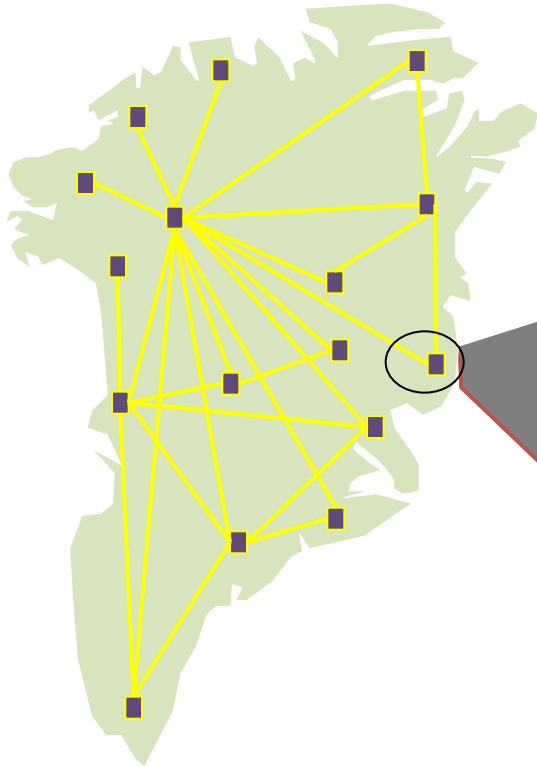
Sufficient spares (numbers in cells) must be acquired (harvest or refurbished) to extend life beyond Year N. Capital savings and sustained network reliability are typical.



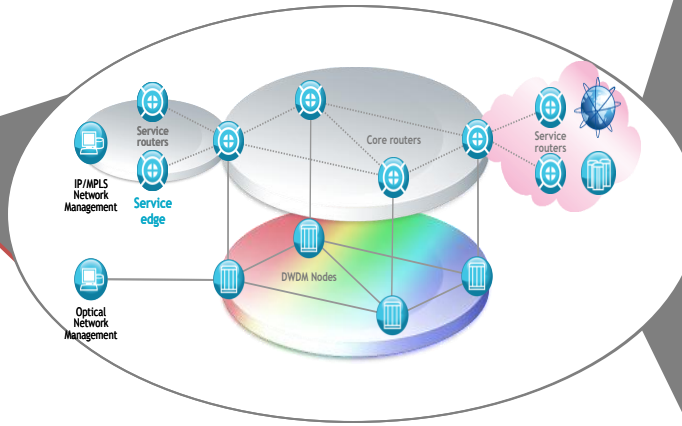
SDH NATIONAL BACKBONE

Project Scope

National Network



Access / Metro Offices

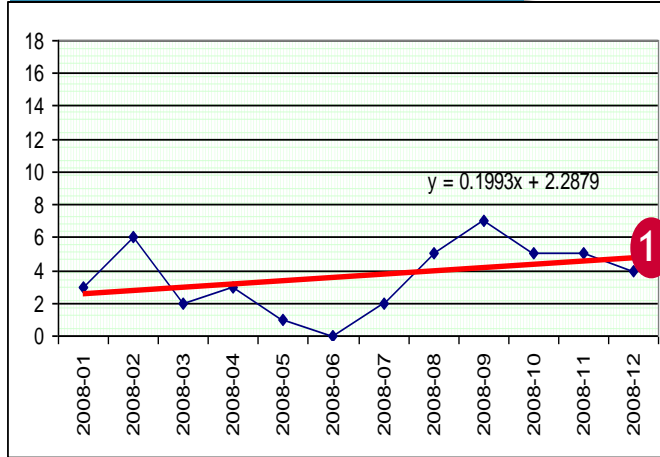


- A** Analyze all cards in the network for Early Warning signs of failure
- B** Analyze and establish the LCM baseline of the network (all SDH cards)
- C** Show the LCM impact of a major transformation project
- D** Calculate network Outage Probability as a critical element of the transformation is decommissioned

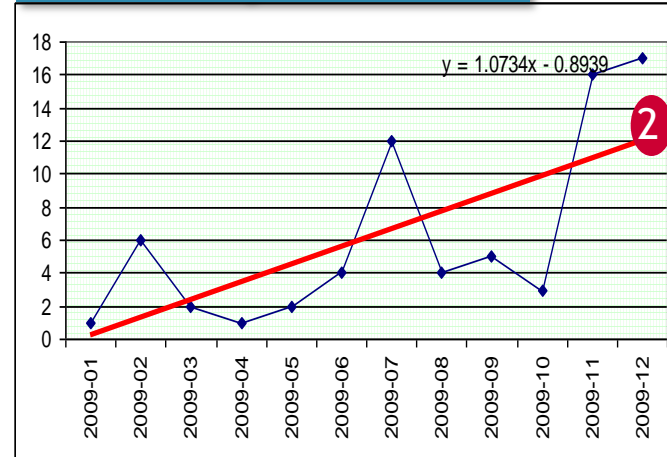
The SDH network is properly diversified and protected, but its challenges now center around sustainment of its legacy elements and containment of operational costs.

FAILURE TRENDING

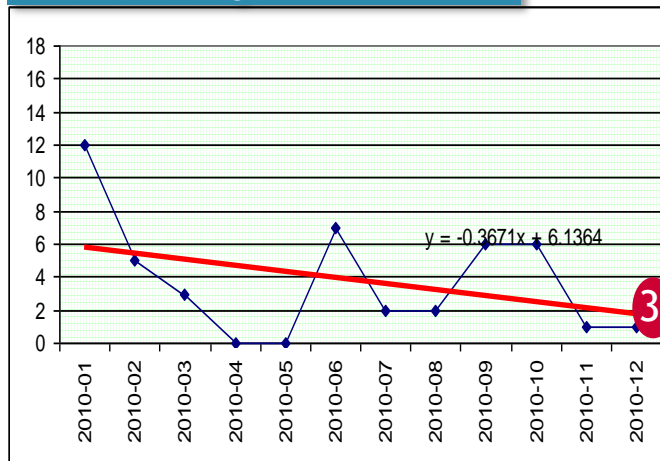
2008 Trending



2009 Trending



2010 Trending

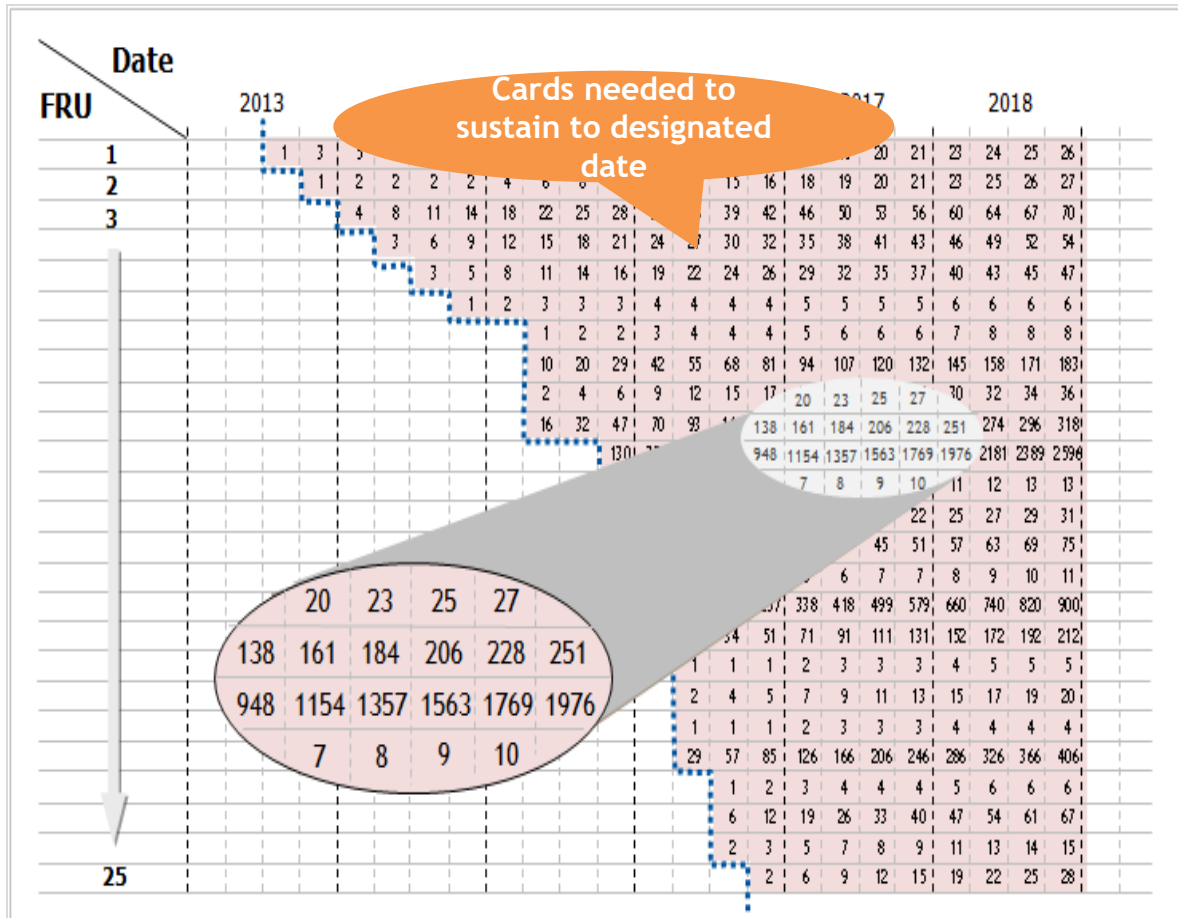


Heuristic Algorithm

- Estimate monthly failure rate for each year (=MAX(regression value at the end of year, average monthly failure rate))
- Predict monthly failure rate at the end of 2010 (=AVERAGE(2008's, 2009's, 2010's)) (6.81 per month or 82 per year)
- Validate the estimation with 1Q2011 data (20 in 1Q2011 or 80 per year)
- Develop a proxy prediction (need to know the installed base information)

WHAT DOES A LIFE CYCLE MANAGEMENT (LCM) ANALYSIS LOOK LIKE?

Spares Gap Analysis - All Cards in a Network



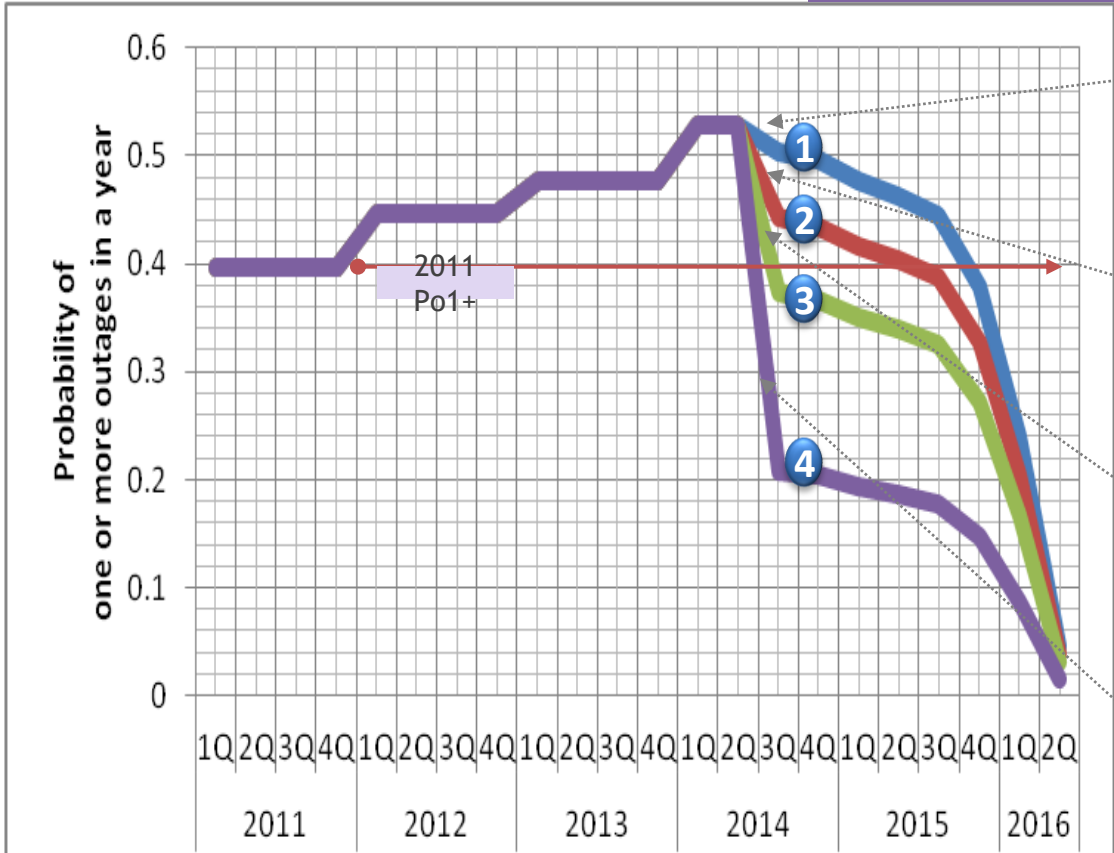
- Applies statistical analyses to capture trending and predict failure rates
- Calculates additional spares required to mitigate any out-of-stock threat
- Additional parameters such as repair contract duration, vendor performance, and on-hand inventory are analyzed
- Capacity to address up to 1000 cards (at a time) and accommodate up to 20 mitigation scenarios.

Po1+ CALCULATED PROFILE SCENARIO ANALYSIS

D Calculate network Outage Probability as a critical element of the transformation is decommissioned

Note: Po1+ represents probability of one or more outages in a year

EXCERPTED EXAMPLE



Scenario 1: This is the BASELINE scenario with current course of speed to implement decommissioning Plan of Record

Scenario 2: This is an improvement to reduce the average simplex recovery time of all common cards to be 2.5 days or less

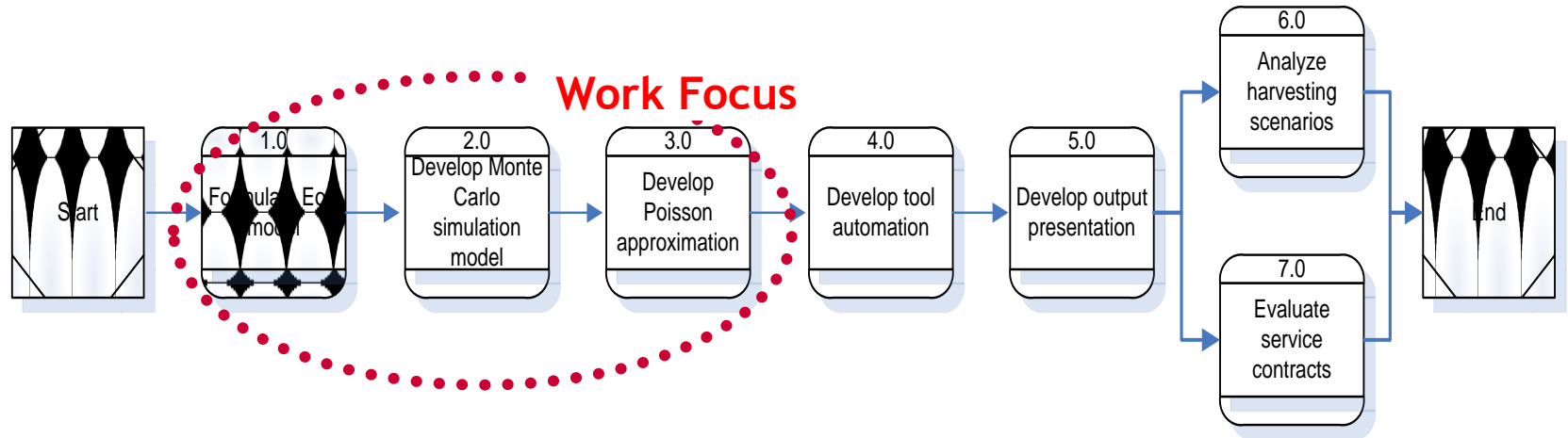
Scenario 3: This is a significant improvement to reduce the average simplex recovery time of all common cards to be 2.0 days or less

Scenario 4: This is a rapid team approach that all simplex trouble tickets are treated as outage trouble tickets; and simplex recovery time of all common cards is reduced to be 1.0 days or less

Scenario 2 can reduce Po1+ to 2011 level by 1H2015 that results in a six-month improvement compared with Baseline Scenario 1. For a more significant improvement, both Scenarios 3 and 4 should be considered.



EoS Modeling & Prediction Process

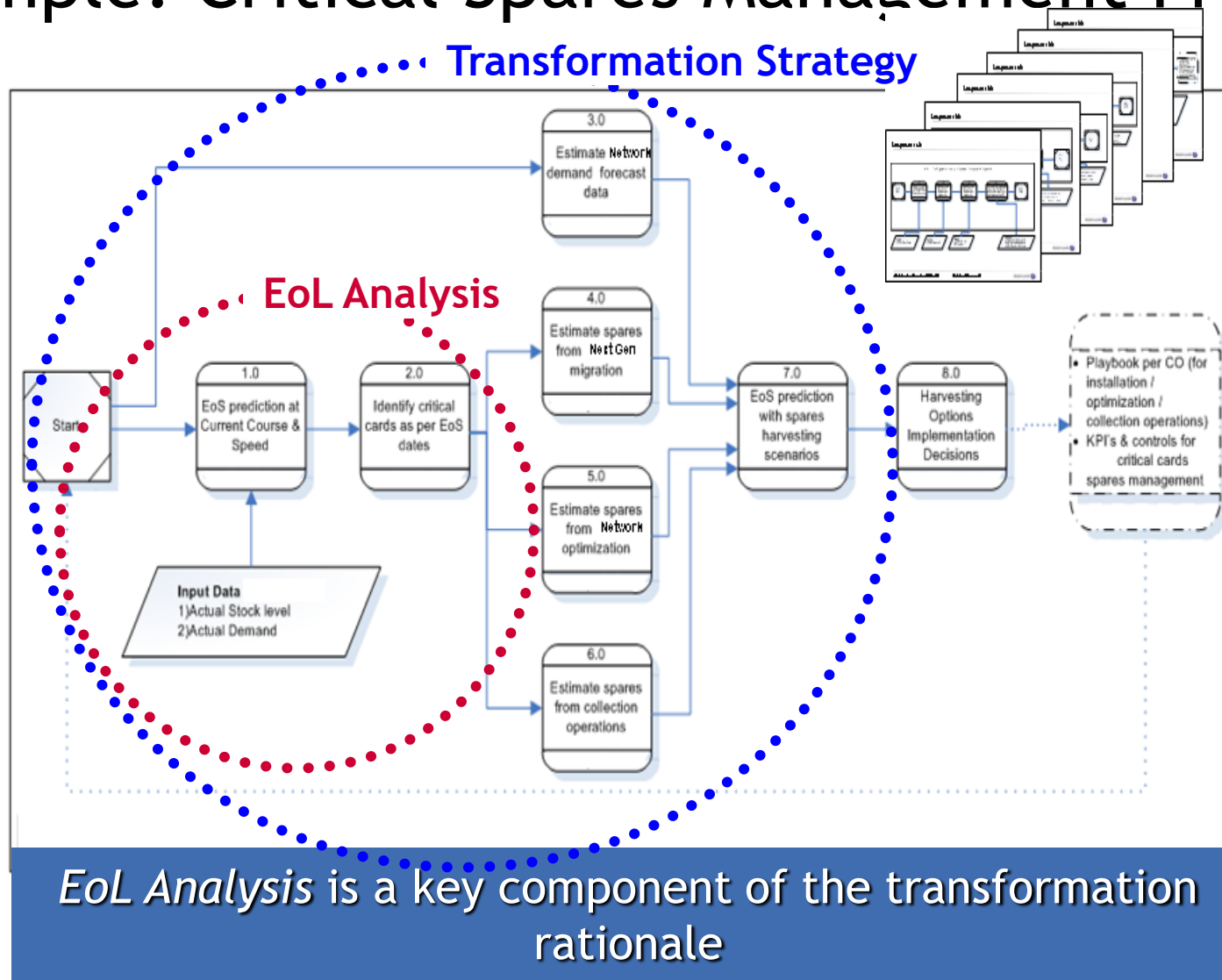


• Key Tasks

- Cluster AR/PR data
- Conduct trending analysis of each cluster
- Define questions to be addressed in the business case
- Develop EoS simulation model
- Develop Poisson approximation model

Life Cycle Management

Example: Critical Spares Management Process



WHAT DOES A LIFE CYCLE MANAGEMENT (LCM) ANALYSIS LOOK LIKE?

Warning Flags - All Cards in a Network

Page of Warning Flags

Project: KPN project 16 (LCA Input Data 2014-06-18-1004v2.xlsm)

Card	WF1 (Recent)	WF2 (Linear)	WF3 (Rate)	WF4 (Frequency)	WF5 (Spare)	WF6 (B)	Overall
3AL 07011 BC	No	No	0.000000	No	65%	130	No
3AL 07011 EC	Yes	No	0.001235	No	109%	192	No
3AL 07013 BB	Yes	No	0.018457	No	30%	167	No
3AL 07013 EB	Yes	No	0.004080	Yes	19%	2556	No
3AL 07017 BA	No	No	0.000000	No	34%	259	No
3AL 07017 EA	No	No	0.000000	No	2%	58	No
3AL 07022 BC	No	No	0.000000	No	144%	18	No
3AL 07022 BD	Yes	No	0.215002	Yes	40%	88	Yes
3AL 07022 BZ	Yes	Yes	0.122222	No	15%	13	Yes
3AL 07023 BA	No	No	0.000000	No	157%	23	No
3AL 07023 EA	Yes	Yes	0.003145	No	66%	91	No
3AL 07024 BA	Yes	No	0.030623	No	83%	36	No
3AL 07225 BD	No	No	0.004762	No	0%	1	No
3AL 07385 BA	Yes	No	0.066195	Yes	7%	187	Yes
3AL 07385 EB	No	No	0.014952	Yes	35%	2695	No
3AL 07386 HB	Yes	No	0.315148	Yes	153%	40	Yes
3AL 07453 BA	No	No	0.000000	No	100%	23	No
3AL 07453 EA	Yes	No	0.006401	No	71%	89	No
3AL 07584 BB	Yes	No	0.068750	Yes	34%	132	Yes
3AL 07584 BC	Yes	No	0.157597	Yes	26%	96	Yes
3AL 07731 BA	No	No	0.000000	No	2%	60	No
3AL 07731 BC	No	No	0.000000	No	0%	60	No
3AL 07731 BD	No	No	0.001840	No	0%	60	No
3AL 07732 BA	No	No	0.000000	No	0%	704	No
3AL 07732 BC	No	No	0.000000	No	0%	58	No
3AL 07732 BD	No	No	0.001840	No	9%	58	No
3AL 07784 BC	Yes	No	0.023914	No	95%	111	No
3AL 07784 EC	Yes	No	0.000462	No	4%	3359	No
3AL 07784 ED	Yes	No	0.005223	Yes	6%	1590	No
3AL 07877 BA	Yes	Yes	0.003936	No	66%	211	No
3AL 07878 BB	No	No	0.000000	No	69%	52	No

- Consistent and proven technique to identify risk across all cards and enable clear, effective and transparent communication
- Algorithms and thresholds proactively identify high risk cards in advance
- Identifies and quantifies risk indicators in multiple dimensions.



EOL ANALYSIS

CRITICAL SPARES DECISION SUPPORT TOOL → FIND / ELIMINATE STOCK-OUTS

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Circuit Card 1	0	2	4	6	9	10	13	15	19	25
Circuit Card 2	0	0	21	22	24	27	29	33	35	42
	0	0	0	5	8	12	15	17	23	33
	0	0	0	7	9	11	13	15	19	28
	0	0	0	19	23	28	33	43	51	55
	0	0	0	1	1	3	7	11	17	21
	0	0	0	0	1	1	1	2	3	3
	0	0	0	0	2	4	5	7	9	9
	0	0	0	0	2	9	15	21	23	27
	0	0	0	0	0	2	4	5	7	9
	0	0	0	0	0	65	129	198	257	338
	0	0	0	0	0	2	3	4	5	7
	0	0	0	0	0	0	2	6	9	12
	0	0	0	0	0	0	29	57	85	126
	0	0	0	0	0	0	16	32	47	70
	0	0	0	0	0	0	4	8	11	14
	0	0	0	0	0	0	10	20	29	42
	0	0	0	0	0	0	2	12	22	37
	0	0	0	0	0	0	0	4	23	35
Outages	0	0	0	0	0	0	0	20	39	53
	0	0	0	0	0	0	0	1	3	7
	0	0	0	0	0	0	0	2	5	9
	0	0	0	0	0	0	0	5	34	56
	0	0	0	0	0	0	0	0	3	5
Circuit Card 25	0	0	0	0	0	0	0	0	6	7

Example Output

Frontier Curve
Indicating Potential
Outages

Number of units needed to avoid Stock-Out

Sufficient spares (numbers in cells) must be acquired (harvest or refurbished) to extend life beyond Year N. Capital savings and sustained network reliability are typical.



WARNING FLAG ANALYSIS

A Analyze all cards in the network for Early Warning signs of failure

EXCERPTED EXAMPLE

SDH Warning Flags Data Set -- Active Cards Only, sorted on Composite Score

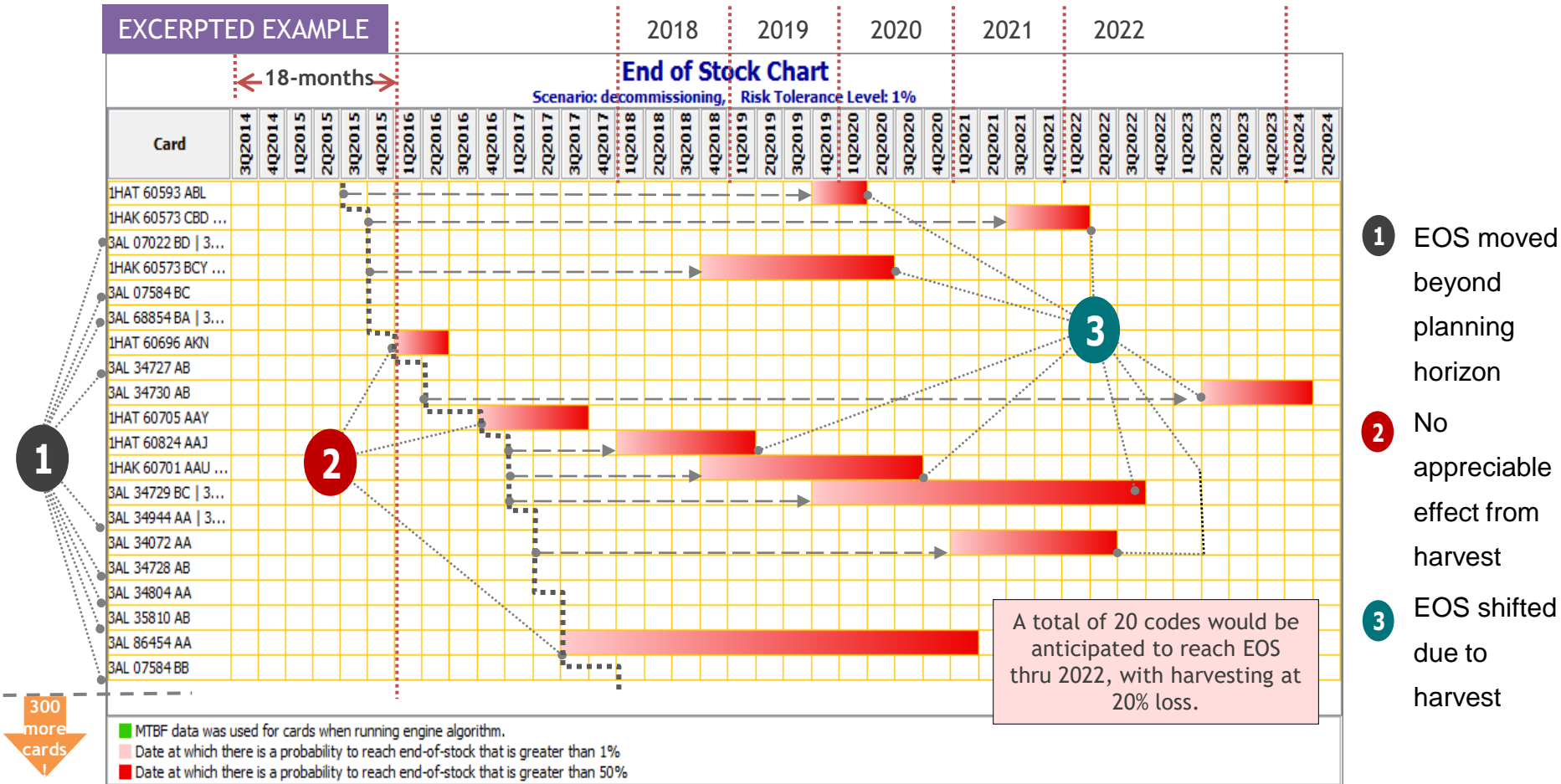
Threshold													
170													
ID	Card	WF1 (Recent)	WF2 (Linear)	WF3 (Rate)	WF4 (Frequenc y)	WF5 (Spare)	WF6 (Repair)	CWF	Installed Base	Description	Supplier	Model	Type
76	3AL 34945 AA	307%	23%	7.7%	1	43%	5%	10	121	L-16.1 aggregate SC	Alcatel	1661SMC	ADM
63	3AL 34727 AB	217%	60%	4.8%	1	9%	1%	10	1149	Aggregate S-16.1	Alcatel	1664SM	ADM
179	1HAK 60573 BCY	120%	16%	7.3%	1	14%	20%	8	517	1550nm TX STM-16 optical interface	Siemens	Siemens	ADM
178	1HAK 60573 CBD	122%	11%	5.9%	1	9%	20%	8	4813	1300nm TX STM-16 optical interface	Siemens	Siemens	ADM
97	3AL 36424 **	208%	100%	4.2%	0	833%	70%	8	6	coluer aggarate	Alcatel	1661SMC	ADM
290	3AL 07022 BD 3AL	99900%	-4%	17.2%	1	28%	80%	7	132	HDD 3 , 5"2.4 GByte	Alcatel	1641SX	DXC
20	3AL 07584 BC	677%	-32%	15.8%	1	30%	80%	7	96	Communication Controller Board A2	Alcatel	1641SX	DXC
289	3AL 68854 BA 3AL	436%	-3%	12.7%	1	23%	50%	7	132	Master Clock Board	Alcatel	1641SX	DXC
285	1HAK 60701 AAU	318%	21%	12.3%	1	56%	98%	7	81	STM-16 TX 1300	Siemens	Siemens	ADM
19	3AL 07584 BB	574%	-11%	6.9%	1	37%	80%	7	132	Communication Controller Board A1	Alcatel	1641SX	DXC
232	1HAT 60593 ABL	206%	24%	6.4%	1	7%	98%	7	11388	STM-4 mux interface card (MIC)	Siemens	Siemens	ADM/TMX
133	3AL 86454 AA	418%	165%	1.0%	0	6%	0%	7	104	F3 MAC FDU	Alcatel	1611SSU	SYNC
87	3AL 35904 AA	259%	43%	17.6%	0	290%	50%	6	21	L-16.2 JE aggregate SC	Alcatel	1664SM	ADM
254	131-7404/03	212%	-19%	12.4%	0	225%	98%	6	4	CCU	Siemens	Siemens	DXC
71	3AL 34731 AA	135%	111%	8.3%	0	225%	98%	6	8	Electric bitrib 140	Alcatel	1664SM	ADM
258	131-7408/01	107%	183%	5.6%	0	300%	98%	6	4	timing distributor	Siemens	Siemens	DXC
86	3AL 35854 AB	206%	49%	3.1%	1	21%	0%	6	396	L-16.2 JE1 HM1 SC Aggregate	Alcatel	1664SM	ADM
28	3AL 07784 EC	527%	31%	0.05%	0	4%	80%	6	3739	Converter 03	Alcatel	1641SX	DXC

Eighteen active cards are red-flagged – starting point for forensics examination



HEAT MAP - TRANSFORMATION-BASED HARVEST (20% LOSS)


C Show the LCM impact of a major transformation project



The harvest from transformation, even when modeled with a 20% loss, proves to be a sufficient mitigation strategy for the short-term sustinment period of 18 months, thru 2015, but is insufficient beyond that. Anticipating 20 codes to reach EOS thru 2022.



FRONTIER CURVE – TRANSFORMATION-BASED HARVEST (20% LOSS)

 Show the LCM impact of a major transformation project

FOCUSED LIST OF ANTICIPATED 20 EOS CODES

EXCERPTED EXAMPLE

Frontier Chart
Scenario: decommissioning, Risk Tolerance Level: 1%

Card	3Q2014	4Q2014	1Q2015	2Q2015	3Q2015	4Q2015	1Q2016	2Q2016	3Q2016	4Q2016	1Q2017	2Q2017	3Q2017	4Q2017	1Q2018	2Q2018	3Q2018	4Q2018	1Q2019	2Q2019	3Q2019	4Q2019	1Q2020	2Q2020	3Q2020	4Q2020	1Q2021	2Q2021	3Q2021	4Q2021	1Q2022	2Q2022	3Q2022	4Q2022	1Q2023	2Q2023	3Q2023	4Q2023	1Q2024	2Q2024
1HAT 60593 ABL	-675	-635	-641	-754	-747	-628	-710	-1...	-18...	-1...	-16...	-1...	-13...	-1...	-10...	-921	-758	-593	-425	-253	-79	99	280	465	652	844	1039	1237	1439	1645	1854	2068	2289	2506	2731	2960	3193	3425	3656	3888
1HAK 60573 CBD ...	-346	-337	-341	-395	-412	-363	-393	-602	-911	-942	-892	-841	-791	-740	-690	-639	-589	-538	-488	-437	-386	-335	-284	-233	-182	-130	-79	-27	25	77	129	181	233	286	339	391	444	497	550	603
1HAK 60573 BCY ...	-59	-51	-50	-56	-57	-47	-46	-56	-66	-66	-57	-49	-41	-33	-24	-16	-8	0	7	15	23	31	39	47	55	63	70	78	86	94	102	110	118	125	133	141	149	157	165	172
1HAT 60696 AKN	-75	-62	-49	-35	-20	-3	18	33	48	62	76	90	104	118	132	146	161	175	189	204	218	233	248	263	278	293	308	324	339	355	371	386	402	419	435	452	468	485	501	518
1HAT 60705 AAY	-79	-71	-63	-55	-47	-38	-29	-20	-10	4	15	25	33	42	51	59	67	75	83	91	99	107	115	123	131	139	146	154	162	170	177	185	193	200	208	216	223	231	238	246
1HAT 60824 AAJ	-179	-162	-150	-141	-125	-109	-109	-98	-90	-76	-62	-46	-24	-8	6	20	34	47	60	73	86	99	112	125	138	151	163	176	189	201	214	226	239	251	264	276	289	301	313	326
1HAK 60701 AAU ...	-41	-38	-38	-37	-35	-32	-34	-34	-34	-32	-28	-24	-17	-13	-9	-5	-1	3	7	10	14	18	22	26	30	34	38	42	47	51	56	60	65	70	75	79	85	90	95	100
3AL 34729 BC 3...	-14	-13	-12	-11	-9	-9	-9	-10	-12	-13	-12	-11	-10	-9	-7	-5	-4	-4	-3	-2	-1	0	0	1	2	2	3	4	4	5	6	6	7	8	8	9	9	10	11	11
3AL 34072 AA	-164	-158	-157	-145	-162	-207	-231	-244	-245	-232	-217	-202	-180	-165	-150	-137	-123	-110	-96	-83	-70	-58	-45	-32	-19	-7	6	19	31	44	56	69	81	94	106	119	131	143	156	168
3AL 86454 AA	-5	-5	-5	-4	-4	-4	-3	-3	-2	-2	-1	-1	1	2	2	3	3	4	5	5	6	6	7	8	8	9	9	10	11	11	12	13	14	14	15	16	17	18	18	19
3AL 97080 AD	-6	-6	-5	-5	-5	-4	-4	-4	-3	-3	-2	-2	-1	-1	1	1	2	2	3	3	3	4	4	5	5	5	6	6	6	7	7	8	8	8	9	9	9	10	10	
3AL 65115 AA	-36	-34	-32	-30	-27	-25	-23	-21	-18	-16	-13	-11	-8	-5	-1	4	7	10	13	15	18	20	22	25	27	29	31	34	36	38	40	42	45	47	49	51	53	55	57	59
3AL 65103 ZZ 3...	-19	-18	-17	-16	-15	-14	-13	-12	-11	-10	-8	-7	-5	-3	-1	2	4	6	8	10	12	14	16	17	19	21	23	25	27	29	32	34	36	39	41	44	46	49	51	54
3AL 97086 AA	-15	-14	-13	-12	-11	-10	-10	-9	-8	-7	-6	-5	-4	-2	-1	1	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	17	18	19	20	21	21	22	23	
3AL 97078 AC	-7	-7	-6	-6	-6	-5	-5	-5	-4	-4	-3	-3	-2	-2	-1	-1	1	1	1	2	3	3	3	4	4	5	5	5	6	6	7	7	7	8	8	8	9	9	9	10
3AL 36517 BB	-12	-12	-11	-13	-12	-12	-12	-13	-14	-16	-15	-15	-14	-14	-13	-13	-12	-11	-11	-10	-9	-7	-7	-6	-5	-4	-3	-3	-2	-1	-1	0	0	1	2	2	3	3	4	5
1HAT 60585 CBT ...	-438	-419	-400	-381	-361	-341	-320	-299	-278	-256	-234	-211	-188	-164	-140	-115	-89	-63	-35	1	35	65	94	122	151	180	209	238	268	298	329	360	391	423	455	488	521	554	587	620
131-9114/03	-201	-193	-185	-176	-168	-159	-150	-141	-131	-122	-112	-102	-92	-81	-70	-59	-48	-36	-23	-9	11	25	39	52	65	78	91	104	117	131	144	158	172	186	200	215	229	244	258	272
131-7404/03	-8	-8	-8	-8	-7	-7	-7	-6	-6	-6	-5	-5	-5	-4	-4	-3	-3	-2	-1	-1	1	1	2	3	3	4	5	5	6	6	7	8	8	9	9	10	11	11	12	12
3AL 34653 AA	-8	-8	-8	-8	-7	-7	-7	-7	-7	-6	-6	-6	-6	-5	-5	-5	-5	-5	-4	-4	-4	-3	-3	-3	-3	-2	-2	-2	-1	-1	-1	1	1	1	1	2	2	2	3	3

The frontier curve of the anticipated 20 codes to reach EOS thru 2022 indicates the quantity of units required to sustain the SDH network, as shown in the inset.

