DEVOPS & MODERNIZATION

AN ENGINEERING EXCELLENCE STORY

Presented by @ScottPrugh

SCOTT PRUGH CHIEF ARCHITECT & SVP, SOFTWARE ENGINEERING

we are CSG

OPTIMIZE

MONETIZE

REVOLUTIONIZE

63 MILLION SUBSCRIBERS

8 BILLION TRANS P/M

100+ GLOBAL DEVOPS TEAMS

24 COUNTRIES

50+ APPS

20+ TECH STACKS

REVENUE MANAGEMENT

DIGITAL MONETIZATION

CUSTOMER COMMUNICATION MANAGEMENT

PAYMENT GATEWAY

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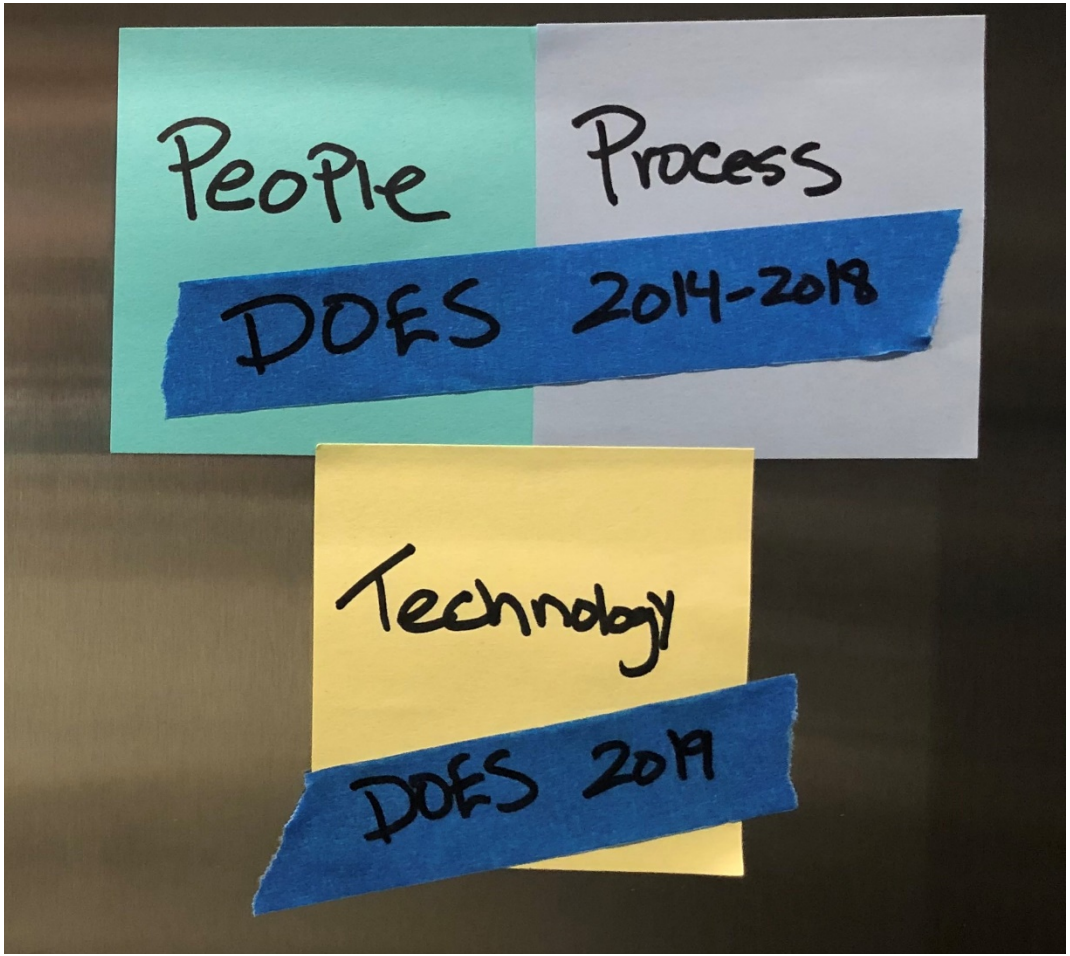

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RECAP: DEVOPS JOURNEY IN METRICS

	Begin	2018		
Release	507	85	-83%	Agile:
eNPS	4	20	400%	PM Meets DevOps

Stability and Growth Enabled via Agile/Lean/DevOps

PROBLEM: ENABLING SPEED, GROWTH & COST MANAGEMENT

Let's grow!

Let's lower costs!

Let's go faster!

Let's be stable!

2010

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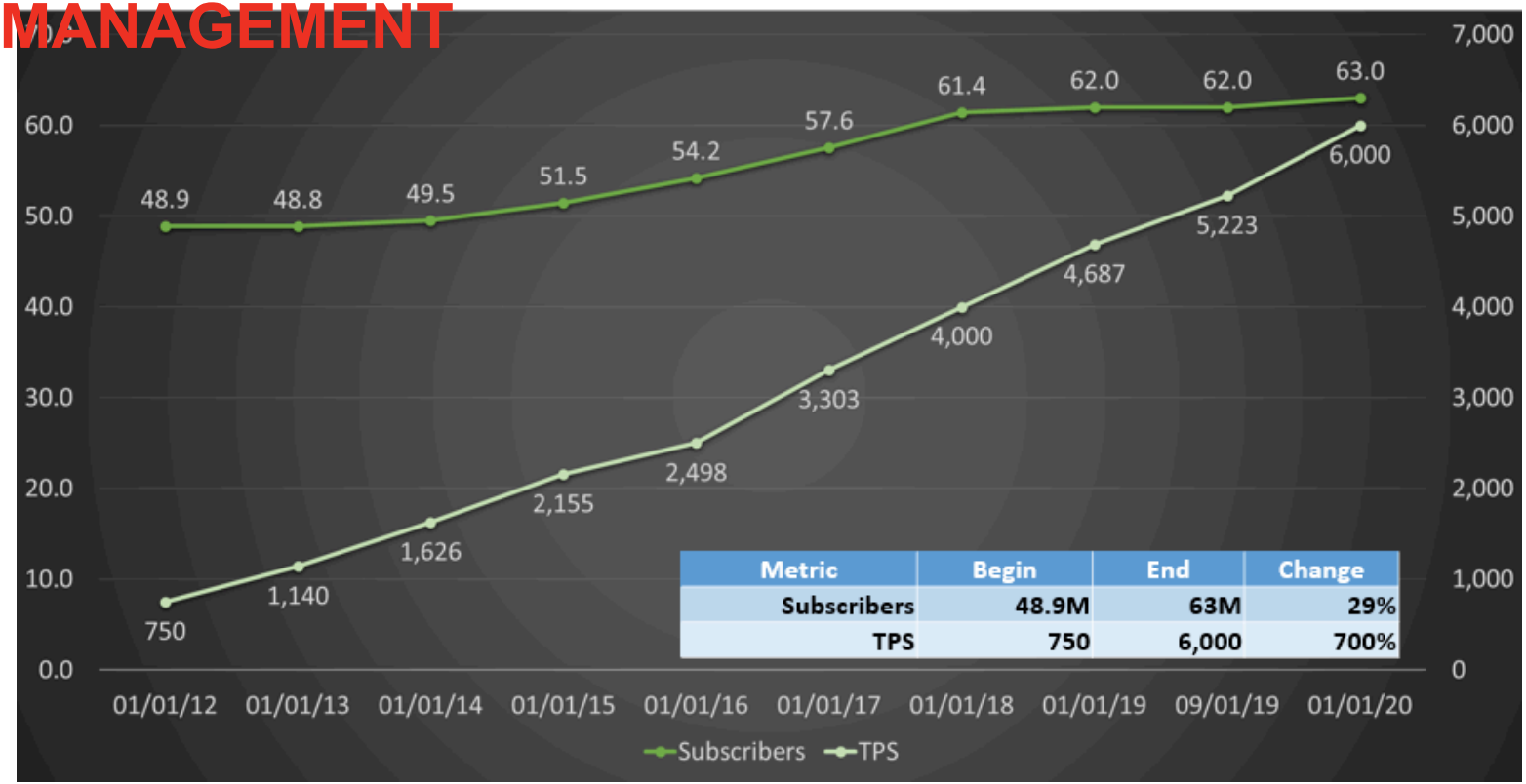
PROBLEM: ENABLING SPEED, GROWTH & COST MANAGEMENT



Metric	Begin	End	Change
Subscribers	48.9M	63M	29%
TPS	750	6,000	700%

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THE PROBLEM WITH “LEGACY” SYSTEMS

HOW DO YOU MAINTAIN, PATCH AND SECURE?

HOW DO YOU INCREASE STABILITY AND SAFETY?

HOW DO YOU GO FASTER AND DELIVER FEATURES?

HOW DO YOU SUPPORT GROWTH WITHOUT A MASSIVE INCREASE IN COST?

HOW DO YOU MINIMIZE EXPOSURE FROM DANGEROUS VENDORS?

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— DON'T BE LEGACY. BE HERITAGE. MODERNIZE.

GREAT ENGINEERING COMPANIES ALLOCATE TIME FOR MODERNIZATION

MODERNIZATION FUELS DEVOPS:

CREATE SAFETY & REDUCE TECHNICAL DEBT

IMPROVE: PRODUCTIVITY, QUALITY, LEAD TIME, RECOVERY

REDUCE RISK: LEGACY TECH, DANGEROUS VENDORS, WORKFORCE

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THE JOB OF MODERNIZATION IS NEVER DONE

APPLICATION MODERNIZATION REALITIES

63M SUBSCRIBERS

1B TRANS/DAY

75M BILLS/MONTH

$87B/YEAR CUSTOMER REVENUE PROCESSED

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APPLICATION MODERNIZATION: KEY CAPABILITIES

How do you approach a massive application modernization?

Feature Switching	Add switches to swap between new and old code.
Code Porting	Port or retarget the code. Assist porting with automation intelligence.
Incremental Rollout	Use feature switches to canary test the rollout. Rollback fast. Small batches.
Strangulation	Strangle off the legacy technology and then cut it out.
Automated Testing	Implement prolific modern test coverage. Do you know how it works today?
Continuous Integration	Version Control. Automate build and deploy. Create fast feedback for change.
Telemetry	Instrument the code. Make it visible. Understand how production behaves.
Infrastructure	Remove proprietary infrastructure. Self service. Infra as code.

APPLICATION MODERNIZATION: 4 STORIES

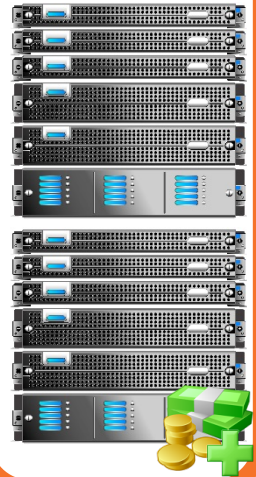
40+ Applications

1200 Integrations

30 Teams
300+ People

STORY 1

SLBOS
API Layer



UNIX/Heavy ESB

STORY 2+3

ACP
Billing, Cust Care

Mainframe

*UNIX/COBOL**

STORY 4

Composition

Foundational Modernization

Continuous Integration
Automated Testing
Telemetry
Infrastructure

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STORY 1: GOLF COURSE SOFTWARE

"Low-Code"

"No Developers!"

"Just map your data!"

"Easy to operate"

"Already integrated"

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STORY 1: API & EVENT LAYER

Problem	Poor developer aesthetics: Low-code, “point and click..” High build and test effort: 14-hour builds, 4 weeks of test Poor operational aesthetics: massive deploys, 45min recycles, low observability Low TPS density Unsustainable cost to support business growth
Approach	Move platform to commodity stack Port 300 transactions leveraged by 1200 integrations to native code Strangle old platform off: feature flags and canary Apply Foundational Modernization: Testing, CI, Telemetry, Infrastructure

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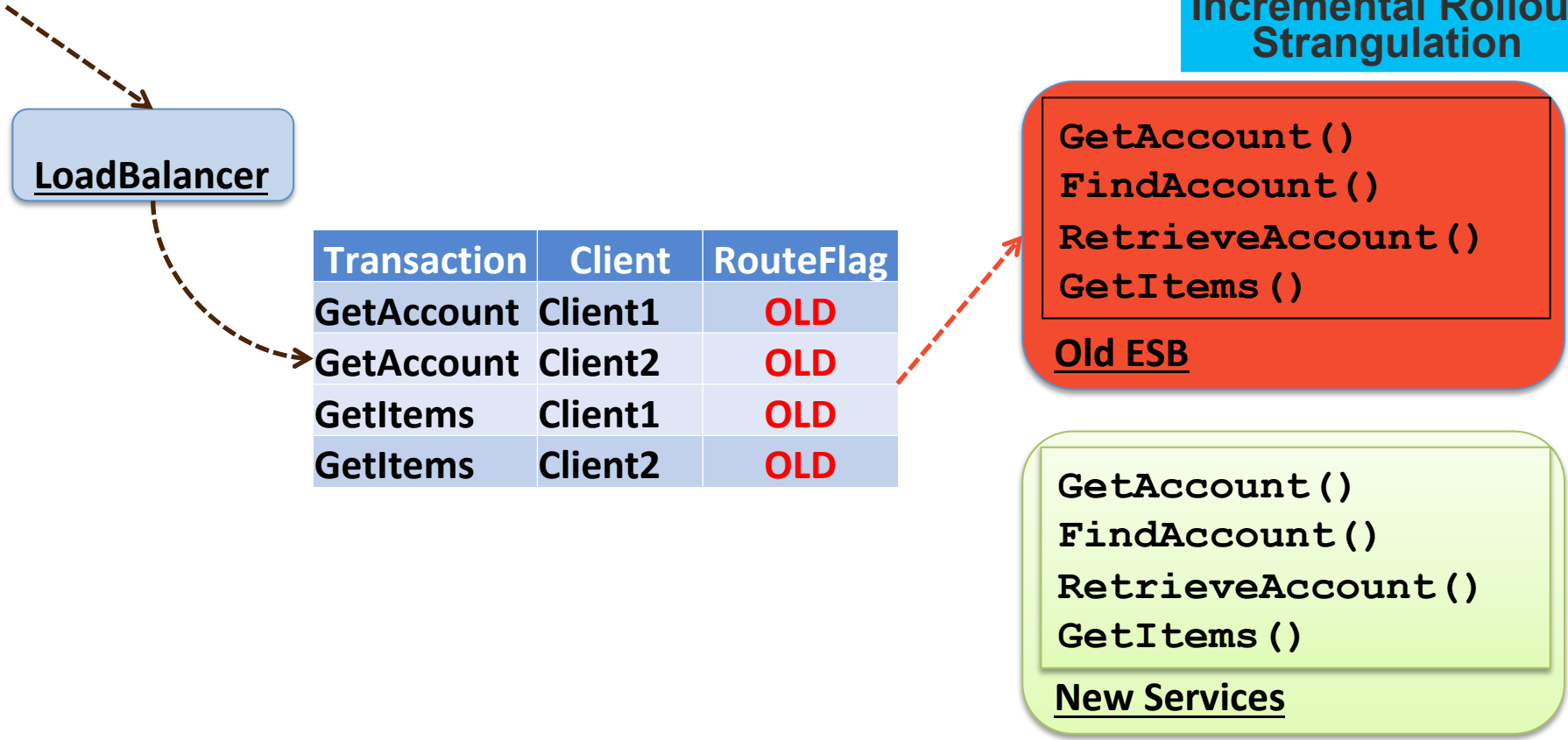
STORY 1: API & EVENT LAYER

Feature Switching
Incremental Rollout
Strangulation



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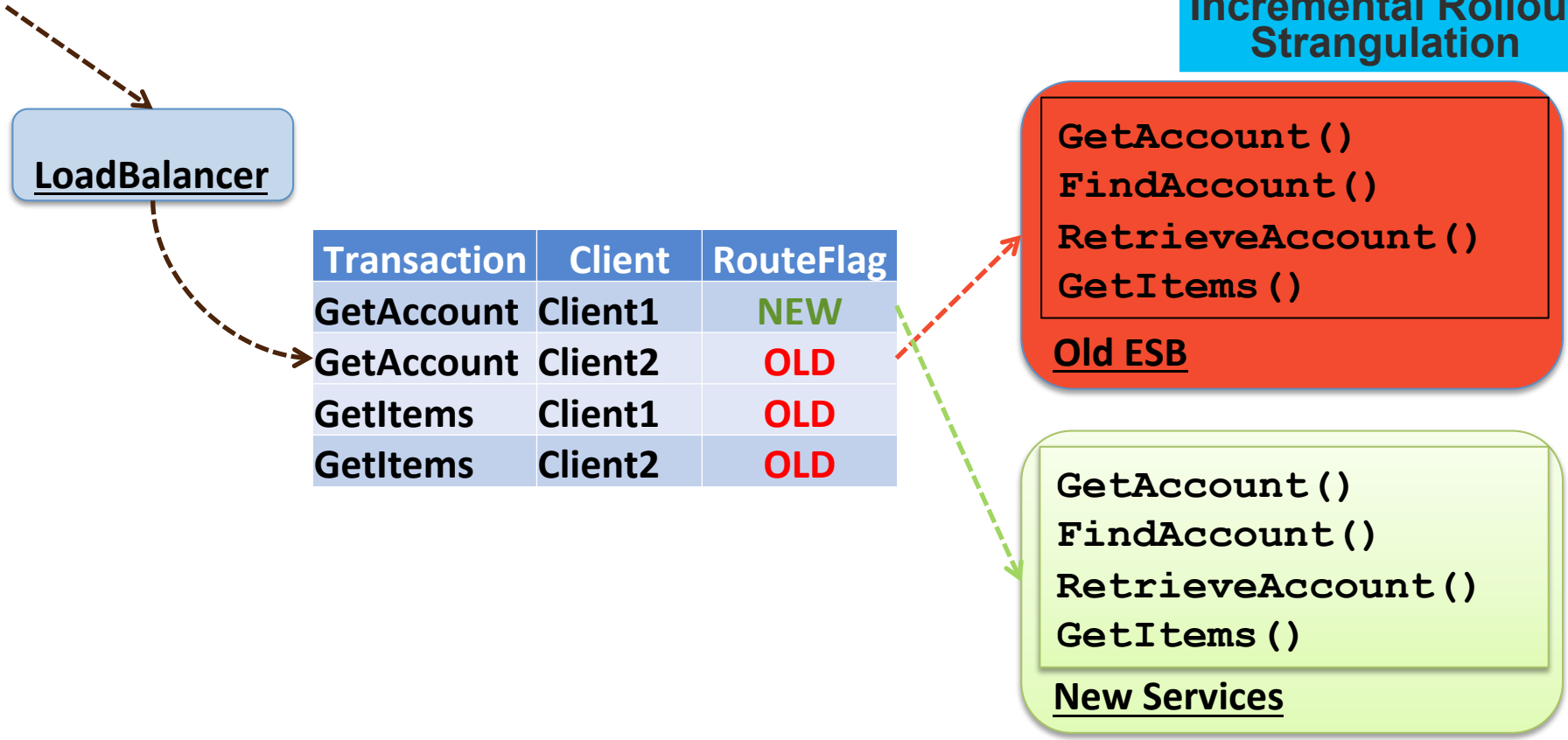

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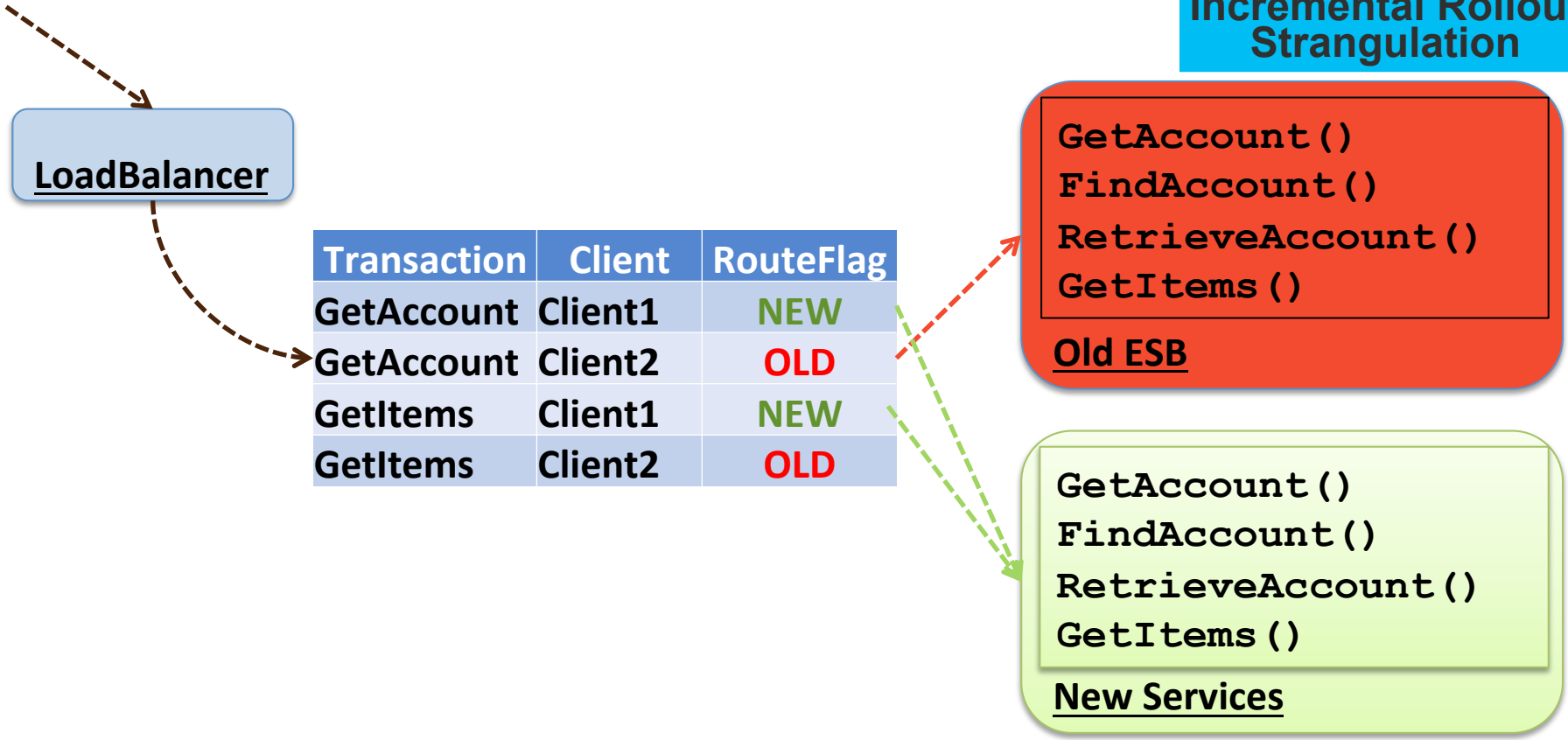

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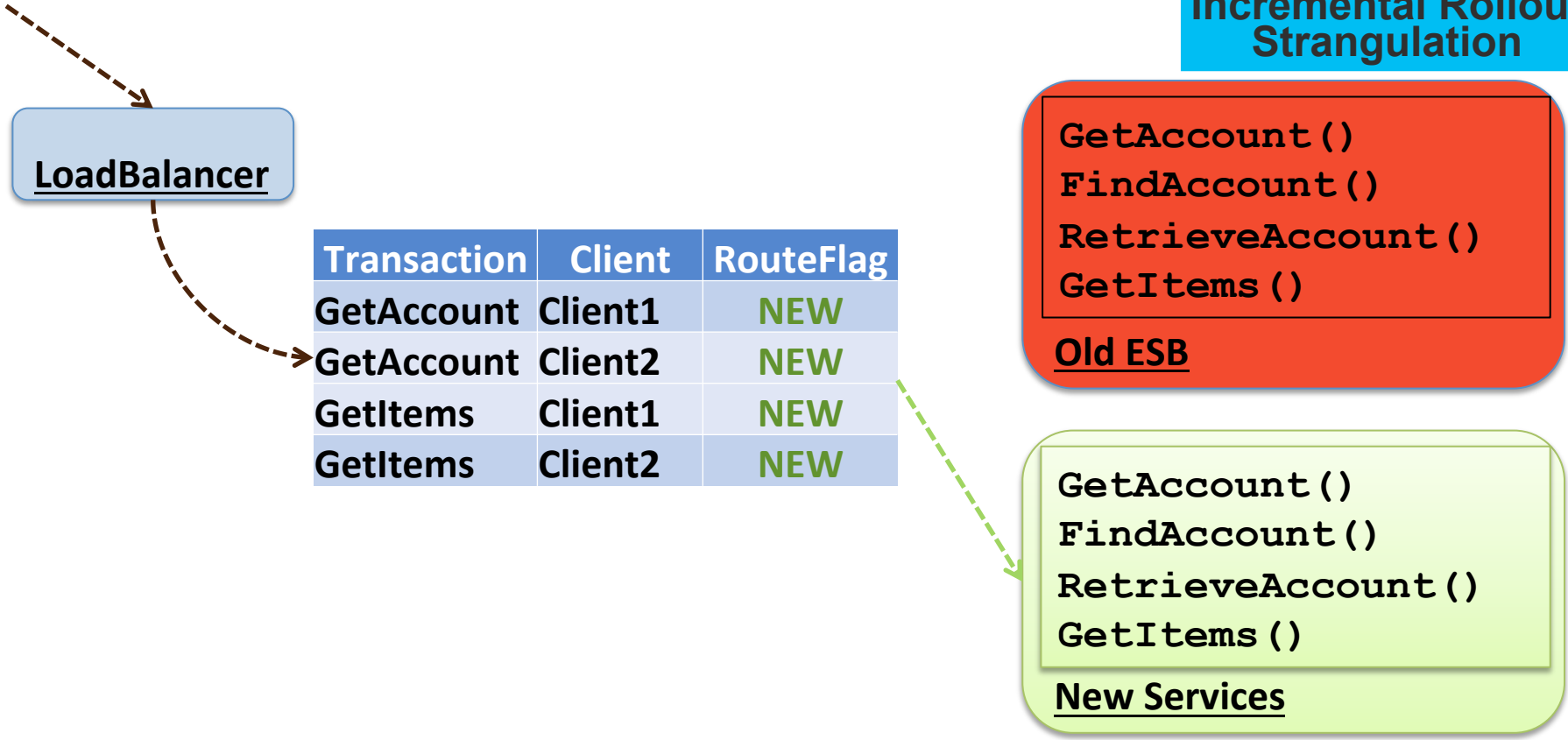

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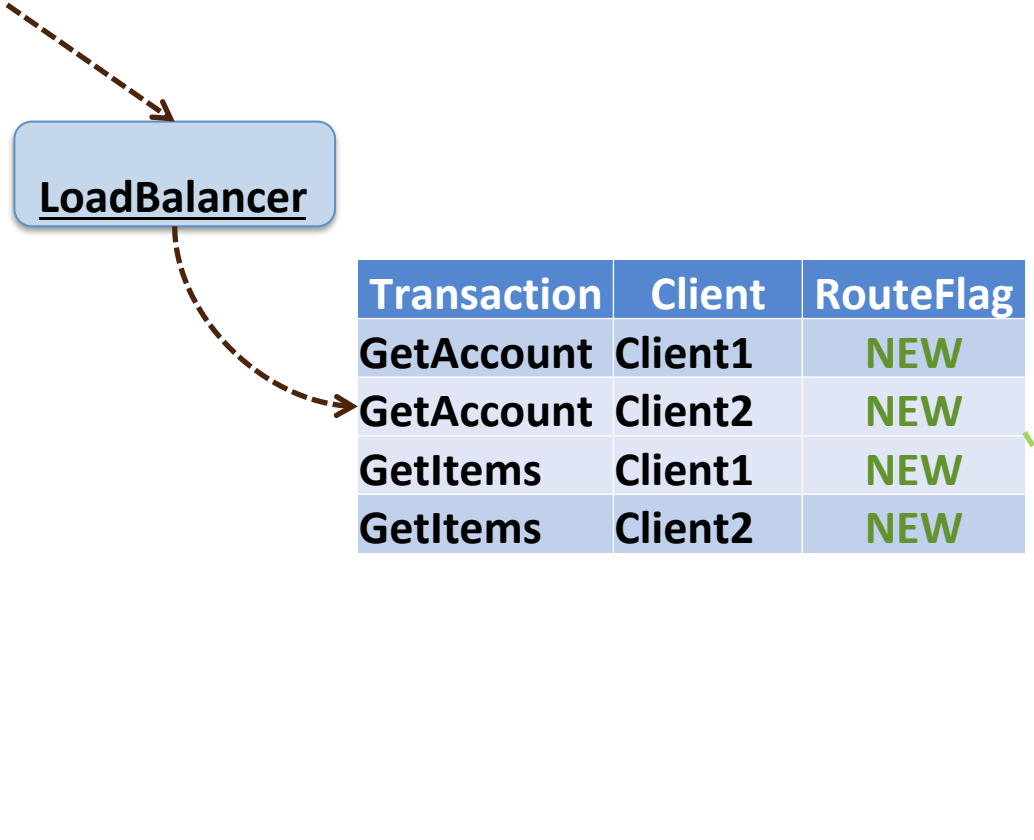
STORY 1: API & EVENT LAYER

Feature Switching
Incremental Rollout
Strangulation



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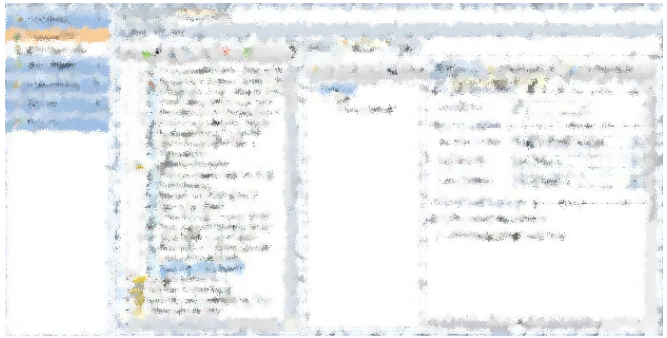
FOUNDATIONAL MODERNIZATION: AUTOMATED TESTING

Automated Testing



Before
Proprietary test tools only used by testers High cost & increasing High manual test effort

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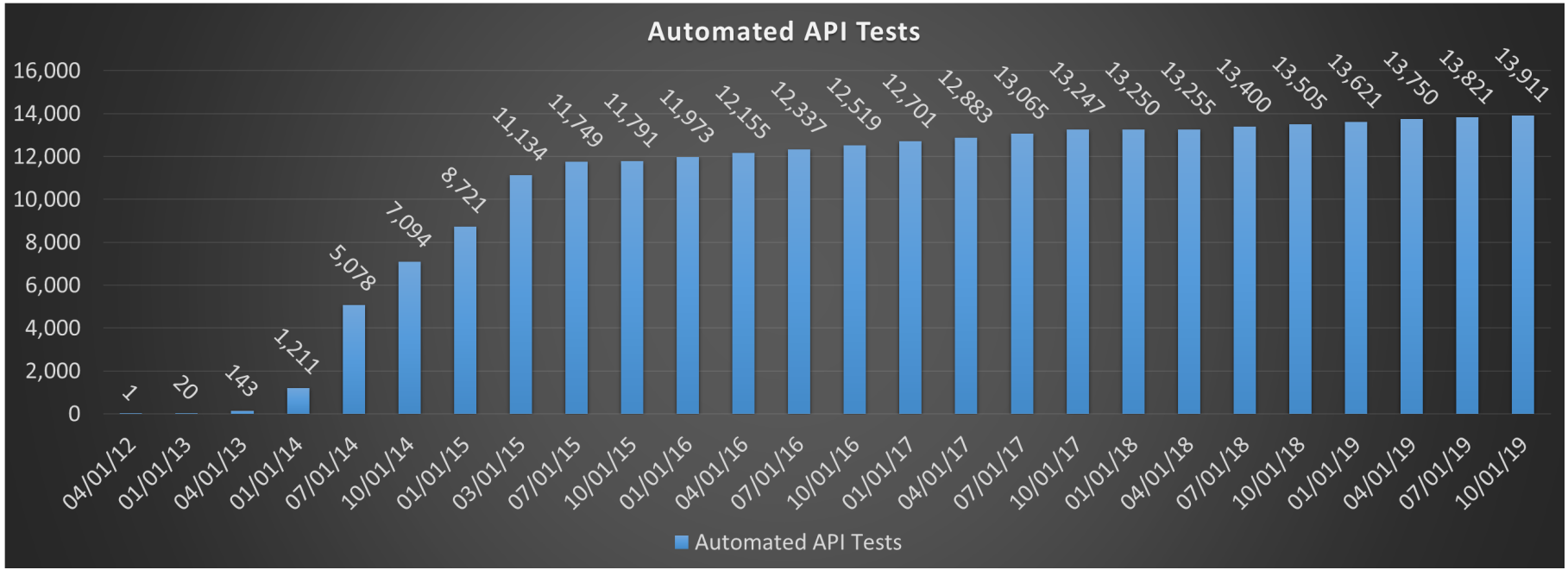
STORY 1: API PLATFORM TEST COVERAGE

Automated Testing



https://itrevolution.com/devops-resource-legacy-code/

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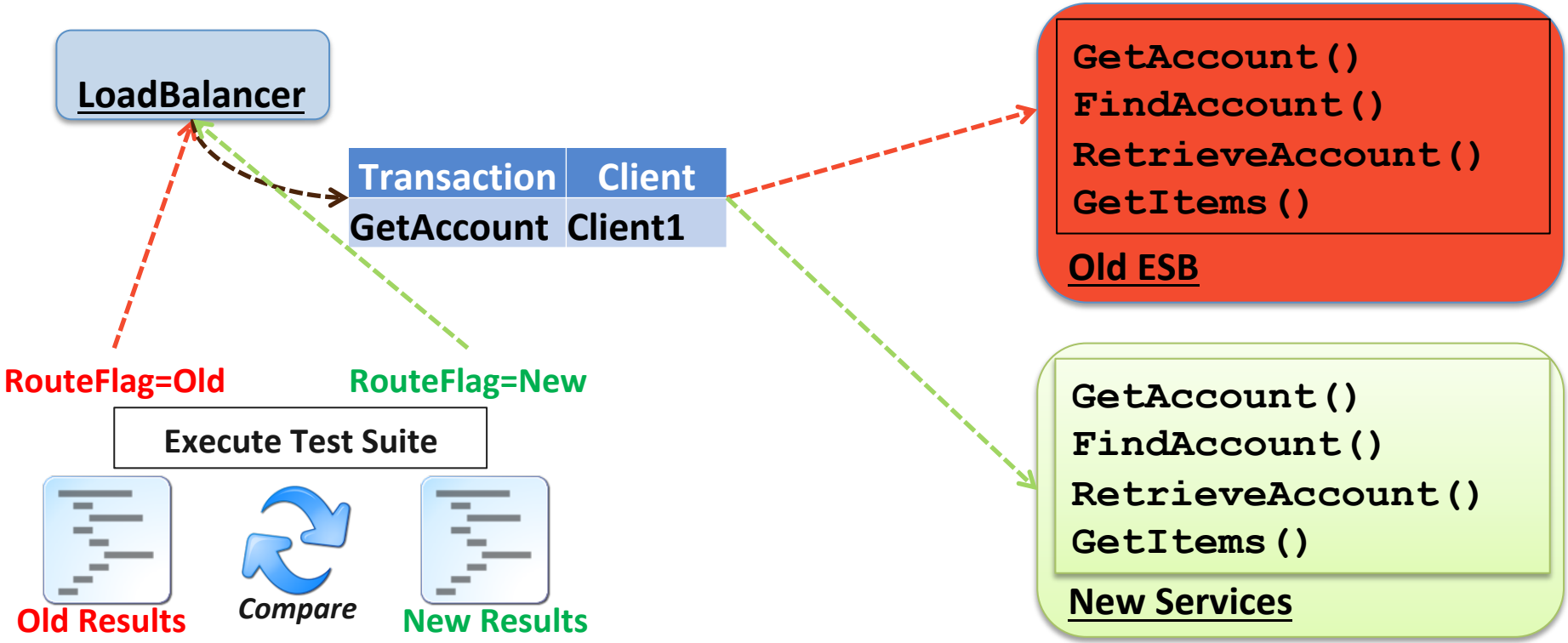
STORY 1: API & EVENT LAYER

Automated Testing

Feature Switching
Incremental Rollout
Strangulation



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STORY 1: API & EVENT LAYER RESULTS

Metric	Before	After
Required TPS	6,000	6,000
Max TPS/Node	215	1,333
Nodes Required	28	4.5
$/TPS	$7,306	$31
Feature Development	15%	55%
Build + Deploy	14hr	5min
Server Recycle	45m	2m
Automated Tests	0	13,011

https://itrevolution.com/devops-resource-legacy-code/

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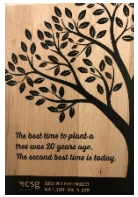
STORY 1: API & EVENT LAYER THANKS



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STORY 1: API & EVENT LAYER CELEBRATION

"Luck favors the prepared." – Edna Mode

"Goodbye, you awful pile of 1990's 8U garbage!!"
-Scott, CSG Parking Lot
-Wes, The Unicorn Project

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STORY 2: MAINFRAME DB2

STORY 1

STORY 2

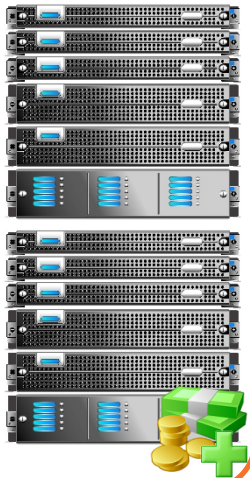
STORY 4

40+ Applications

1200 Integrations

30 Teams
300+ People

SLBOS
API Layer



UNIX/Heavy ESB

ACP
Billing, Cust Care

Mainframe

*UNIX/COBOL**

Composition

Foundational Modernization

Continuous Integration
Automated Testing
Telemetry
Infrastructure

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STORY 2: MAINFRAME DB2

Problem	Lack of commodity data access(Access via CICS only) Maintainability at risk: Productivity, Agility, Workforce Sustainability Unsustainable cost increases jeopardizing viability
Approach	Convert VSAM master files into 500+ DB2 tables Incremental rollout via: Feature switching and VSAM transparency Strangle off VSAM datastore and VSAM subsystems Offload **READ** transactions from CICS to direct DB2 queries

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STORY 2: MAINFRAME DB2

Feature Switching Datastore Edition

PORTING DATASTORES IS HARDER THAN CODE…

DATASTORE MIGRATION PATTERN

1. Old datastore is primary.
2. Old datastore is primary, new datastore is replica. Compare.
3. New datastore is primary, old datastore is replica. Compare.
4. New datastore is primary.

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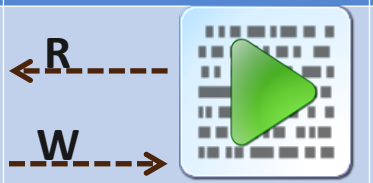
STORY 2: MAINFRAME DB2

Data Switch	Behavior	VSAM	DB2
SW1	VSAM only		

Feature Switching Datastore Edition

Nightly batch compares

Find bad and dirty data!

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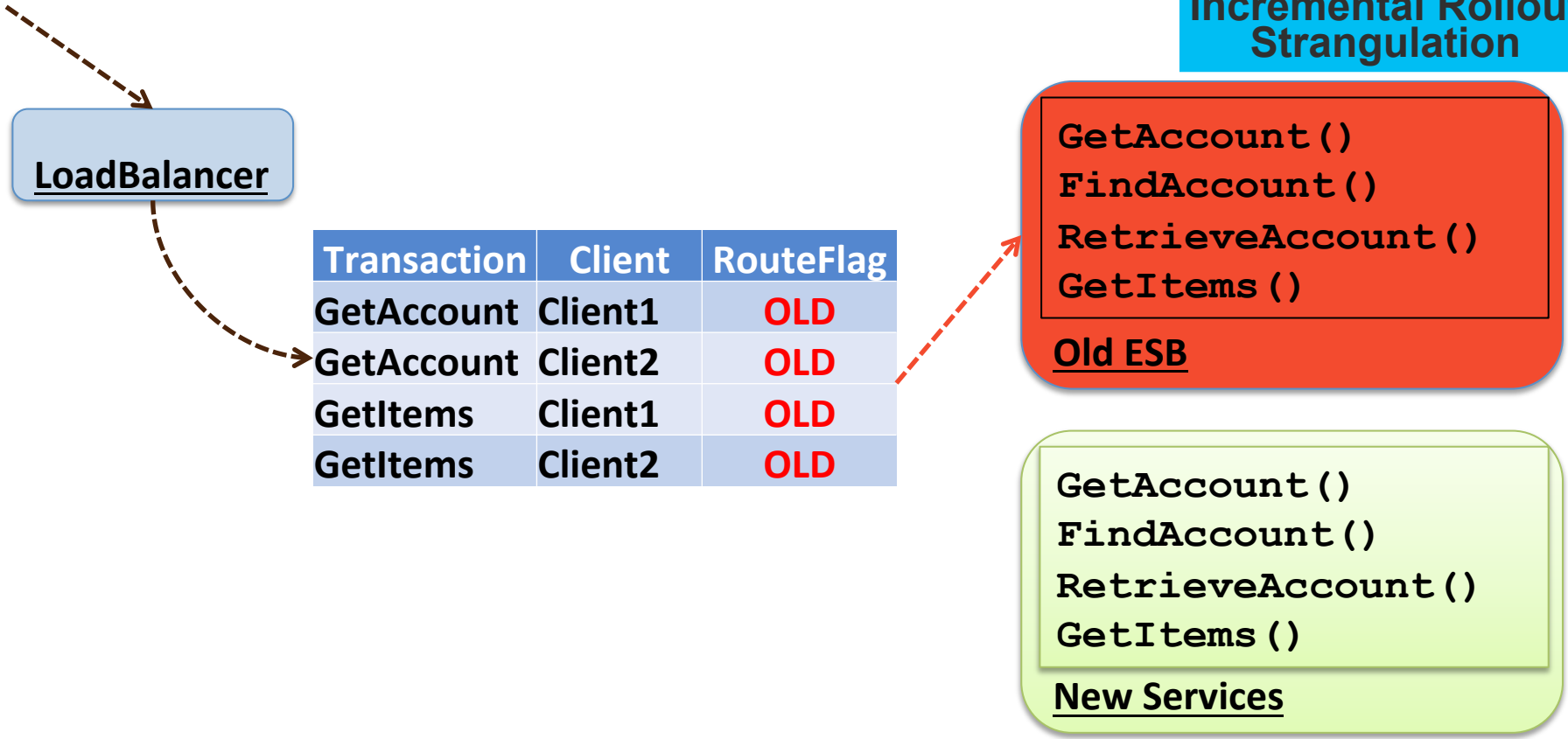
STORY 2: MAINFRAME DB2 DATA ACCESS

Feature Switching
Incremental Rollout
Strangulation



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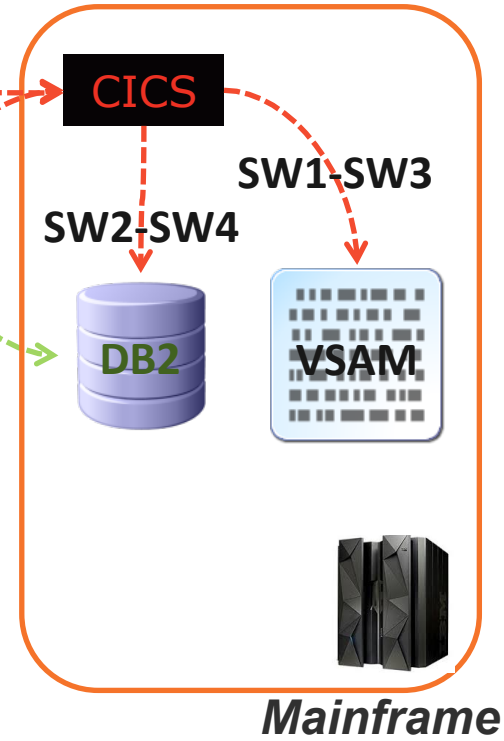
STORY 2: MAINFRAME DB2 DATA ACCESS

```
GetAccount()
FindAccount()
RetrieveAccount()
GetItems()
```

New Services

Transaction	Client	ReadFlag
GetAccount	Client1	CICS
GetAccount	Client2	DB2
GetItems	Client1	DB2
GetItems	Client2	CICS

Feature Switching
Incremental Rollout
Strangulation



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STORY 2: MAINFRAME DB2 RESULTS

Metric	Before	After
Data Access	VSAM via CICS	DB2 direct and CICS
Read Transactions	100% CICS	62% direct DB2
Data Accessibility	Low	High
Average Response	40ms	25ms(38% better)

Near zero customer impact

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STORY 3: MAINFRAME JAVA

STORY 1

STORY 3

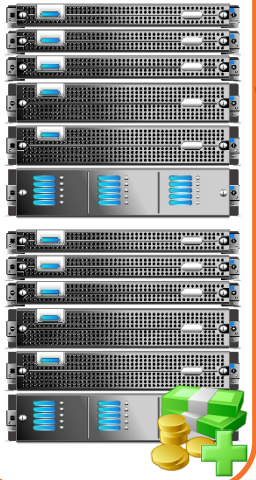
STORY 4

40+ Applications

1200 Integrations

30 Teams
300+ People

SLBOS
API Layer



UNIX/Heavy ESB

ACP
Billing, Cust Care

Mainframe

*UNIX/COBOL**

Composition

Foundational Modernization

Continuous Integration
Automated Testing
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Infrastructure

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STORY 3: MAINFRAME JAVA

Problem	3.7M lines of HLASM Maintainability at risk: Productivity, Agility, Workforce Sustainability Unsustainable cost increases jeopardizing viability
Approach	Cross compiler tooling: HLASM->Java Target more complex **UPDATE** logic All converted code in CI with full test coverage All Java code can run ***OFFBOARD*** or on mainframe Incremental rollout via: Feature switching. Deploys during the day! Strangle off HLASM subsystems

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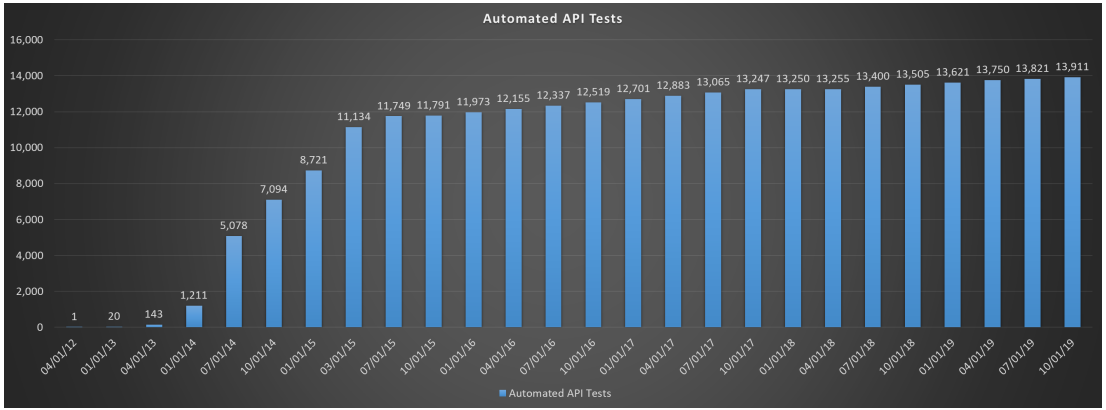
STORY 3: MAINFRAME JAVA: FUNCTIONAL TEST COVERAGE

Functional Test Coverage → Code Analysis → Cross Compilation → Version Control & CI → Unit Testing → Refactor Cross Compilation → Functional Test Coverage

Cover entire legacy code base(HLASM) with both breadth and depth



Automated Tests=13,911

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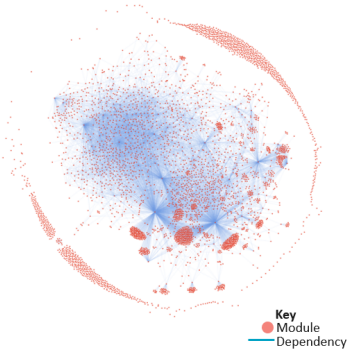
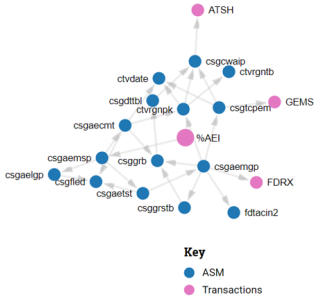
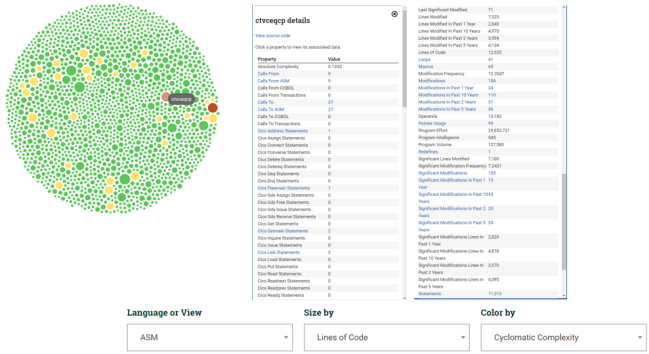
STORY 3: MAINFRAME JAVA: CODE ANALYSIS

Functional Test Coverage → Code Analysis → Cross Compilation → Version Control & CI → Unit Testing → Refactor Cross Compilation → Functional Test Coverage

Leverage Code Analysis to Better Understand Dependencies







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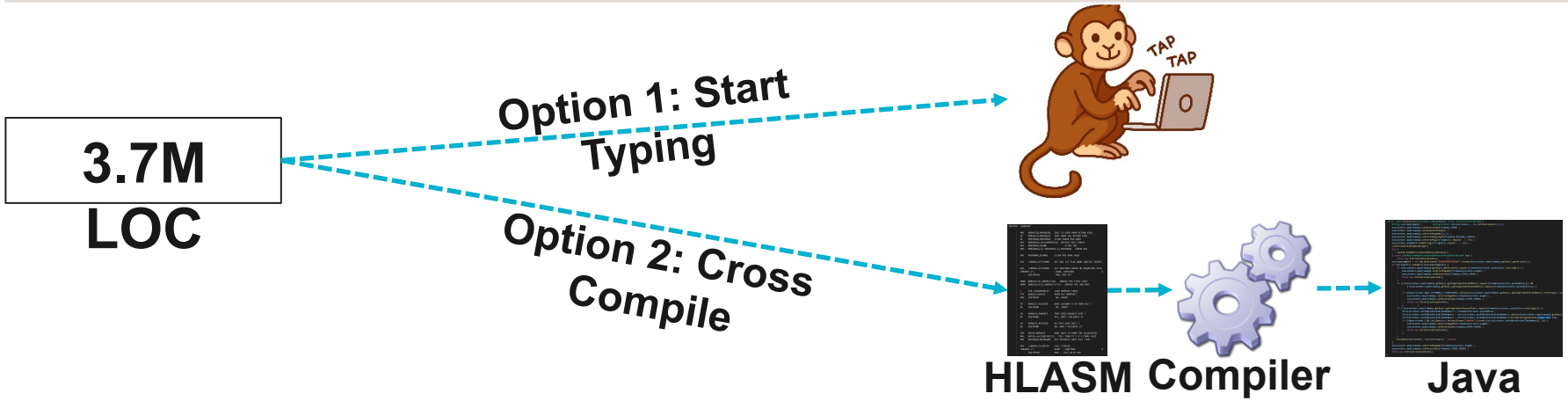
STORY 3: MAINFRAME JAVA: CROSS COMPILATION

Functional Test Coverage → Code Analysis → Cross Compilation → Version Control & CI → Unit Testing → Refactor Cross Compilation → Functional Test Coverage

Leverage Cross Compilation to Mass Migrate, Codify Patterns & Refactor Learnings



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STORY 3: MAINFRAME JAVA: CROSS COMPILATION

```
INITRTN  CSMBEGRT

         MVI   MOPRETCD,MOPRGOOD   INIT TO GOOD PARM RETURN CODE
         XC    MOPSQLCD,MOPSQLCD   INIT PARM SQL RETURN CODE
         XC    MOPERRAD,MOPERRAD   CLEAR ERROR MSG ADDR
         MVC   MOPERRLN,=AL2(MOPMSGLN)  DEFAULT MSG LENGTH
         MVI   MOPERMSG,BLANK              CLEAR THE
         MVC   MOPERMSG+1(L'MOPERMSG-1),MOPERMSG   ERROR MSG

         MVC   MSG98WRK,BLANKS     CLEAR MSG WORK AREA

         BAS   LINKREG,GTFLG000    GET DB2 I/O FLAG ADDR (BATCH) 14207A

         BAS   LINKREG,SETRTNAD    SET ROUTINES BASED ON REQUESTED VIEW
         CBRANCH (*,                GOOD, CONTINUE                    X
               INITR970)            BAD, MSG SET

         UNPK  WORK16(14),MOPACCT(8)   UNPACK THE FIRST PART
         UNPK  WORK16+13(3),MOPACCT+7(2)   UNPACK THE 2ND PART

         L     R14,=A(NUMTABLE)    LOAD NUMERIC TABLE
         TRT   WORK16,0(R14)       PARM KEY NUMERIC?
         BNZ   INITR850             NO, ERROR

         CP    MOPACCT,PCKZERO     HAVE ACCOUNT # IN PARM KEY ?
         BZ    INITR900             NO, ERROR

         CP    MOPDATE,P4NINES     THEY USED HIGHEST DATE ?
         BE    INITR400            YES, DON'T VALIDATE IT

         CP    MOPDATE,PCKZERO     DO THEY HAVE DATE ?
         BE    INITR400            NO, DON'T VALIDATE IT

         ZAP   DAT9P,MOPDATE       MOVE DATE TO PARM FOR VALIDATION
         MVC   DATIN,=AL2(DATFMT17)   TELL TEHM IT'S 9'S COMPL DATE
         MVI   DATREQCD,DATREQVD   SET VALIDATE DATE CALL TYPE

         BAS   LINKREG,CALDATEP    CALL CTVDATE
         CBRANCH (*,               GOOD -- CONTINUE                  X
               INITR950)           BAD -- EXIT WITH ERR
```

```
public void initialize(ExecuteVars executeVars) throws InitializeException4 {
    String overlappingWork ;        InitializeVars initializeVars = new InitializeVars(null);
    executeVars.mopCtvmemlp.setReturnCode(Ctvmemlp.GOOD) ;
    executeVars.mopCtvmemlp.setSqlReturnCode(0) ;
    executeVars.mopCtvmemlp.setErrorMsgAddr(null) ;
    executeVars.mopCtvmemlp.setErrorMsgLength(Ctvmemlp.MESSAGE_LENGTH) ;
    executeVars.mopCtvmemlp.setErrorMsg(StringUtils.repeat(" ", 39)) ;
    executeVars.msg98wrk.fromString(StringUtils.repeat(' ', 28)) ;
    callCtvcomitToGetDb2IOFlag();
    try {
        setRoutineAddressesBasedOnPassedViewId();
    } catch (SetRoutineAddressesBasedOnPassedViewIdException4 exp) {
        throw new InitializeException4();       }
    overlappingWork = new DecimalFormat("0000000000000000").format(executeVars.mopCtvmemlp.getKey().getAccount());
    if (StringUtils.isNumeric(overlappingWork)) {
        if (executeVars.mopCtvmemlp.getKey().getAccount().equals(CtvmemluConstants.packedZero.toString())) {
            executeVars.mopCtvmemlp.setErrorMsgAddr(CtvmemluConstants.msg02) ;
            executeVars.mopCtvmemlp.setReturnCode(Ctvmemlp.OTHER_ERROR) ;
            throw new InitializeException4();
        }
        if ((!(executeVars.mopCtvmemlp.getKey().getComplimentPackedDate().equals(CtvmemluConstants.packedNines))) &&
                (!(executeVars.mopCtvmemlp.getKey().getComplimentPackedDate().equals(CtvmemluConstants.packedZero)))) {

            if (!ReportFormat.DATE_YYYYMMDD_9_COMPLEMENT.validate(executeVars.mopCtvmemlp.getKey().getComplimentPackedDate().toString(), exe
                executeVars.mopCtvmemlp.setErrorMsgAddr(CtvmemluConstants.msg07) ;
                executeVars.mopCtvmemlp.setReturnCode(Ctvmemlp.OTHER_ERROR) ;
                throw new InitializeException4();
            }         }
        if (!(executeVars.mopCtvmemlp.getKey().getComplimentPackedTime().equals(CtvmemluConstants.packedZero.toString()))) {
            initializeVars.work4BytePackedTimeHhmmsst = CtvmemluConstants.packedNines ;
            initializeVars.work4BytePackedTimeHhmmsst = initializeVars.work4BytePackedTimeHhmmsst.subtract(executeVars.mopCtvmemlp.getKey().
            initializeVars.work4BytePackedTimeHhmmsst = initializeVars.work4BytePackedTimeHhmmsst.divideToIntegralValue(BigDecimal.TEN);
            if (!ReportFormat.TIME.validate(new DecimalFormat("000000").format(initializeVars.work4BytePackedTimeHhmmsst), 6)) {
                executeVars.mopCtvmemlp.setErrorMsgAddr(CtvmemluConstants.msg08) ;
                executeVars.mopCtvmemlp.setReturnCode(Ctvmemlp.OTHER_ERROR) ;
                throw new InitializeException4();
            }
        }
        buildKey(executeVars, initializeVars);  return;
    }
    executeVars.mopCtvmemlp.setErrorMsgAddr(CtvmemluConstants.msg06) ;
    executeVars.mopCtvmemlp.setReturnCode(Ctvmemlp.OTHER_ERROR) ;
    throw new InitializeException4();
}
```

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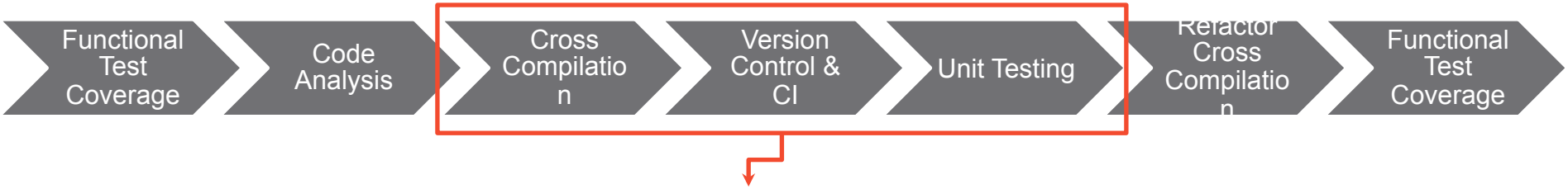
STORY 3: MAINFRAME JAVA: CROSS COMPILATION



All Cross Compiled Code Gets Foundational Version Control, CI, Unit Tests

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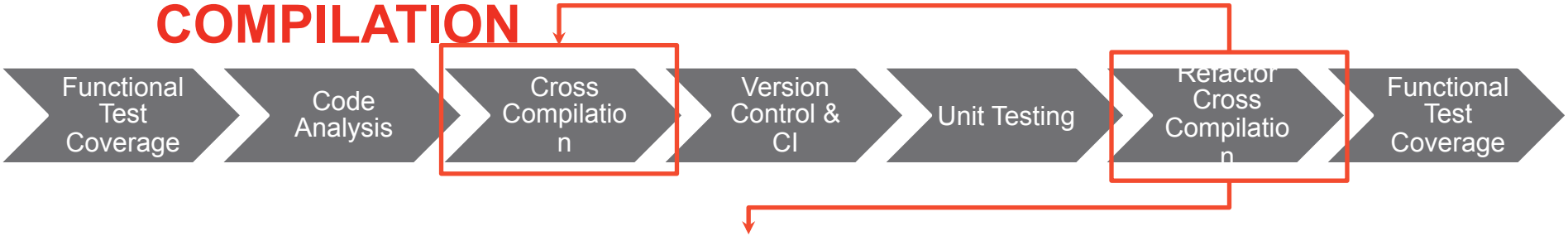
STORY 3: MAINFRAME JAVA: CROSS COMPILATION



Continually Refactor Cross Compilation:

- Recognize domain specific patterns
- Increase target code base maintainability

File	Original Name	Generated Name	File Ty	Generated Ty	View Name
ci#table	I#CALTC2	BASE_CUST_NUMBER_VALIDATION	Copy	Constant	2018-03-22 memo
ci#table	I#CALTC3	RETURN_CURRENT_OL_REG_ID	Copy	Constant	2018-03-22 memo
ci#table	I#CALTC5	ENHANCED_CAMPAIGN_CALL_TYPE	Copy	Constant	2018-03-22 memo
ci#table	I#CALTC9	RETURN_CYCLE_INFORMATION	Copy	Constant	2018-03-22 memo
ci#table	I#CALTCN	CUSTOMER_NUMBER_VALIDATION	Copy	Constant	2018-03-22 memo
ci#table	I#CALTD5	RETURN_NEXT_DAY_OL_REG_ID	Copy	Constant	2018-03-22 memo
ci#table	I#CALTE8	CONVERGENT_XREF	Copy	Constant	2018-03-22 memo
ci#table	I#CALTE9	GENERATE_CHECK_DIGIT	Copy	Constant	2018-03-22 memo
ci#table	I#CALTF0	VAL_VISA_6_DIG_BINS_ICAS	Copy	Constant	2018-03-22 memo
ci#table	I#CALTF1	FILL_IN_TABLE_FOR_NUMBER	Copy	Constant	2018-03-22 memo
ci#table	I#CALTF2	FILL_IN_TABLEGEN_DUMMY	Copy	Constant	2018-03-22 memo
ci#table	I#CALTF3	GENERATE_DISPLAYS_ONLY	Copy	Constant	2018-03-22 memo
ci#table	I#CALTF4	GENERATE_CHECK_DIGET	Copy	Constant	2018-03-22 memo
ci#table	I#CALTF5	FILL_IN_TABLE_FOR_ICA_NUMBE	Copy	Constant	2018-03-22 memo

Naming Overrides

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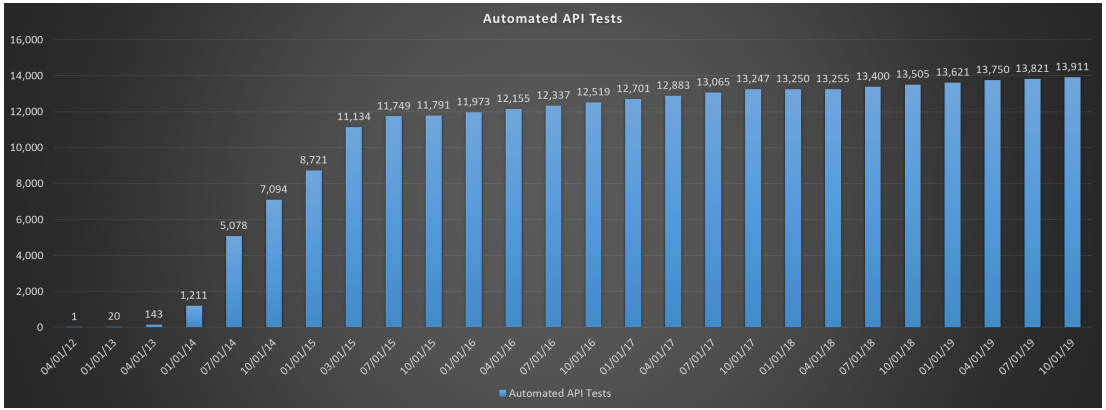
STORY 3: MAINFRAME JAVA: FUNCTIONAL TEST COVERAGE

Functional Test Coverage → Code Analysis → Cross Compilation → Version Control & CI → Unit Testing → Refactor Cross Compilation → Functional Test Coverage

Leverage Functional Coverage to Verify Congruent Behavior



Automated Tests=13,911

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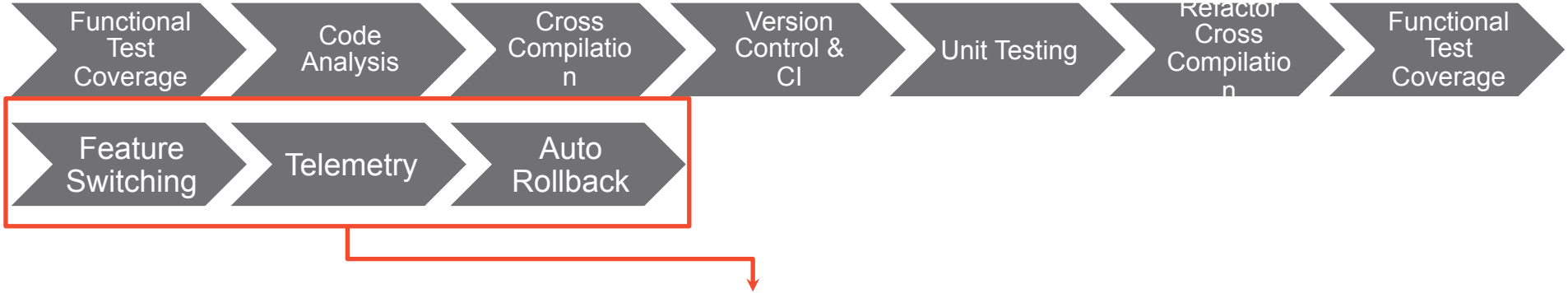
STORY 3: MAINFRAME JAVA: PRODUCTION ROLLOUT



Leverage Feature Switching to Rollout and Rollback
Integrate Heavily to Production Telemetry
Detect Errors and Auto Rollback Upon Failure

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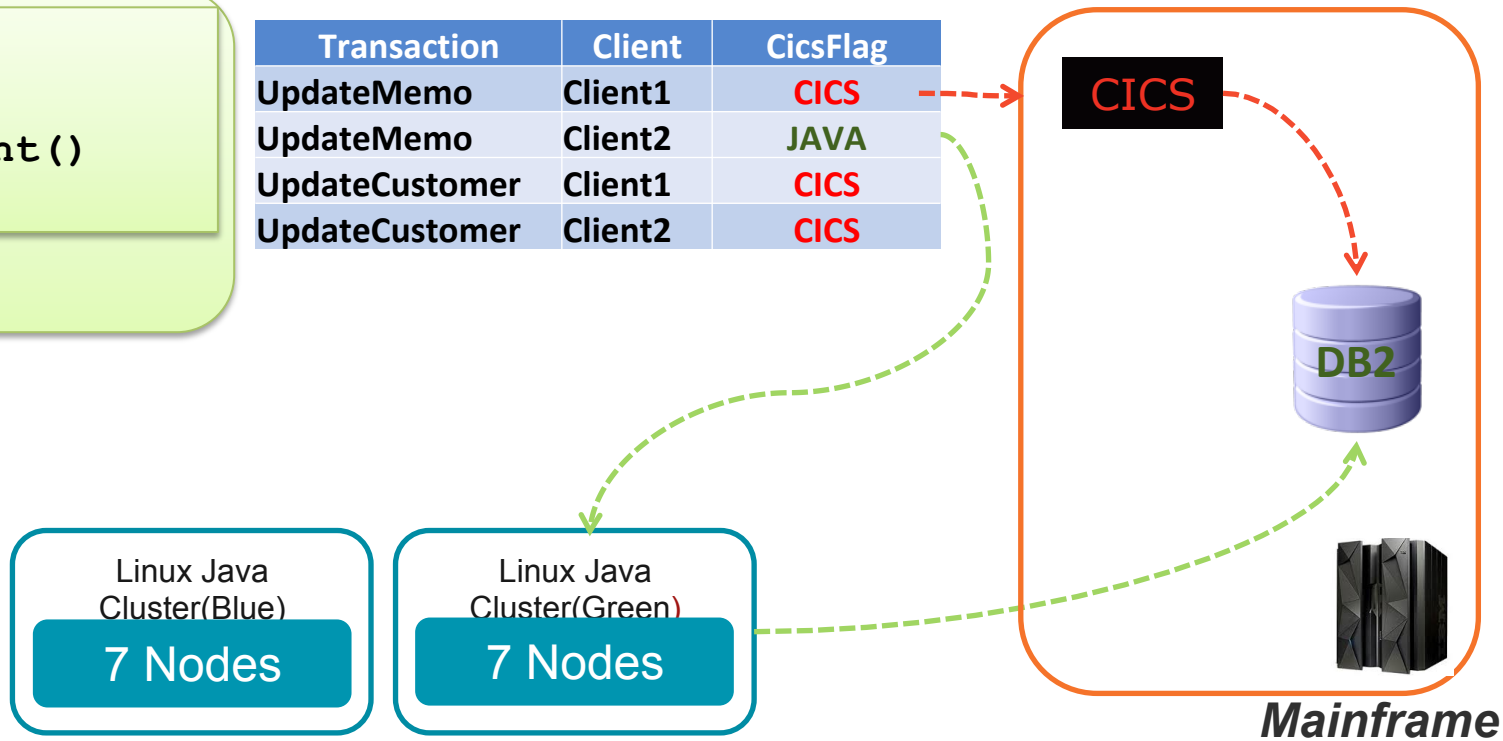
STORY 3: MAINFRAME JAVA: PRODUCTION TOPOLOGY

Feature Switching
Strangulation
Incremental Rollout

```
GetAccount()
FindAccount()
RetrieveAccount()
GetItems()
```

New Services

Transaction	Client	CicsFlag
UpdateMemo	Client1	CICS
UpdateMemo	Client2	JAVA
UpdateCustomer	Client1	CICS
UpdateCustomer	Client2	CICS



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STORY 3: MAINFRAME JAVA: PRODUCTION TOPOLOGY

Feature Switching
Strangulation
Incremental Rollout

```
GetAccount()
FindAccount()
RetrieveAccount()
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```
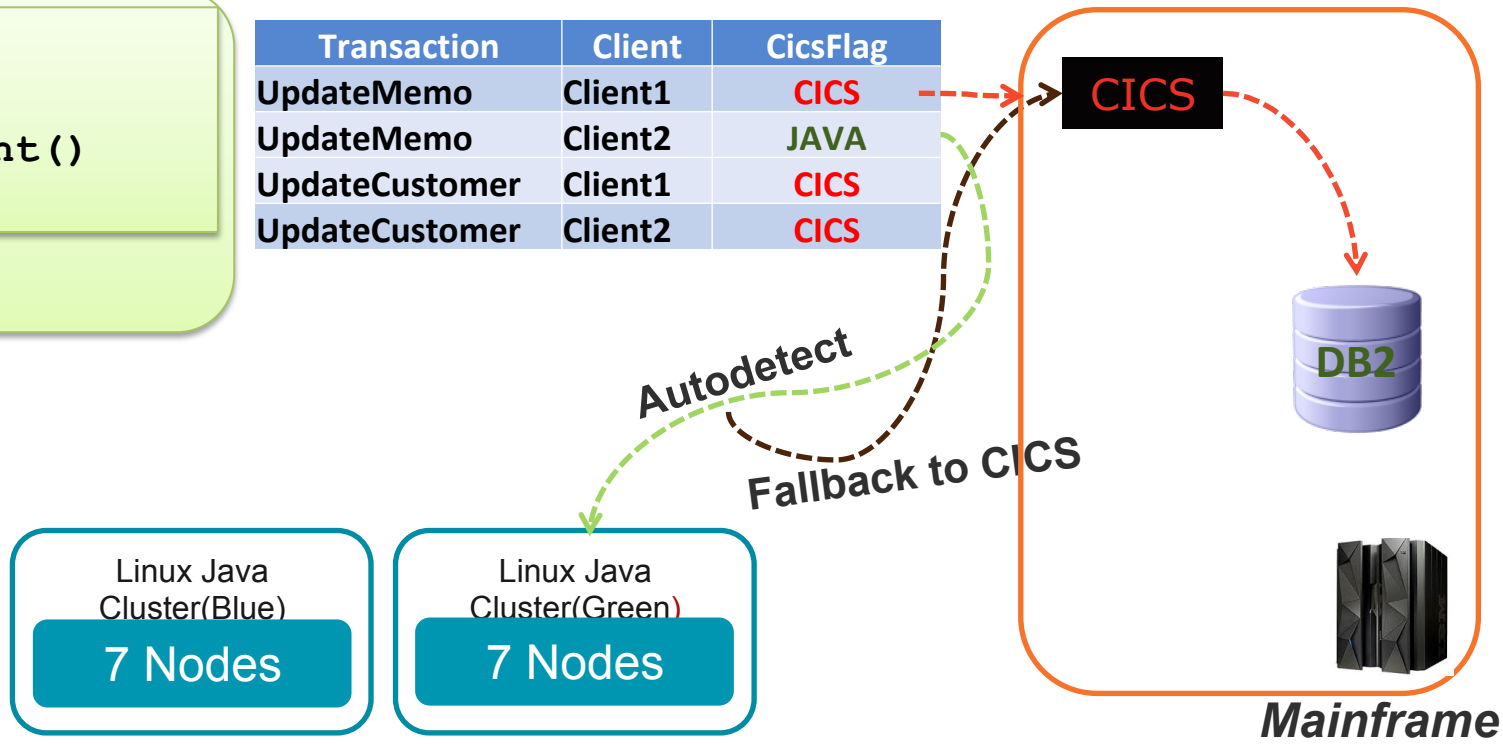

New Services

Transaction	Client	CicsFlag
UpdateMemo	Client1	CICS
UpdateMemo	Client2	JAVA
UpdateCustomer	Client1	CICS
UpdateCustomer	Client2	CICS



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STORY 3: MAINFRAME JAVA RESULTS

Metric	Before	After*
Online Code Base(3.7M)	100% HLASM	85% Java
Update Transactions	100% CICS	40% direct DB2
Maintainability	Hard	Supportable
Productivity	Low	Moderate
Telemetry	Low/Closed	Open/Common
Shared Practices/ Tools	Low	High

Near zero customer impact

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STORY 3: MAINFRAME DB2 & JAVA THANKS

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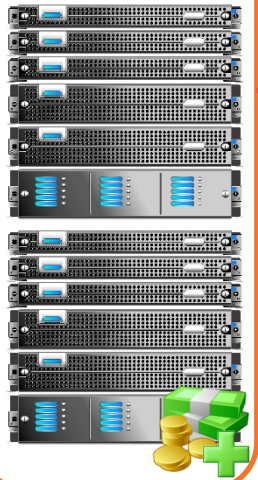
STORY 4: COMPOSITION PLATFORM

40+ Applications

1200 Integrations

30 Teams
300+ People

SLBOS
API Layer



UNIX/Heavy ESB

STORY 1

ACP
Billing, Cust Care

Mainframe

STORY 2+3

*UNIX/COBOL**

Composition

STORY

Foundational Modernization

Continuous Integration
Automated Testing
Telemetry
Infrastructure

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STORY 4: PRINT PLATFORM

Problem	4M lines of Proprietary Cobol(25 years) without Version Control or CI Proprietary Unix & Proprietary Vendors No Unit or E2E Functional Tests No telemetry Lack of horizontal scale. Unaffordable vertical scale. Multiple impacting tickets/day
Approach	Add foundational CI, Cobol Unit Testing, E2E Functional Testing Add feature flags to support trunk-based development & incremental rollout Convert Proprietary UNIX & COBOL to Linux/GnuCobol Remove difficult/dangerous vendors

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STORY 4: PRINT PLATFORM CELEBRATION

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STORY 4: PRINT PLATFORM RESULTS

90% converted to date:

4M lines proprietary COBOL to GNUCOBOL

Almost zero impacting tickets

Telemetry: doc retrieval, run time stats, job run time, errors

Commodity solution: Linux and GnuCobol	Before	After*
Incidents	Multiple/day	1 in 24 months
Release On Demand	<5%	100%
Lead Time	Months	Days

Near zero customer impact

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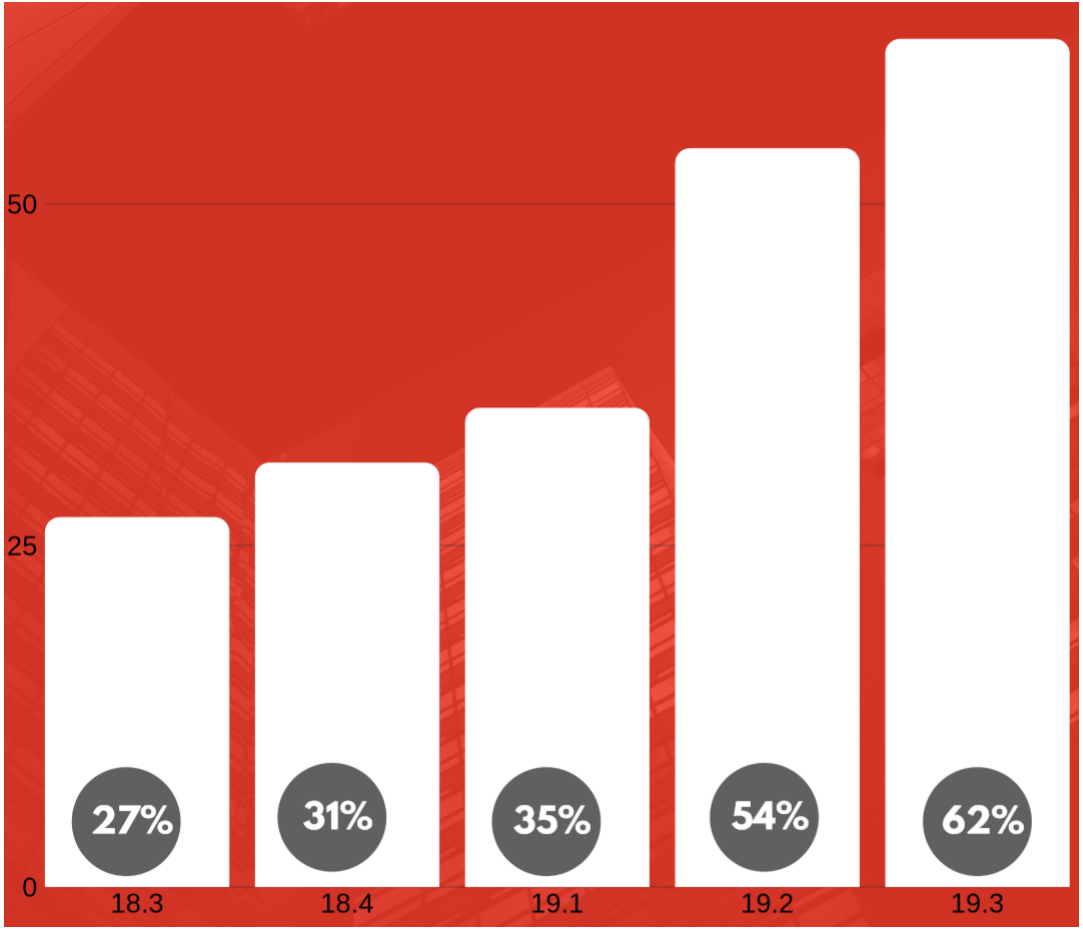
CSG PROCESS UPDATE: RELEASE ON



Modernization Improves Lead Time

ROD BY PI

What's ROD?

Releasing value when it's ready and decoupling release from the PI Cadence.

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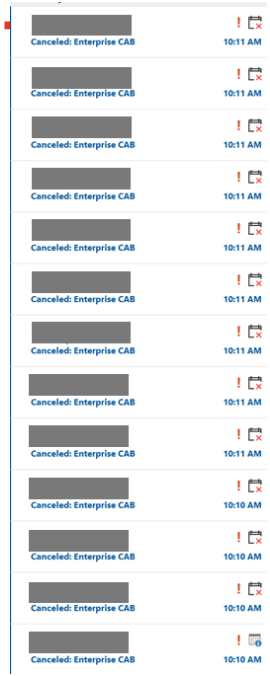
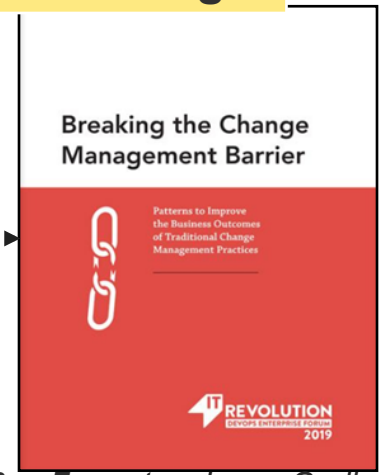
CSG PROCESS UPDATE: CHANGE MANAGEMENT



Modernization Improves Change

Patterns for Improving Change



Ron Forrester, Jayne Groll, Chris Hill, Dr. Steve Mayner, Erica Morrison, Scott Nasello, Scott Prugh, Rosalind Radcliffe

A CLEAR CHANGE PROCESS **positively** impacts Software Delivery Performance

A HEAVYWEIGHT CHANGE PROCESS **negatively** impacts Software Delivery Performance

ACCELERATE State of DevOps Report 2019, Dr. Nicole Forsgren

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DEVOPS JOURNEY IN METRICS

	Begin	2018	
Release Impact	507	85	-83%
Incidents/mo.	1640	427	-74%
Subscribers	48.9M	62M	27%
TPS	750	4,000	433%
Impact Minutes	22,932	9,481	-58%
Release On Demand	<5%	28%	460%
eNPS	4	20	400%

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MODERNIZATION: WHAT WE LEARNED

YOU CAN MODERNIZE YOUR LEGACY APPLICATIONS. BE HERITAGE.

MODERNIZATION IS VITAL AND REQUIRES ENGINEERING EXCELLENCE

LEVERAGE AUTOMATED TESTING, CI, TELEMETRY, INFRASTRUCTURE

OPTIMIZE FOR DEVELOPER AND OPERATIONS AESTHE

FEATURE SWITCHES, CODE PORTING, INCREMENTA ROLLOUT, STRANGULATION

FUEL DEVOPS:

CREATE SAFETY & REDUCE TECHNICAL DEBT

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HELP I'M LOOKING FOR

"CAPACITY" FORECASTING AND "ESTIMATION" & WISHFUL THINKING

CAPEX TO OPEX CLOUD HURDLE COSTING

IMPROVING INTAKE LEADTIME WITH TRADATIONAL IT MINDSETS

CREATING CAPACITY FOR "BACKLOG SWARMING"

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