IMS API's : You Don't Know What you Don't Know!!!

Dusty Rivers

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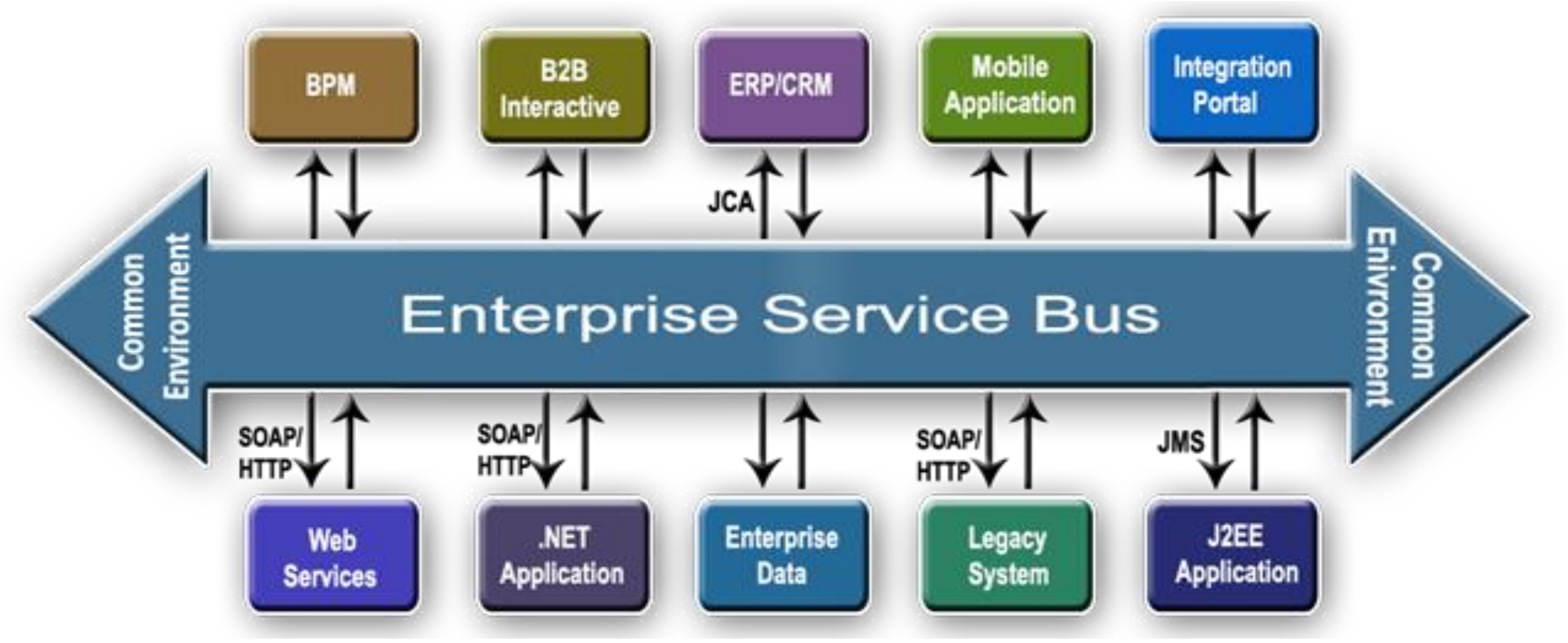
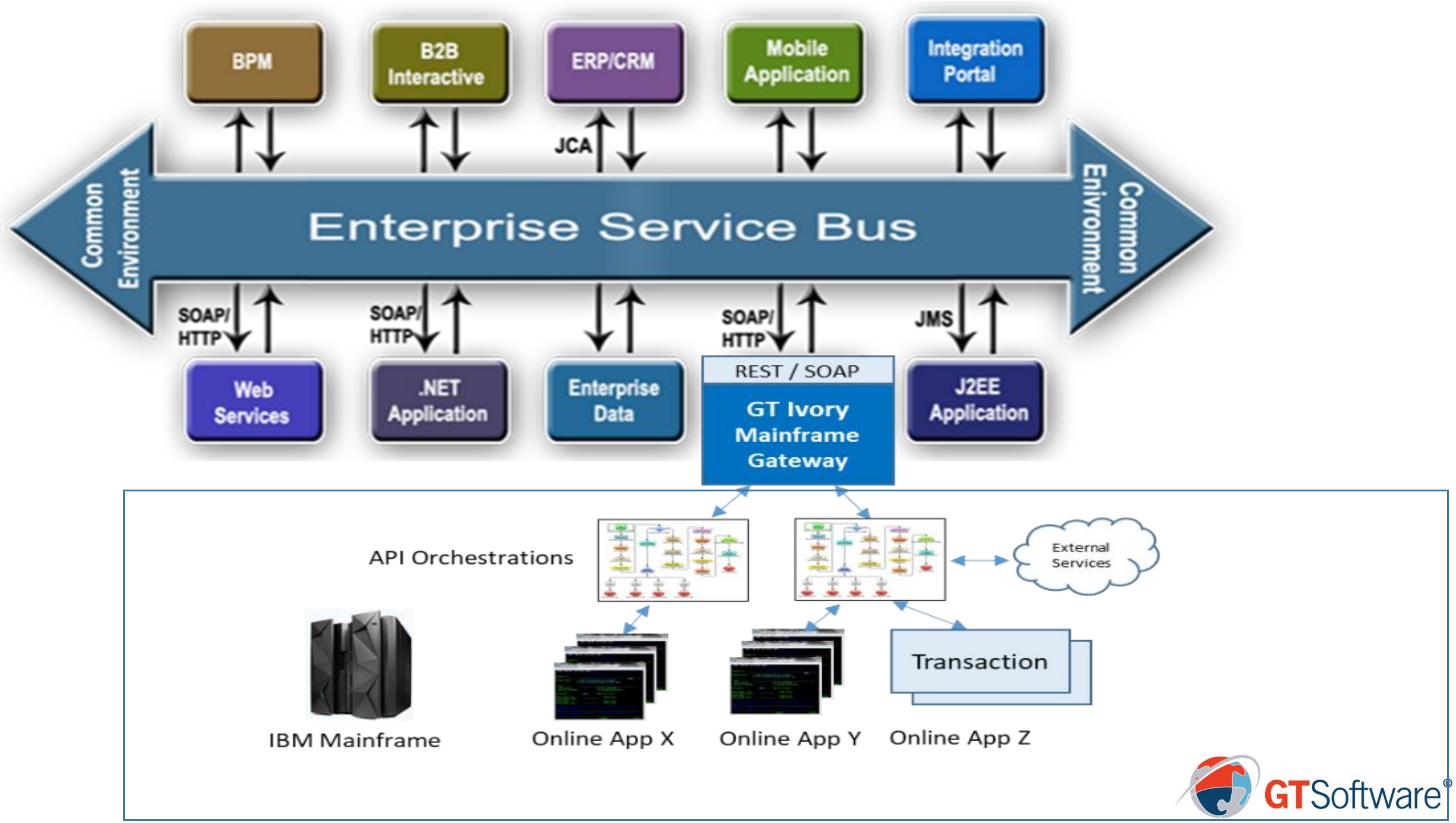
IMS API's *: We are already doing that!!!!!*

Lessons Learned, War Stories, Successes

We have an ESB to do all that!!!!!!!!!!!!!!!


BPM
B2B Interactive
ERP/CRM
Mobile Application
Integration Portal
JCA
Common Environment
Enterprise Service Bus
Common Environment
SOAP/ HTTP
SOAP/ HTTP
SOAP/ HTTP
JMS
Web Services
.NET Application
Enterprise Data
Legacy System
J2EE Application


BPM
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Integration Portal
JCA
Common Environment
Enterprise Service Bus
Common Environment
SOAP/ HTTP
SOAP/ HTTP
SOAP/ HTTP
JMS
Web Services
.NET Application
Enterprise Data
REST / SOAP
GT Ivory Mainframe Gateway
J2EE Application
API Orchestrations
External Services
IBM Mainframe
Online App X
Online App Y
Transaction
Online App Z

What else don’t I know about????

Do You Have the Right Mainframe Integration Technologies?

- How old are your legacy backend applications?
- What technologies are they using?
- Is the application code structured or unstructured?
- Did your core applications first start out as commercial offerings?
- What third-party components are embedded in the code?
- How complex is the code and data structure design?
- Do your support teams fully understand the application?
- How many coding ‘standards’ have been used over the past years?

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Understanding Your Legacy Applications & API Requirements

- Most mainframe online applications were designed to interact with 3270 terminals (end user dialog).
- Integration technologies should be transparent to the backend systems.
- Changing legacy code to work better as an API introduces more complexity and code to manage.
- Fine grain APIs (microservices) may be easier to build, but put more work onto the consumer.
- More intelligent the API, less effort for the API consumer processing logic.
- Legacy mainframe apps are like a box of chocolates, it is hard to see what is inside.

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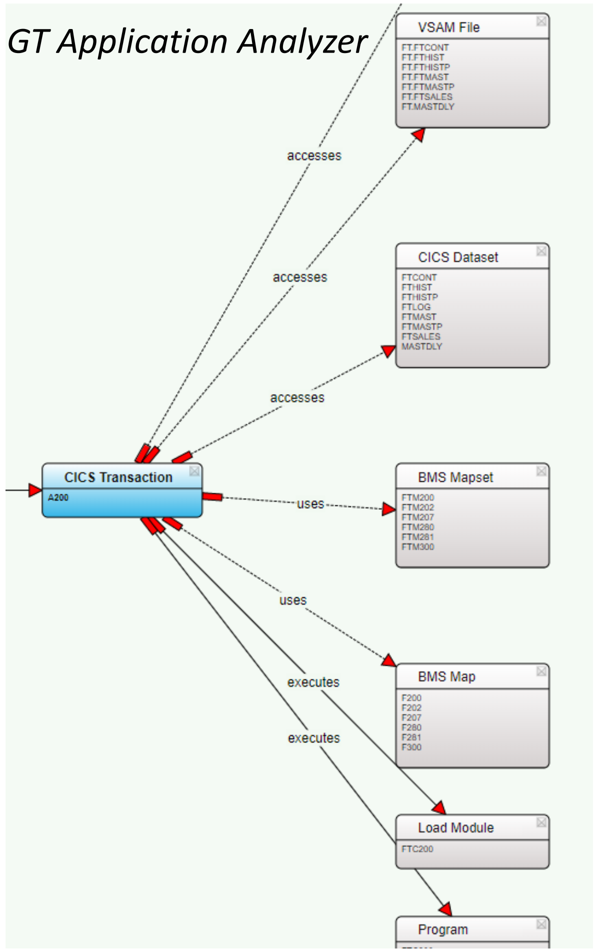
Legacy Application Complexities

- Message switching / multiple program calls
- Multiple input and output messages
- Variable length, multi-part messages, different layouts
- Complex structures (REDEFINES & ODO)
- Null terminations, non-standard code
- Screen macros
- Conversational dialogs
- External and other 3270 applications
- Complex Conversational Transactions



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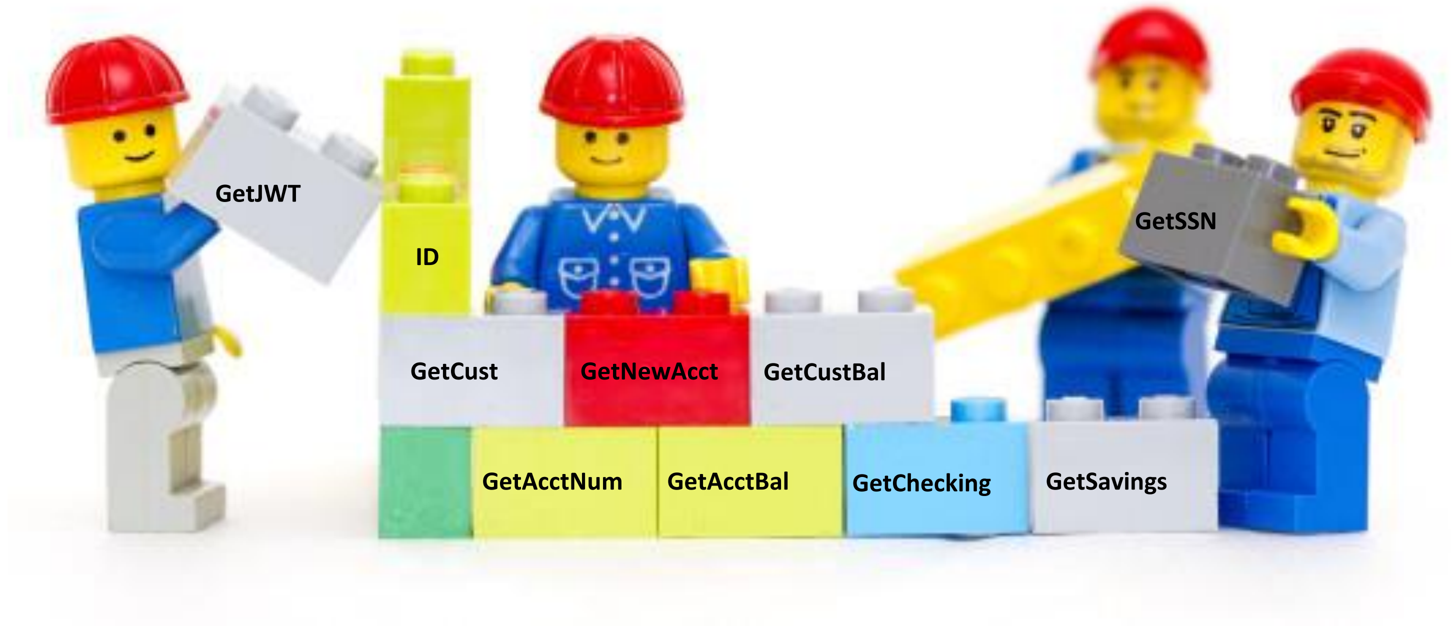
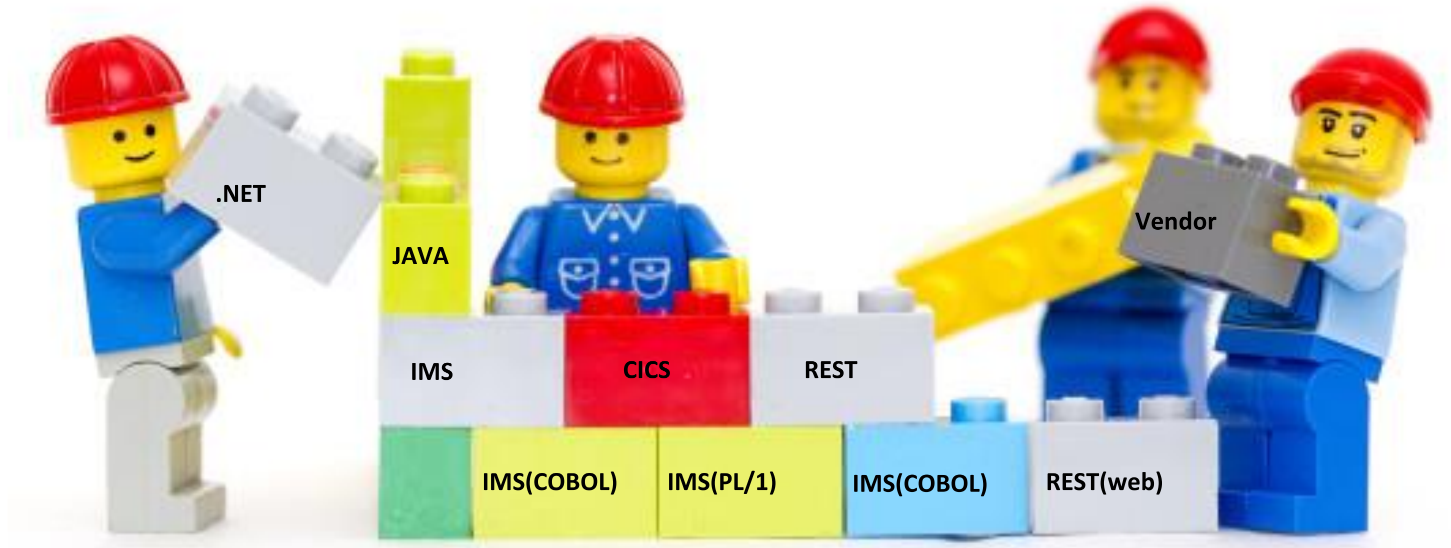
building blocks



building blocks



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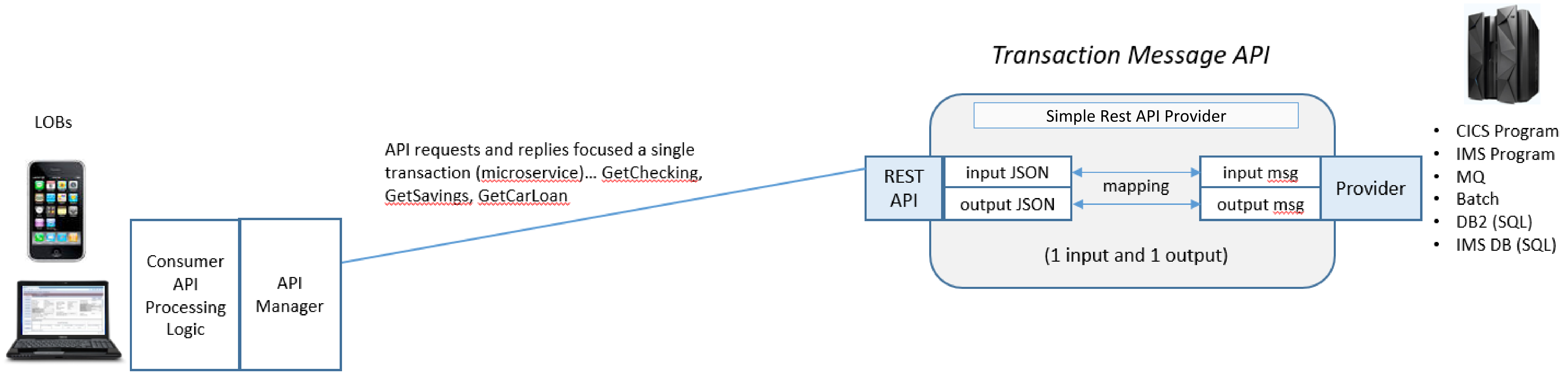
Mainframe APIs – Understanding Legacy Environments & Integration Requirements

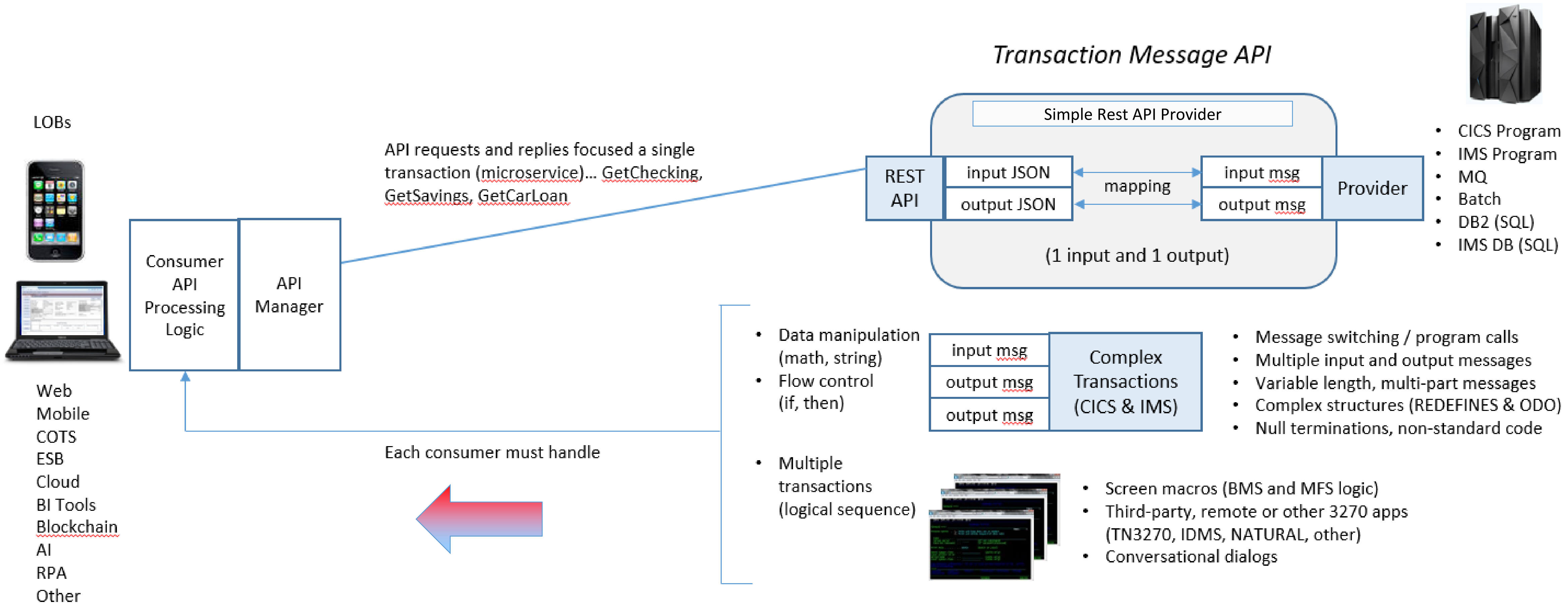


API requests and replies focused a single transaction (microservice)… GetChecking, GetSavings, GetCarLoan

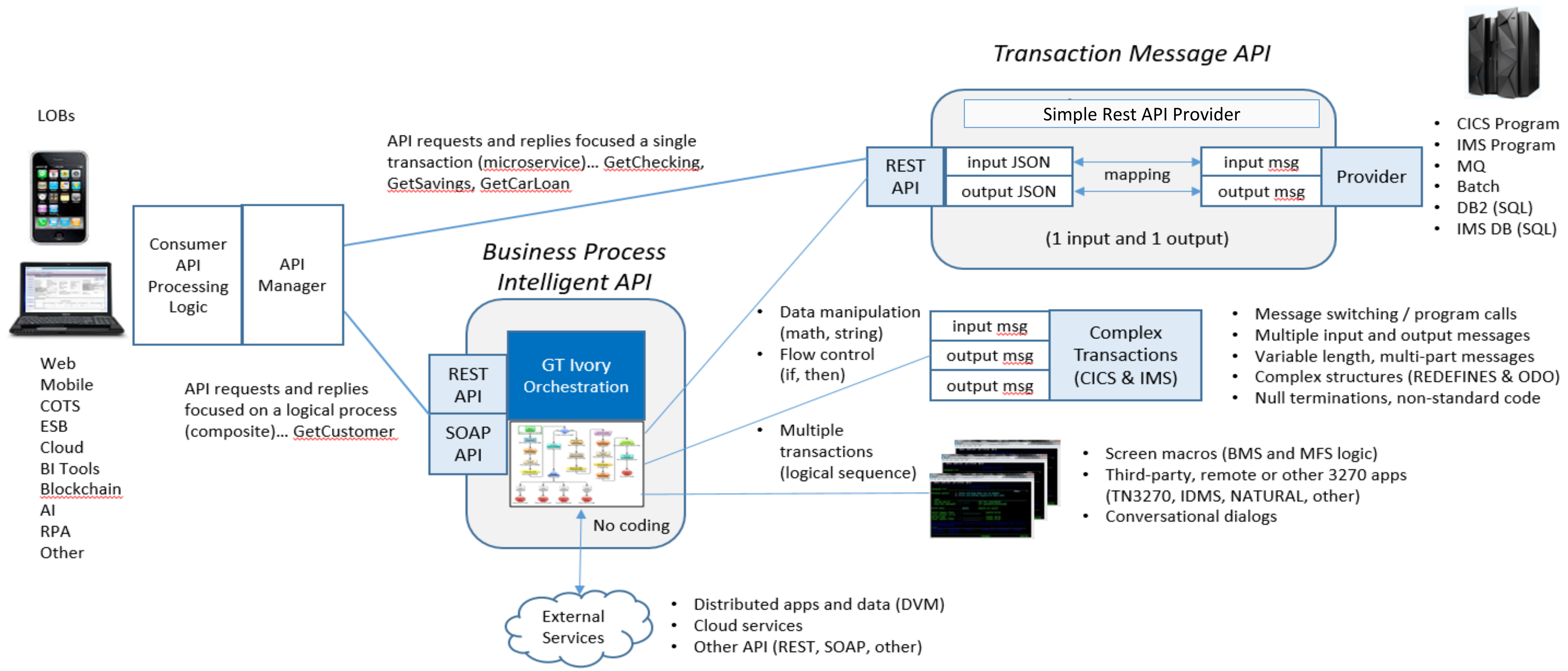
Web
Mobile
COTS
ESB
Cloud
BI Tools
Blockchain
AI
RPA
Other

- CICS Program
- IMS Program
- MQ
- Batch
- DB2 (SQL)
- IMS DB (SQL)

Mainframe APIs – Understanding Legacy Environments & Integration Requirements


Transaction Message API
LOBs
Web
Mobile
COTS
ESB
Cloud
BI Tools
Blockchain
AI
RPA
Other
Consumer API Processing Logic
API Manager
API requests and replies focused a single transaction (microservice)… GetChecking, GetSavings, GetCarLoan
Simple Rest API Provider
REST API
input JSON
output JSON
mapping
input msg
output msg
Provider
(1 input and 1 output)
• CICS Program
• IMS Program
• MQ
• Batch
• DB2 (SQL)
• IMS DB (SQL)
Each consumer must handle
• Data manipulation (math, string)
• Flow control (if, then)
• Multiple transactions (logical sequence)
input msg
output msg
output msg
Complex Transactions (CICS & IMS)
• Message switching / program calls
• Multiple input and output messages
• Variable length, multi-part messages
• Complex structures (REDEFINES & ODO)
• Null terminations, non-standard code
• Screen macros (BMS and MFS logic)
• Third-party, remote or other 3270 apps (TN3270, IDMS, NATURAL, other)
• Conversational dialogs

Mainframe APIs – Understanding Legacy Environments & Integration Requirements


LOBs
Web
Mobile
COTS
ESB
Cloud
BI Tools
Blockchain
AI
RPA
Other
Consumer API Processing Logic
API Manager
API requests and replies focused a single transaction (microservice)… GetChecking, GetSavings, GetCarLoan
API requests and replies focused on a logical process (composite)… GetCustomer
Transaction Message API
Simple Rest API Provider
REST API
input JSON
output JSON
mapping
input msg
output msg
Provider
(1 input and 1 output)
CICS Program
IMS Program
MQ
Batch
DB2 (SQL)
IMS DB (SQL)
Business Process Intelligent API
REST API
SOAP API
GT Ivory Orchestration
No coding
Data manipulation (math, string)
Flow control (if, then)
Multiple transactions (logical sequence)
input msg
output msg
output msg
Complex Transactions (CICS & IMS)
Message switching / program calls
Multiple input and output messages
Variable length, multi-part messages
Complex structures (REDEFINES & ODO)
Null terminations, non-standard code
Screen macros (BMS and MFS logic)
Third-party, remote or other 3270 apps (TN3270, IDMS, NATURAL, other)
Conversational dialogs
External Services
Distributed apps and data (DVM)
Cloud services
Other API (REST, SOAP, other)

- GT Ivory runtime options… z/OS, IFL (Linux on Z), Linux Server, Windows/Java Server, hybrid

Environment

- IMS

IBM IMS

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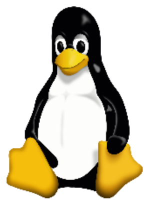
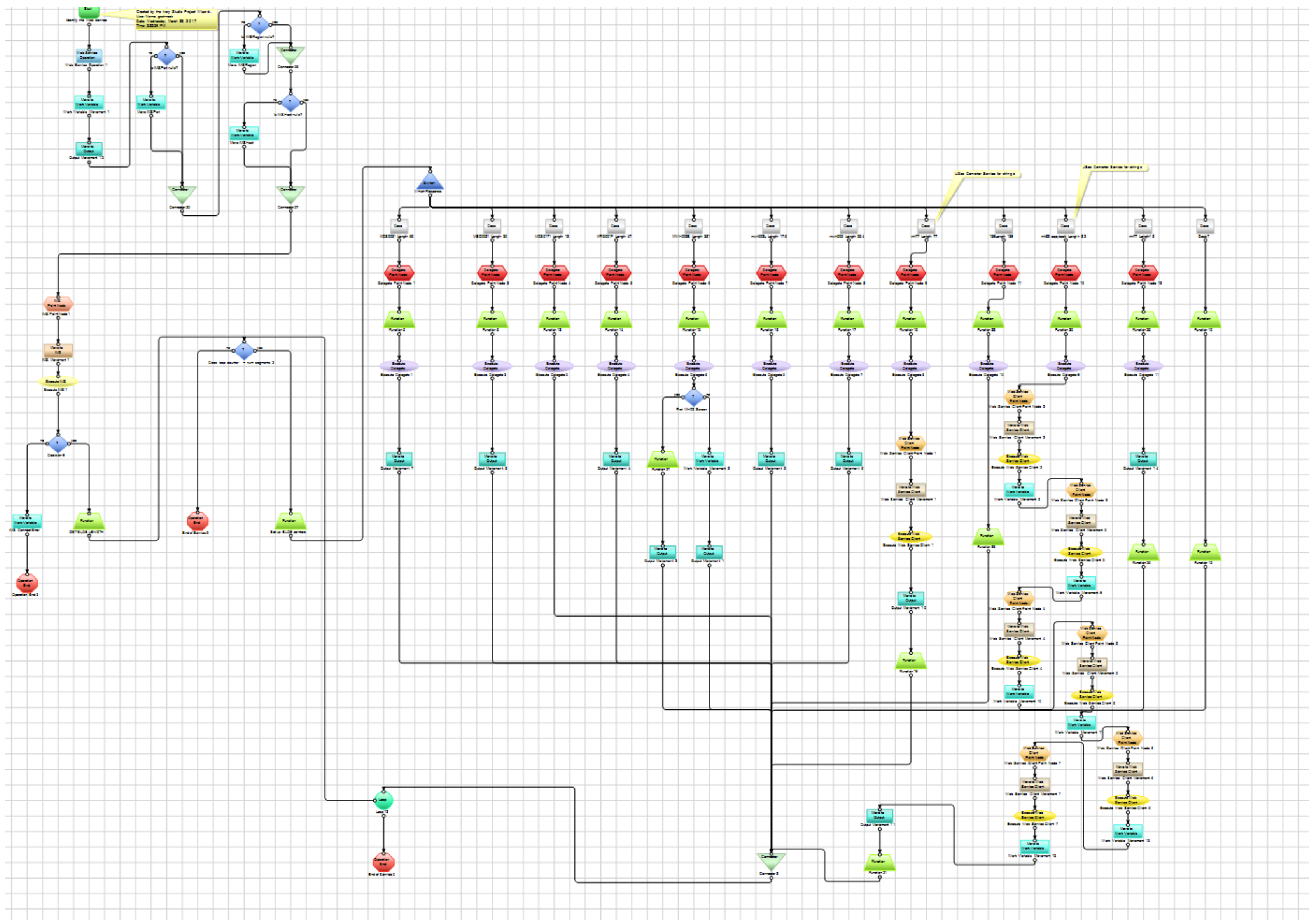
Environment

- IMS
- Ivory Service Architect(API creation & orchestration)
- Github (source version control)
- Jenkins (*automation*)
- .NET , Java, Node.js , COBOL
- Linux (redhat) JBOSS
- Tomcat
- MoogSoft
- dynatrace
- urbancode



Design Methodology

- **Base Services** (closely matched to individual Transactions when possible)
- **Composite Services** (combined calling of multiple base services for business services)
- Outbound calls to third party software from COBOL



Start
Identify the Web service
Created by the Ivory Studio Project Wizard.
Web Service Operation
Web Service Operation 1
Move to Work Variable
Work Variable Movement 1
Move to Output
Output Movement 13
Is MSPort null?
Is MSRegion null?
Is MSHost null?
Connector

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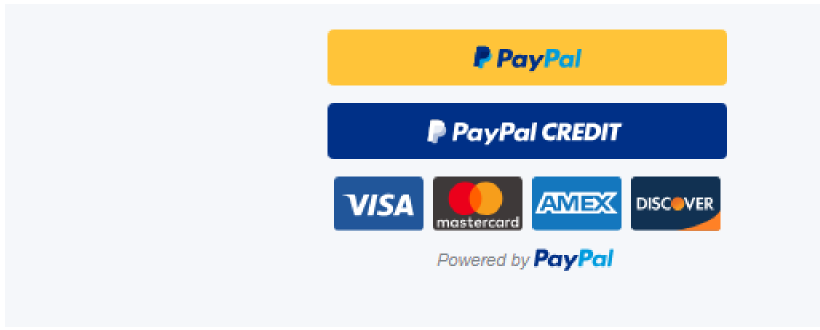
Financial

- Domestic Banks
- Domestic Insurance
- International Banks
- International Insurance

IBM IMS

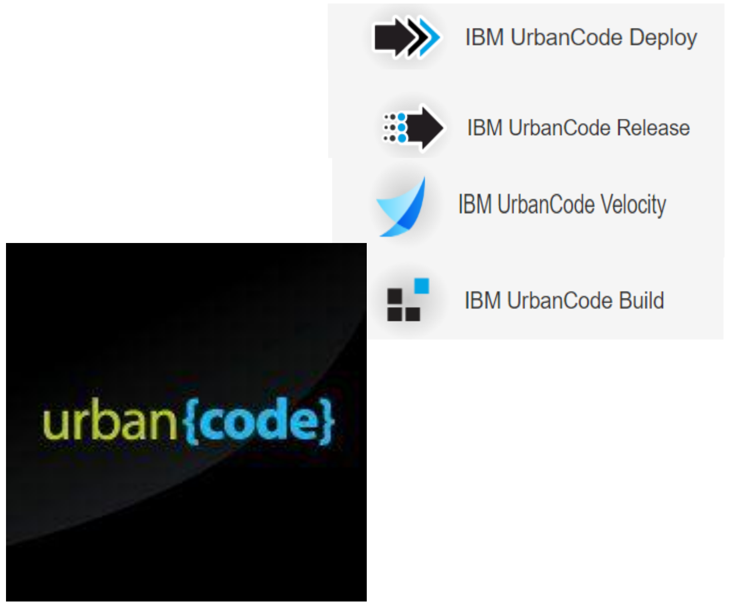
- IMS systems of record
- Instant Payment (Europe)
- Outbound calls to Google resources
- Outbound calls to Credit resources
- Outbound calls to Account Control Website
- Outbound calls to Terrorist Check sites
- Inbound API calls to existing IMS Trans with no code change
- ATM system inbound API's(SOAP then REST)

https://maps.googleapis.com/maps/api/geocode/json?



What Have Customers Asked For…..

- JWT(enhanced)
- Calling out to REST Clients(with orchestration)
- API Repositories(which one)
- DevOPS(urbancode)
- Zowe
- CLI based Service creation



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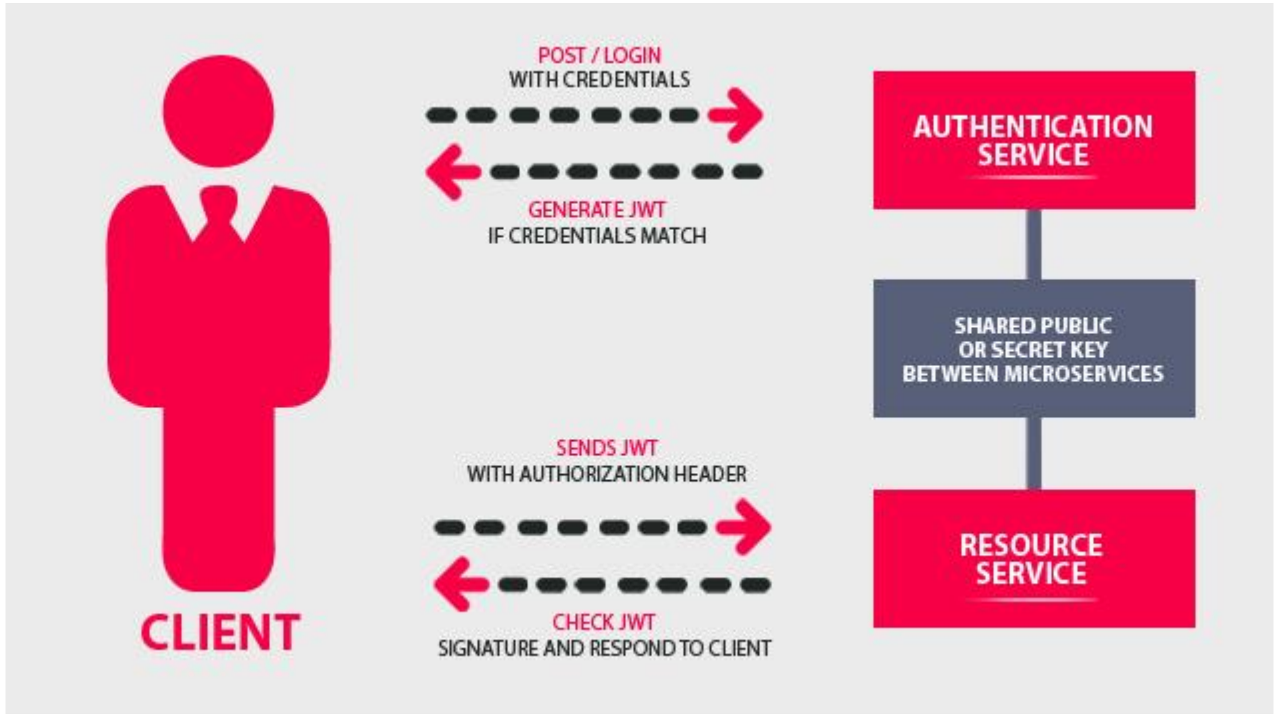
JWT(JSON Web Token)



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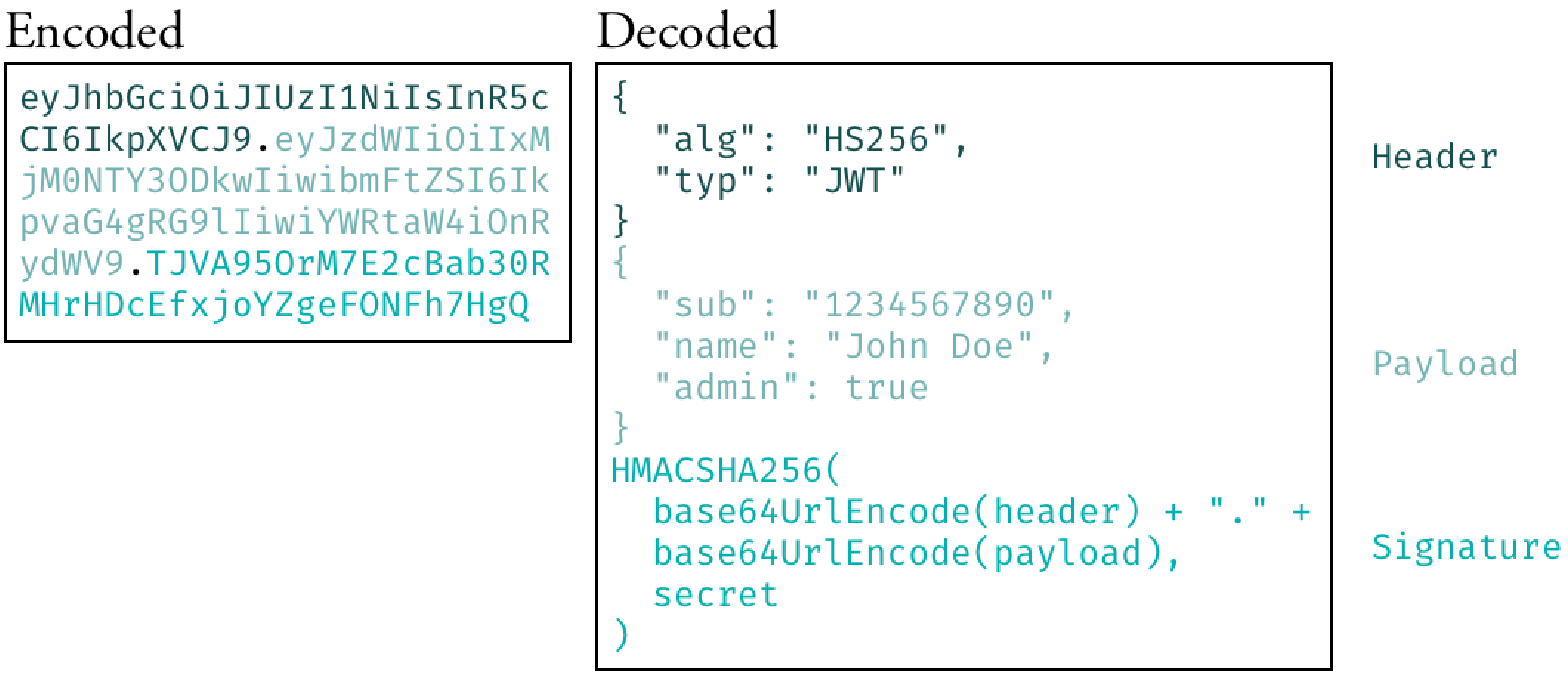
JWT



Encoded

```
eyJhbGciOiJIUzI1NiIsInR5c
CI6IkpXVCJ9.eyJzdWIiOiIxM
jM0NTY3ODkwIiwibmFtZSI6Ik
pvaG4gRG9lIiwiYWRtaW4iOnR
ydWV9.TJVA95OrM7E2cBab30R
MHrHDcEfxjoYZgeFONFh7HgQ
```

Decoded

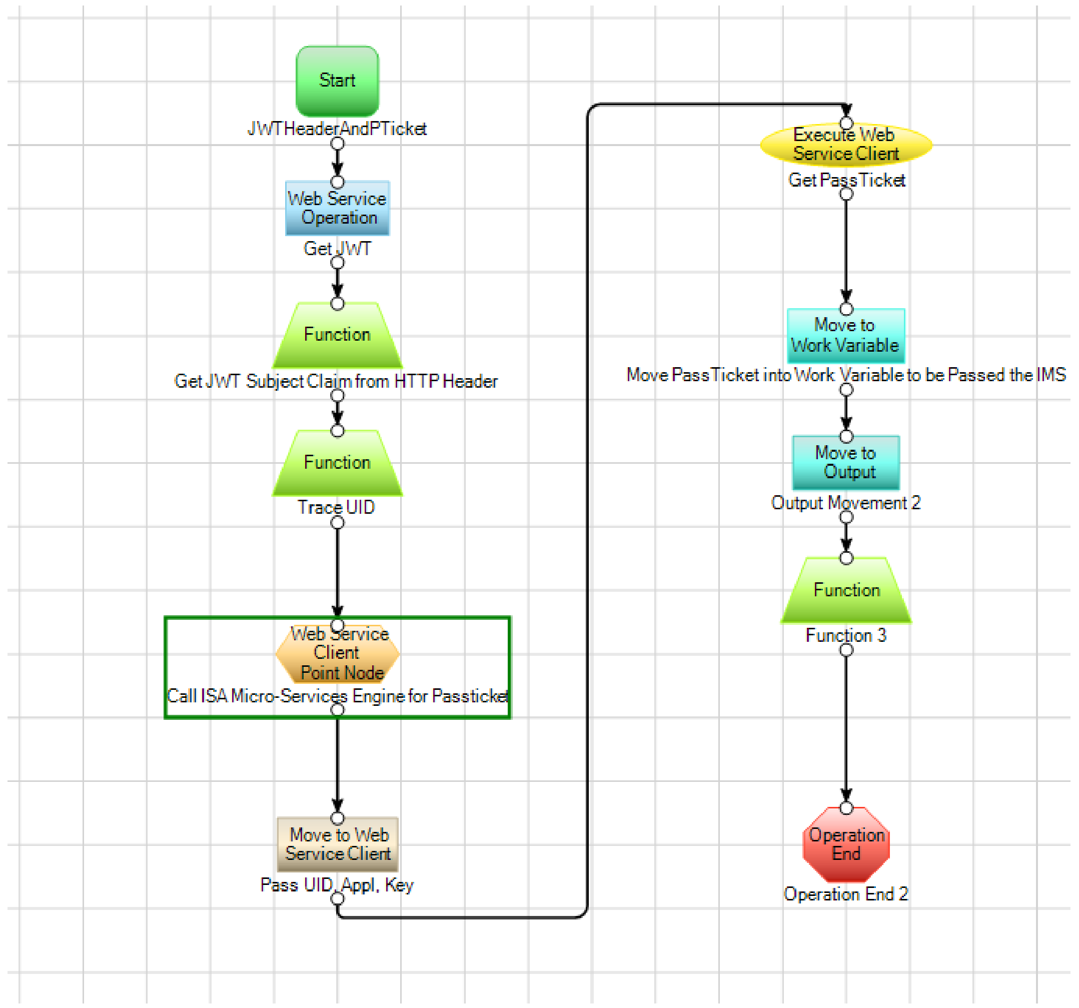
```
{
  "alg": "HS256",
  "typ": "JWT"
}
{
  "sub": "1234567890",
  "name": "John Doe",
  "admin": true
}
HMACSHA256(
  base64UrlEncode(header) + "." +
  base64UrlEncode(payload),
  secret
)
```

Header

Payload

Signature

JWT Sample


Start
JWTHeaderAndPTicket
Web Service Operation
Get JWT
Function
Get JWT Subject Claim from HTTP Header
Function
Trace UID
Web Service Client Point Node
Call ISA Micro-Services Engine for Passticket
Move to Web Service Client
Pass UID, Appl, Key
Execute Web Service Client
Get PassTicket
Move to Work Variable
Move PassTicket into Work Variable to be Passed the IMS
Move to Output
Output Movement 2
Function
Function 3
Operation End
Operation End 2

Callable(outbound Services)

What are Callable Services?

- Access to SOAP and JSON Services via COBOL or PL/I Call
- Call – Procedural Application Programming Interface (API)
- Used before API became a popular Web / Restful Service Term

What is needed?

- Generation of Callable Service Interface (Call) for COBOL / PL/I
- Processing of all TCPIP Services for Target Service
- Dynamic Marshaling / Parsing of all XML and/or JSON

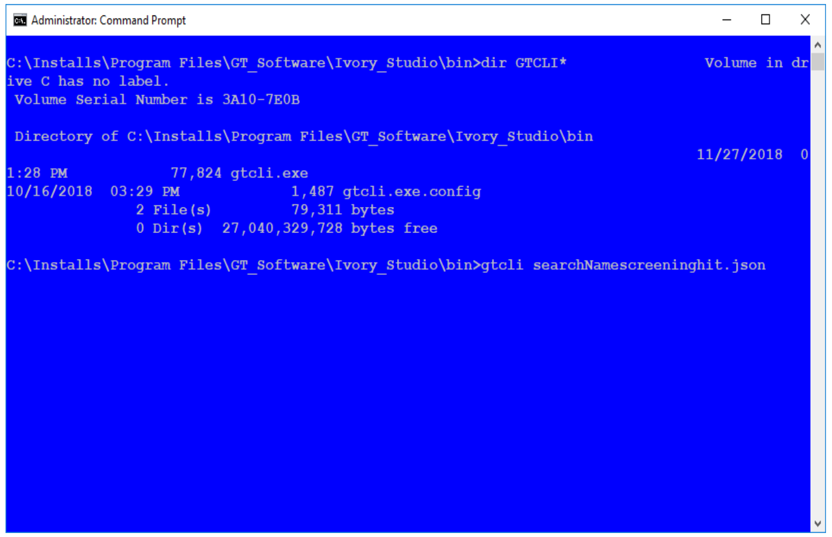
Callable(outbound Services)

- **Command-Line Interface**

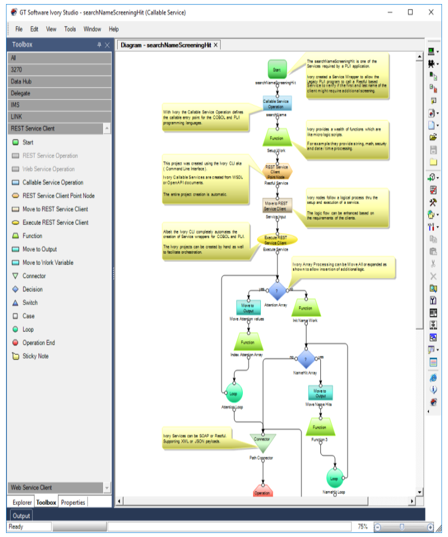
  A command-line interface or command language interpreter (CLI), also known console user interface and character user interface (CUI), is a means of interacting with a computer program where the user/client issues commands to the program in the form of successive lines of text aka command lines. Commonly processed by a command language interpreter or shell interface.

CLI

Ivory Studio


Administrator: Command Prompt

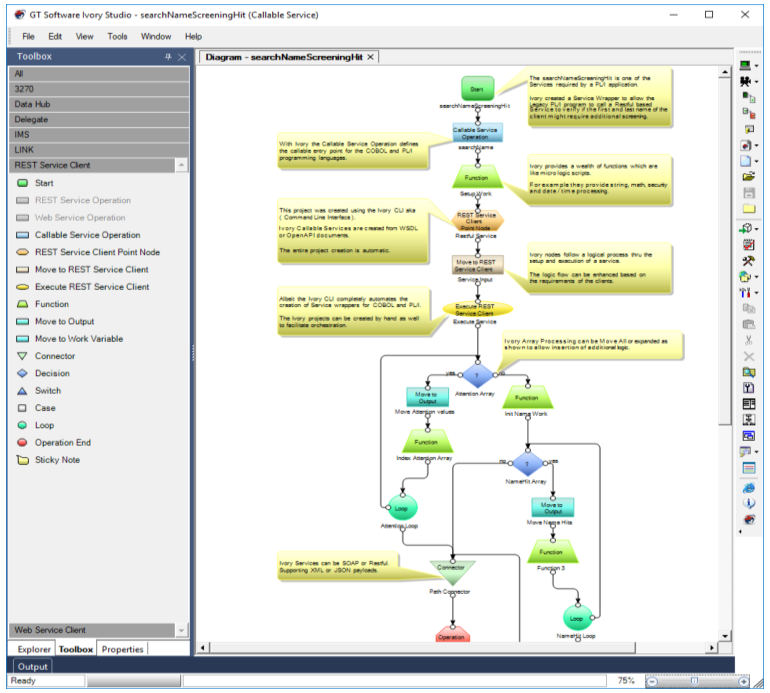
```
C:\Installs\Program Files\GT_Software\Ivory_Studio\bin>dir GTCLI*              Volume in dr
ive C has no label.
 Volume Serial Number is 3A10-7E0B

 Directory of C:\Installs\Program Files\GT_Software\Ivory_Studio\bin
                                                                              11/27/2018  0
1:28 PM            77,824 gtcli.exe
10/16/2018  03:29 PM             1,487 gtcli.exe.config
               2 File(s)         79,311 bytes
               0 Dir(s)  27,040,329,728 bytes free

C:\Installs\Program Files\GT_Software\Ivory_Studio\bin>gtcli searchNamescreeninghit.json
```


GT Software Ivory Studio - searchNameScreeningHit (Callable Service)
File Edit View Tools Window Help
Toolbox
Diagram - searchNameScreeningHit
Start
REST Service Operation
Web Service Operation
Callable Service Operation
REST Service Client Point Node
Move to REST Service Client
Execute REST Service Client
Function
Move to Output
Move to Work Variable
Connector
Decision
Switch
Case
Loop
Operation End
Sticky Note
Explorer Toolbox Properties
Output
Ready

Callable(outbound Services)

- Command Line Interface
- Input…
  - OpenAPI (Restful JSON Services)
  - WSDL (SOAP XML Services)
- Generates Callable Services
- Removes XML/JSON Complexity
- Output…
  - Ivory Service Project

Ivory Studio



The searchNameScreeningHit is one of the Services required by a PL/I application.

Ivory created a Service Wrapper to allow the Legacy PL/I program to call a Restful based Service to verify if the first and last name of the client might require additional screening.

With Ivory the Callable Service Operation defines the callable entry point for the COBOL and PL/I programming languages.

Ivory provides a wealth of functions which are like micro logic scripts.

For example they provide string, math, security and date / time processing.

This project was created using the Ivory CLI aka (Command Line Interface).

Ivory Callable Services are created from WSDL or OpenAPI documents.

The entire project creation is automatic.

Ivory nodes follow a logical process thru the setup and execution of a service.

The logic flow can be enhanced based on the requirements of the clients.

Albeit the Ivory CLI completely automates the creation of Service wrappers for COBOL and PL/I.

The Ivory projects can be created by hand as well to facilitate orchestration.

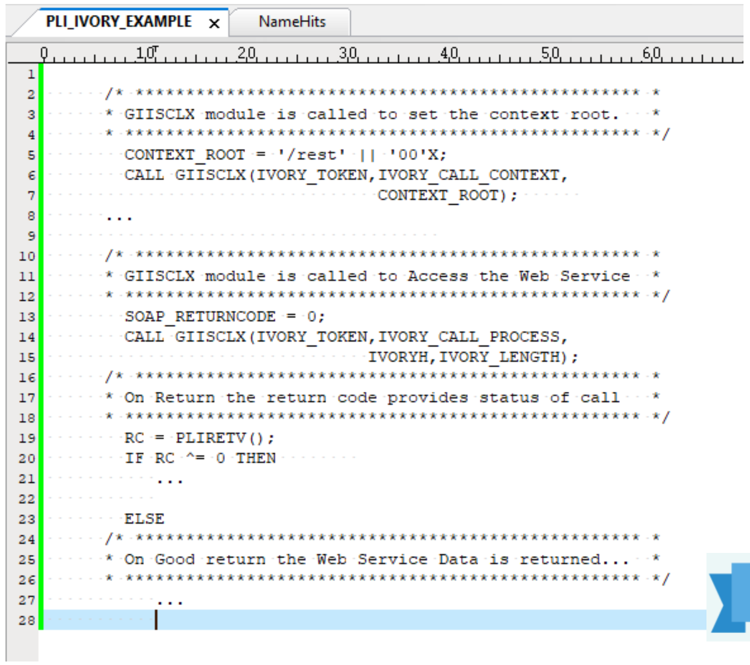
Ivory Array Processing can be Move All or expanded as shown to allow insertion of additional logic.

Ivory Services can be SOAP or Restful. Supporting XML or JSON payloads.

Callable(outbound Services)

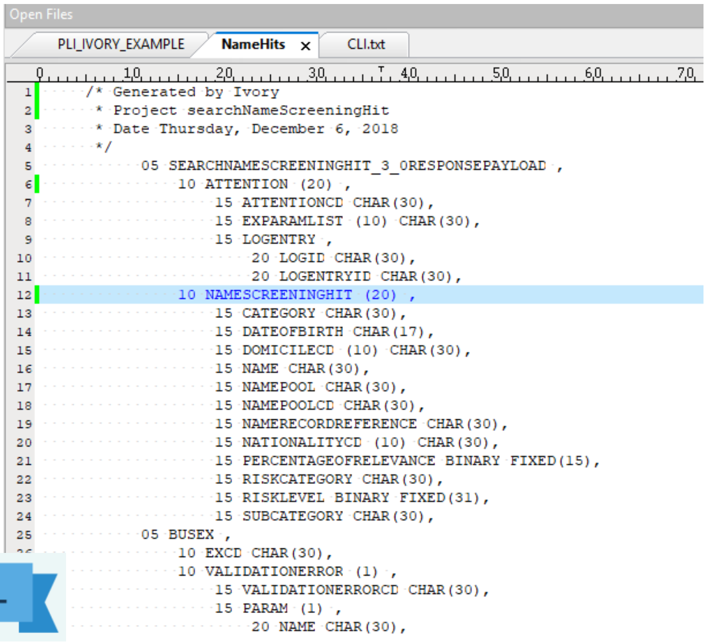
- Procedural Language API (Call)
- Procedural Language Data Layouts (Copybook)

PL/I
CALL



```
    /* ************************************************** *
    * GIISCLX module is called to set the context root.   *
    * ************************************************** */
      CONTEXT_ROOT = '/rest' || '00'X;
      CALL GIISCLX(IVORY_TOKEN,IVORY_CALL_CONTEXT,
                         CONTEXT_ROOT);
    ...

    /* ************************************************** *
    * GIISCLX module is called to Access the Web Service  *
    * ************************************************** */
      SOAP_RETURNCODE = 0;
      CALL GIISCLX(IVORY_TOKEN,IVORY_CALL_PROCESS,
                        IVORYH,IVORY_LENGTH);
    /* ************************************************** *
    * On Return the return code provides status of call   *
    * ************************************************** */
      RC = PLIRETV();
      IF RC ^= 0 THEN
         ...

      ELSE
    /* ************************************************** *
    * On Good return the Web Service Data is returned...  *
    * ************************************************** */
         ...
```

REST/JSON SOAP/XML

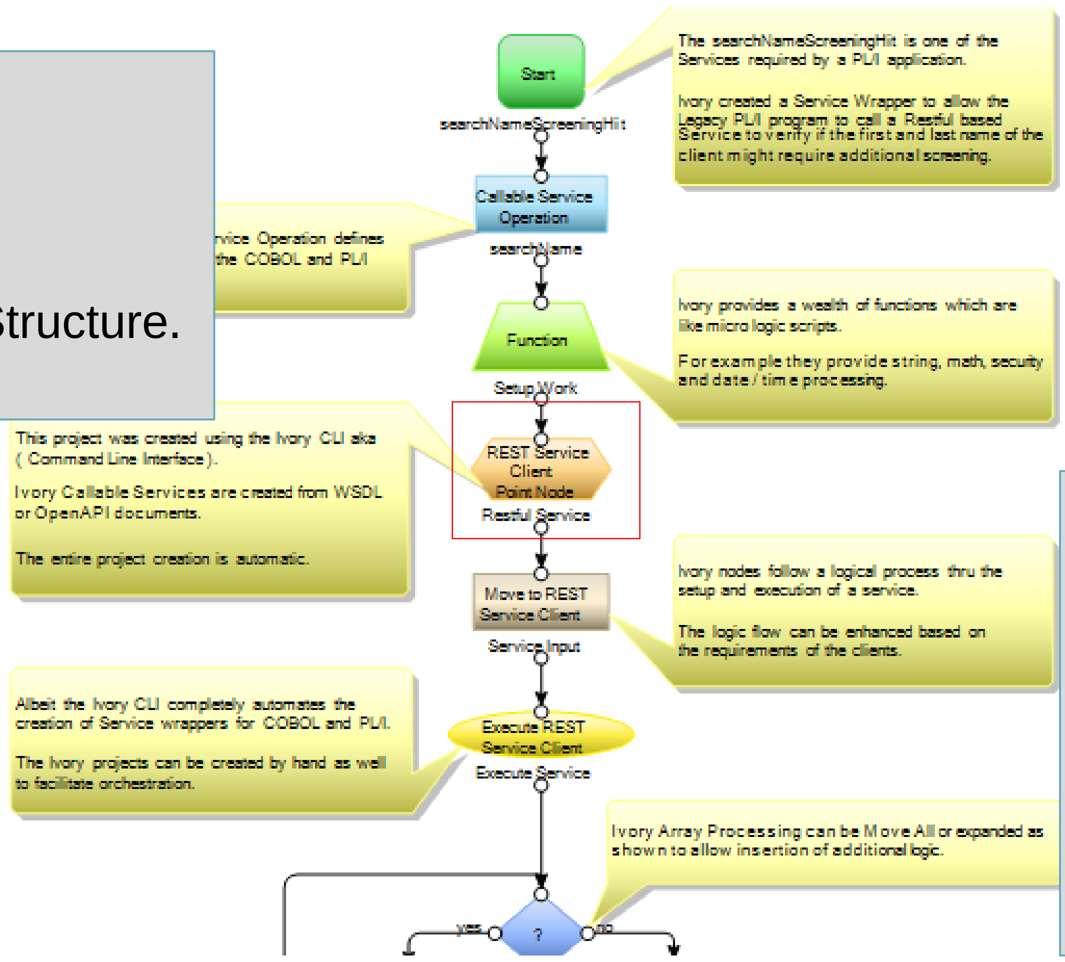


```
    /* Generated by Ivory
     * Project searchNameScreeningHit
     * Date Thursday, December 6, 2018
     */
          05 SEARCHNAMESCREENINGHIT_3_0RESPONSEPAYLOAD ,
              10 ATTENTION (20) ,
                  15 ATTENTIONCD CHAR(30),
                  15 EXPARAMLIST (10) CHAR(30),
                  15 LOGENTRY ,
                      20 LOGID CHAR(30),
                      20 LOGENTRYID CHAR(30),
              10 NAMESCREENINGHIT (20) ,
                  15 CATEGORY CHAR(30),
                  15 DATEOFBIRTH CHAR(17),
                  15 DOMICILECD (10) CHAR(30),
                  15 NAME CHAR(30),
                  15 NAMEPOOL CHAR(30),
                  15 NAMEPOOLCD CHAR(30),
                  15 NAMERECORDREFERENCE CHAR(30),
                  15 NATIONALITYCD (10) CHAR(30),
                  15 PERCENTAGEOFRELEVANCE BINARY FIXED(15),
                  15 RISKCATEGORY CHAR(30),
                  15 RISKLEVEL BINARY FIXED(31),
                  15 SUBCATEGORY CHAR(30),
          05 BUSEX ,
              10 EXCD CHAR(30),
              10 VALIDATIONERROR (1) ,
                  15 VALIDATIONERRORCD CHAR(30),
                  15 PARAM (1) ,
                      20 NAME CHAR(30),
```

PL/I
Data
Area

Callable(outbound Services)

Ivory Callable Services access the JSON/SOAP on processes and return a COBOL or PL/I Data Structure.


Start
searchNameScreeningHit
Callable Service Operation
searchName
Function
Setup Work
REST Service Client Point Node
Restful Service
Move to REST Service Client
Service Input
Execute REST Service Client
Execute Service
yes
?
no

The searchNameScreeningHit is one of the Services required by a PL/I application.

Ivory created a Service Wrapper to allow the Legacy PL/I program to call a Restful based Service to verify if the first and last name of the client might require additional screening.

rvice Operation defines the COBOL and PL/I

Ivory provides a wealth of functions which are like micro logic scripts.

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The logic flow can be enhanced based on the requirements of the clients.

Albeit the Ivory CLI completely automates the creation of Service wrappers for COBOL and PL/I.

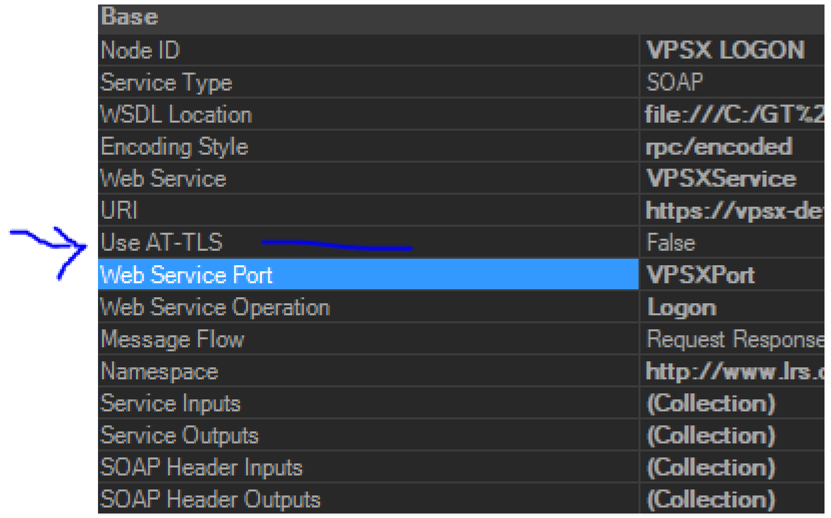
The Ivory projects can be created by hand as well to facilitate orchestration.

Ivory Array Processing can be Move All or expanded as shown to allow insertion of additional logic.

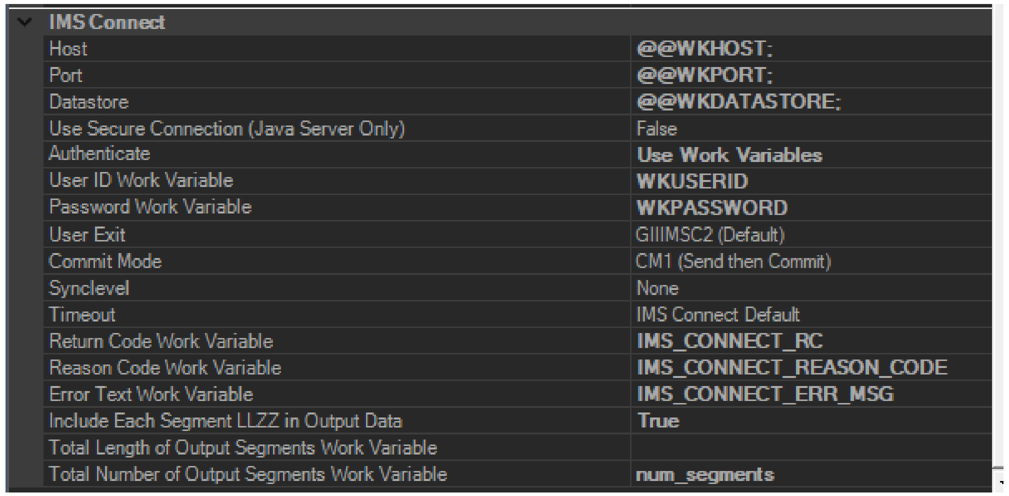
Ivory CLI automates Callable Services creation to access external JSON/SOAP services. Additionally, the Ivory CLI will build SOAP and JSON Service wrappers for any CICS or IMS System z application.

Security………

- AT-TLS
- RACF,ACF2,Top Secret
- WS-*
- SOAP Header
- HTTP/S
- JWT(JSON Web Token)
- Passtickets



Base	
Node ID	VPSX LOGON
Service Type	SOAP
WSDL Location	file:///C:/GT%2
Encoding Style	rpc/encoded
Web Service	VPSXService
URI	https://vpsx-de
Use AT-TLS	False
Web Service Port	VPSXPort
Web Service Operation	Logon
Message Flow	Request Response
Namespace	http://www.lrs.
Service Inputs	(Collection)
Service Outputs	(Collection)
SOAP Header Inputs	(Collection)
SOAP Header Outputs	(Collection)



IMS Connect	
Host	@@WKHOST;
Port	@@WKPORT;
Datastore	@@WKDATASTORE;
Use Secure Connection (Java Server Only)	False
Authenticate	Use Work Variables
User ID Work Variable	WKUSERID
Password Work Variable	WKPASSWORD
User Exit	GIIIMSC2 (Default)
Commit Mode	CM1 (Send then Commit)
Synclevel	None
Timeout	IMS Connect Default
Return Code Work Variable	IMS_CONNECT_RC
Reason Code Work Variable	IMS_CONNECT_REASON_CODE
Error Text Work Variable	IMS_CONNECT_ERR_MSG
Include Each Segment LLZZ in Output Data	True
Total Length of Output Segments Work Variable	
Total Number of Output Segments Work Variable	num_segments

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Where to put them..............

IBM apiconnect

MuleSoft®

CA API Developer Portal

CA API Management SaaS

CA API Gateway

CA / APIM

apigee

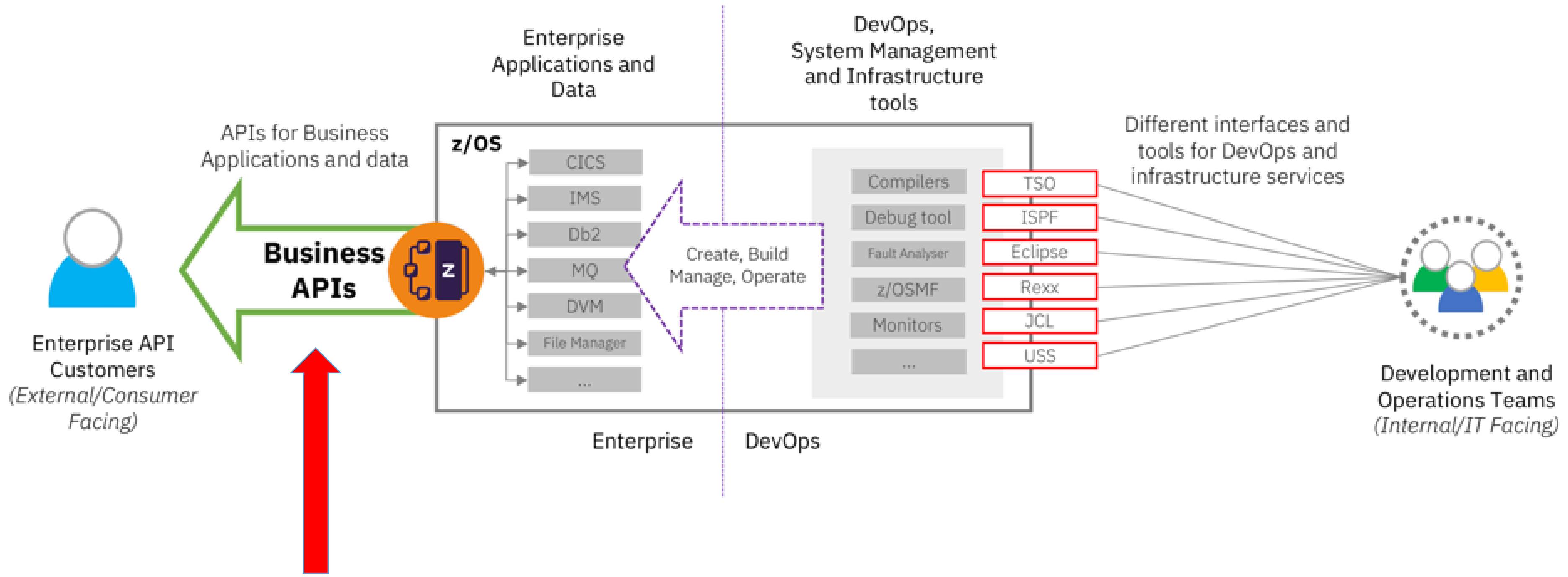
3scale BY RED HAT®

GTSoftware®

SHOW & TELL

What’s Next……………………………

Zowe



Enterprise Applications and Data
DevOps, System Management and Infrastructure tools
APIs for Business Applications and data
z/OS
CICS
IMS
Db2
MQ
DVM
File Manager
...
Business APIs
Create, Build Manage, Operate
Compilers
Debug tool
Fault Analyser
z/OSMF
Monitors
...
TSO
ISPF
Eclipse
Rexx
JCL
USS
Different interfaces and tools for DevOps and infrastructure services
Enterprise API Customers
(External/Consumer Facing)
Development and Operations Teams
(Internal/IT Facing)
Enterprise
DevOps

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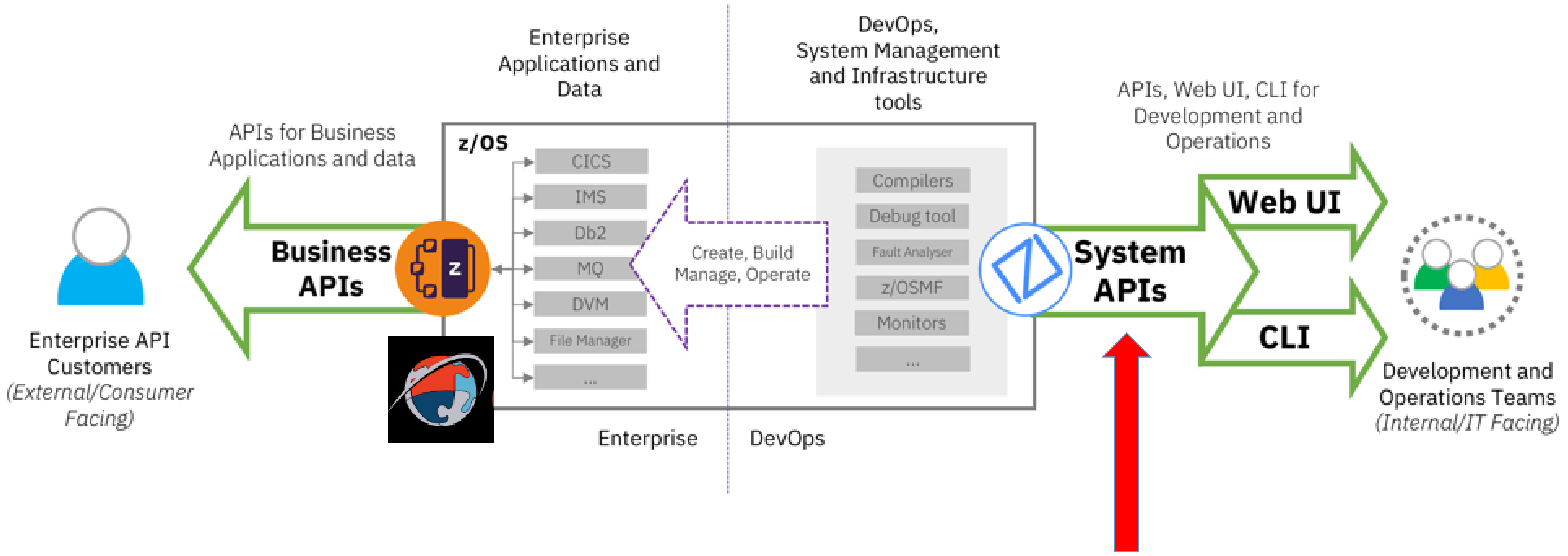
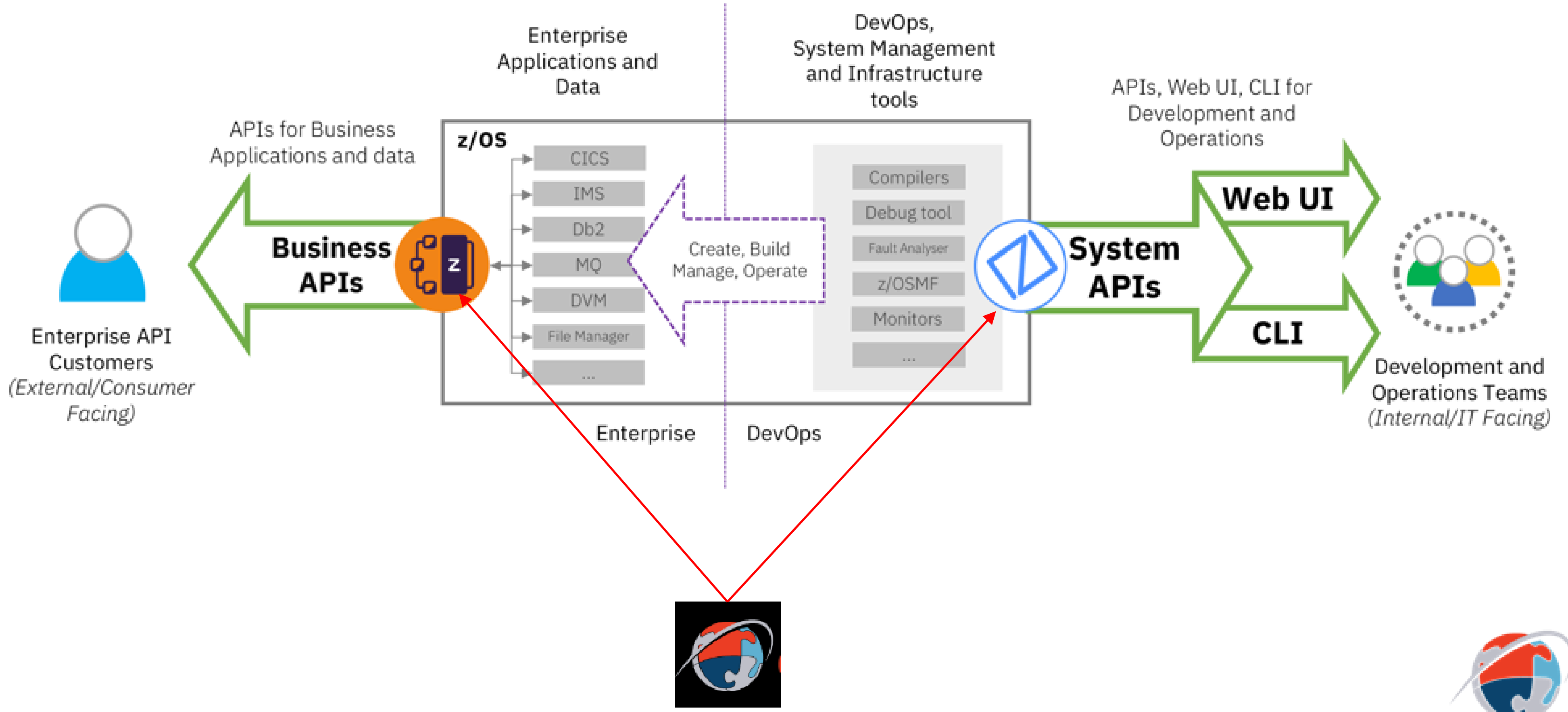
Zowe


Enterprise Applications and Data
DevOps, System Management and Infrastructure tools
APIs for Business Applications and data
APIs, Web UI, CLI for Development and Operations
z/OS
CICS
IMS
Db2
MQ
DVM
File Manager
...
Create, Build Manage, Operate
Compilers
Debug tool
Fault Analyser
z/OSMF
Monitors
...
Business APIs
System APIs
Web UI
CLI
Enterprise API Customers
(External/Consumer Facing)
Development and Operations Teams
(Internal/IT Facing)
Enterprise
DevOps

Zowe


Enterprise Applications and Data
DevOps, System Management and Infrastructure tools
APIs, Web UI, CLI for Development and Operations
APIs for Business Applications and data
z/OS
CICS
IMS
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MQ
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...
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Create, Build Manage, Operate
Business APIs
System APIs
Web UI
CLI
Enterprise API Customers
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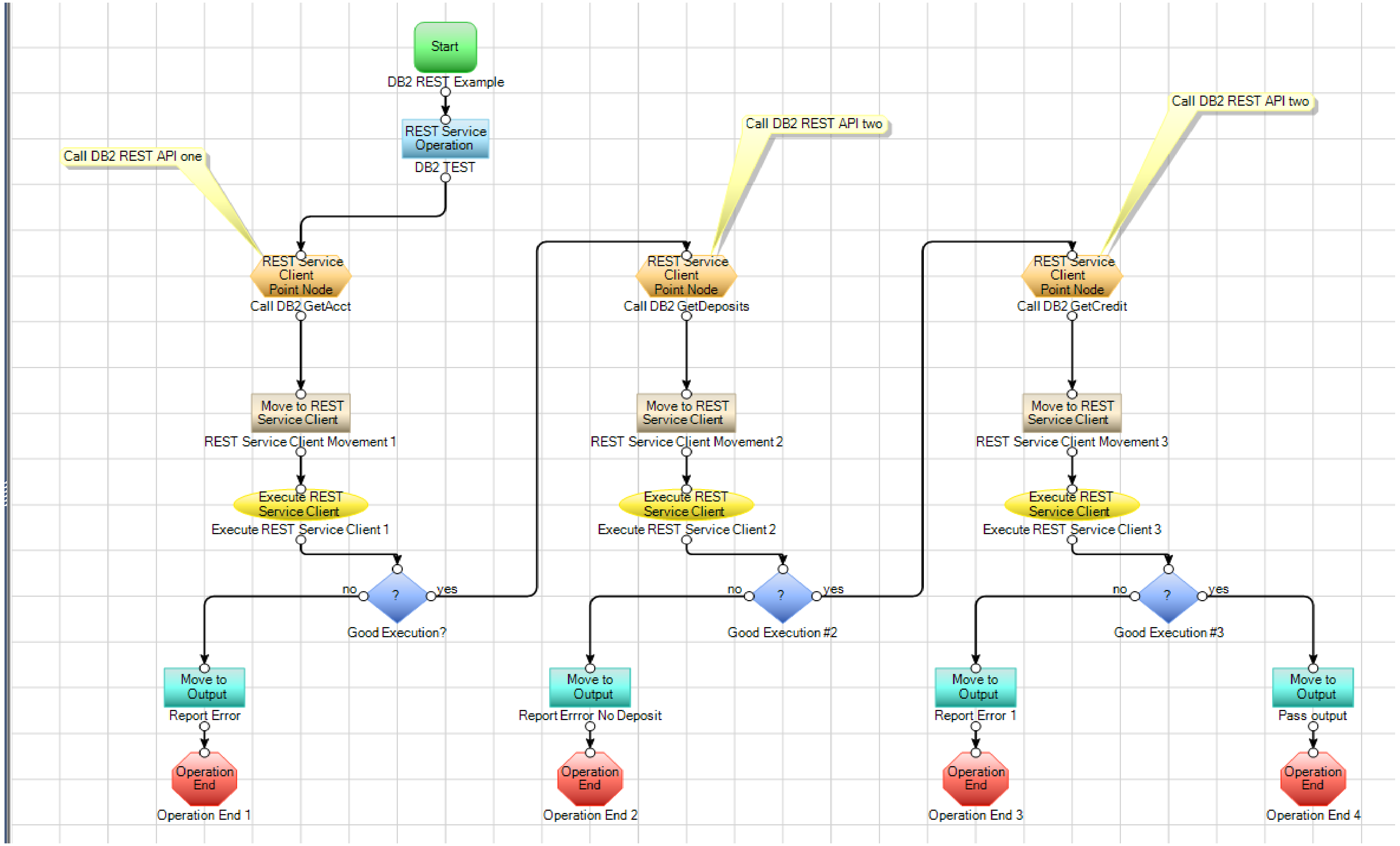
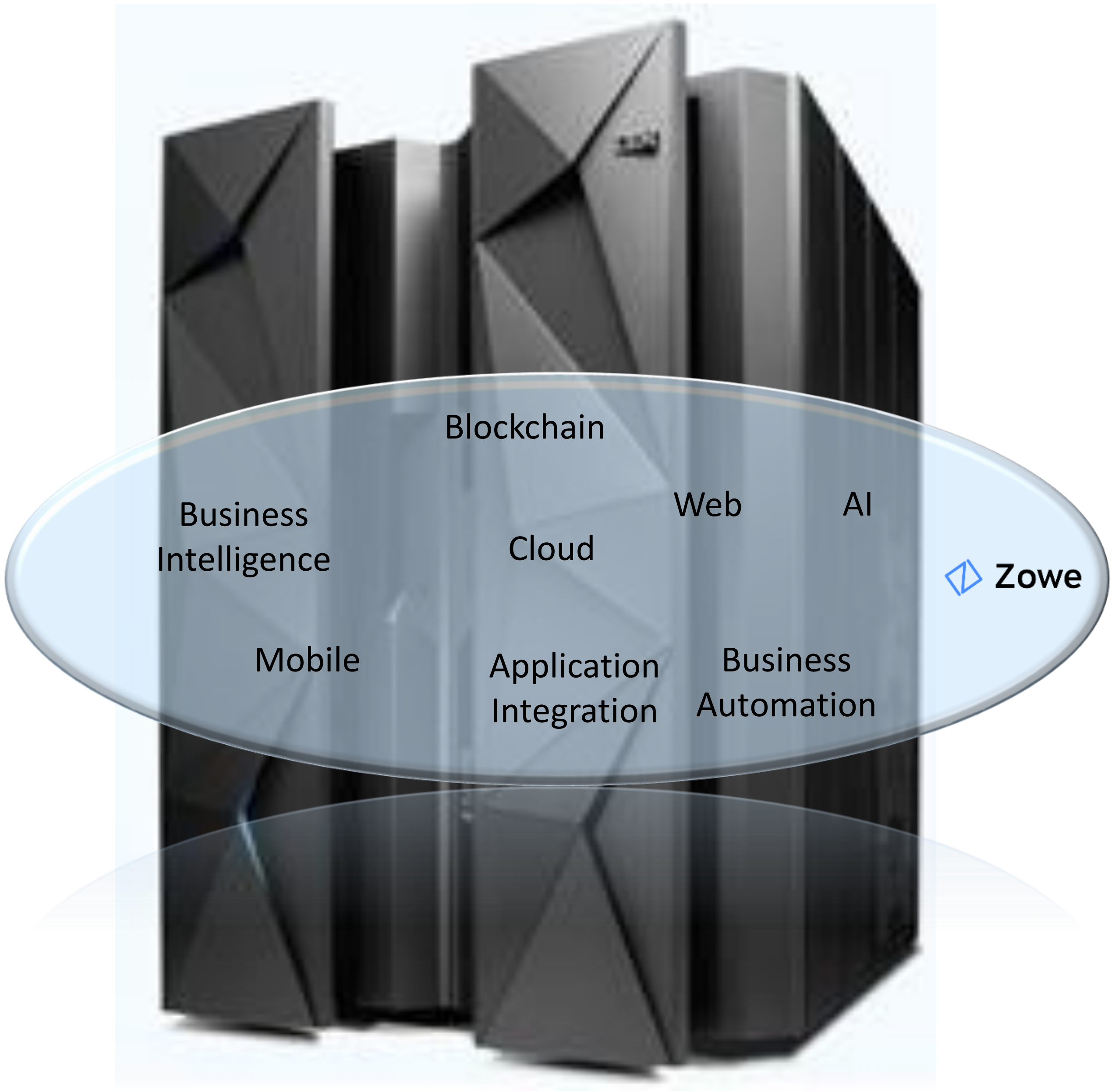
Enterprise
DevOps

DB2 REST


Start
DB2 REST Example
REST Service Operation
DB2 TEST
Call DB2 REST API one
Call DB2 REST API two
Call DB2 REST API two
REST Service Client Point Node
Call DB2 GetAcct
REST Service Client Point Node
Call DB2 GetDeposits
REST Service Client Point Node
Call DB2 GetCredit
Move to REST Service Client
REST Service Client Movement 1
Move to REST Service Client
REST Service Client Movement 2
Move to REST Service Client
REST Service Client Movement 3
Execute REST Service Client
Execute REST Service Client 1
Execute REST Service Client
Execute REST Service Client 2
Execute REST Service Client
Execute REST Service Client 3
no
?
yes
Good Execution?
no
?
yes
Good Execution #2
no
?
yes
Good Execution #3
Move to Output
Report Error
Move to Output
Report Error No Deposit
Move to Output
Report Error 1
Move to Output
Pass output
Operation End
Operation End 1
Operation End
Operation End 2
Operation End
Operation End 3
Operation End
Operation End 4

Whatever comes next…………………………….



API Lessons Learned

COBOL and PL/1

THE GOOD	THE BAD	THE UGLY
All Data Structures Supported	Some structures don’t map well to distributed Apps	Comp-3, Binary , ODO REDEFINES, unbounded sequences
All can be exposed as service inputs/outputs	Names in COBOL-PL/1 may be cryptic and need to be renamed	Blank When Zero.
Can expose existing programs without changes	May need more data to drive than the app knows	Message switches, and other calls

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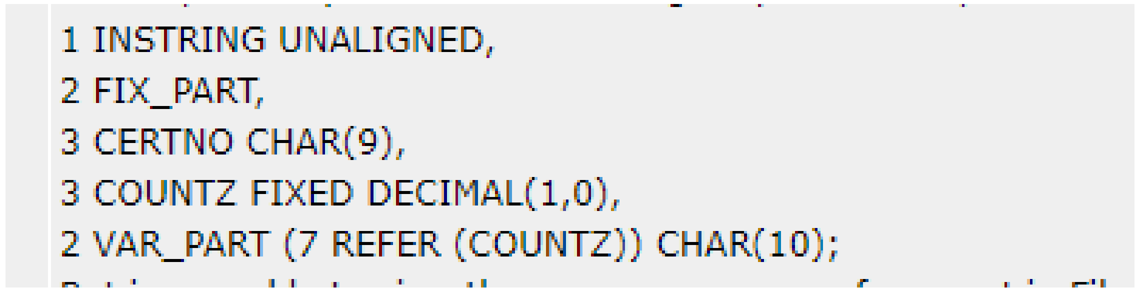
```
01 VAR-RECORD.
 05  REC-OTHER-DATA     PIC X(30).
 05  REC-AMT-CNT        PIC 9(4).
 05  REC-AMT            PIC 9(5)
       OCCURS 1 TO 100 TIMES
            DEPENDING ON REC-AMT-CNT.
  .
```



```
1 INSTRING UNALIGNED,
2 FIX_PART,
3 CERTNO CHAR(9),
3 COUNTZ FIXED DECIMAL(1,0),
2 VAR_PART (7 REFER (COUNTZ)) CHAR(10);
```

IMS Transactions

THE GOOD	THE BAD	THE UGLY
Existing Transactions can be exposed as REST or SOAP	A Transaction may be too fine grained	Multiple Transactions may have to be used in service
Data from transaction returned as a service output	Data may be to convoluted to use in service	Volume of data may be too large to return to distributed client
PFKEY = TRANCODE	Maybe need multiple Trans	Maybe need to call multiple Trans in sequence

IMS Transactions Combined

THE GOOD	THE BAD	THE UGLY
Combine Transactions in one service	May not work well with others	API's that run for minutes
Use Conversational Transactions	Long running conversations may be long running API's	No understanding of conversational impact
No Code re-write	May be easier to combine logic to keep from calling multiples transactions	May return different copybook

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IMS Conversational

THE GOOD	THE BAD	THE UGLY
Wrap a conversation in a service	Wrap a conversation in a service	Wrap a conversation in a service
Use Conversational Transactions	Long running conversations may be long running API's	*Conversational rollback*
Psuedo-Conversational	May need Manual Intervention	Unforeseen Tran behavior

IMS Multi-Segment Messages

THE GOOD	THE BAD	THE UGLY
Multiple Segment Output can be returned from the transaction	May be variable Length in one response	May be variable length multi-segment response
Multiple Segment Input can be passed to the transaction	May be variable Length in one request	

IMS Other…………………

Null Termination x’3F’

Ex.

03 LAST-NAME   PIC X(20). | ‘RIVERS   ‘ D9C9E5C5D9E24040404040404040404040404040

To: ‘RIVERS   ‘ D9C9E5C5D9E23F’

XML   <lastName>RIVERS3#A2<lastName>

IMS Other…………………

Null Termination x’00’

Ex.

03 NAME   PIC X(20). | ‘RIVERS   DUSTY   ‘ D9C9E5C5D9E2404040**0000**C4D9E2E3E8

To: ‘RIVERS   ‘ D9C9E5C5D9E2’

XML   <NAME>RIVERS<NAME>

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