

# ***z/OS API's in Action:*** **Several User Success Stories**

Glenn Schneck

Principal Technical Architect

*gschneck@gtsoftware.com*



# IBM Mainframes Retain the System of Record



**IMS Systems for Banks**  
(ATM, loans, account management)



**IMS Systems for Insurance**  
(Claims & policy management)



**Mainframe Systems for Manufacturing**



**Mainframe Systems for Finance**

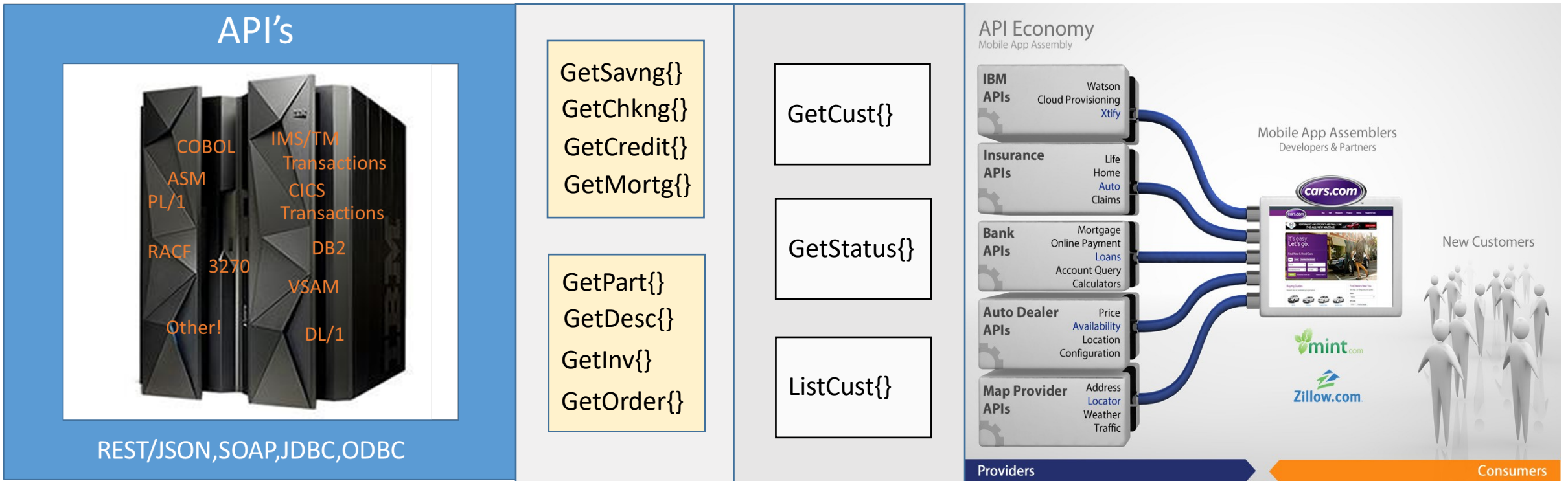


**Mainframe Systems for Medical**



**Mainframe Systems for Airline**

# API Economy for Digital Transformation



# What is an API?

## Wikipedia

**Application Programming Interface** (API) is a set of subroutine definitions, protocols, and tools for building application software. In general terms, it is a set of clearly defined methods of communication between various software components. A good API makes it easier to develop a computer program by providing all the building blocks, which are then put together by the programmer.

## Popular API Protocols

**REST** (REpresentational State Transfer)

**SOAP** (Simple Object Access Protocol)



## Atomic API or Microservice

Think of an API like a menu in a restaurant. The menu provides a list of dishes you can order, along with a description of each dish. When you specify what menu items you want, the restaurant's kitchen does the work and provides you with some finished dishes. You don't know exactly how the restaurant prepares that food, and you don't really need to.

<https://www.howtogeek.com/343877/what-is-an-api/>

## Composite API or Business Service

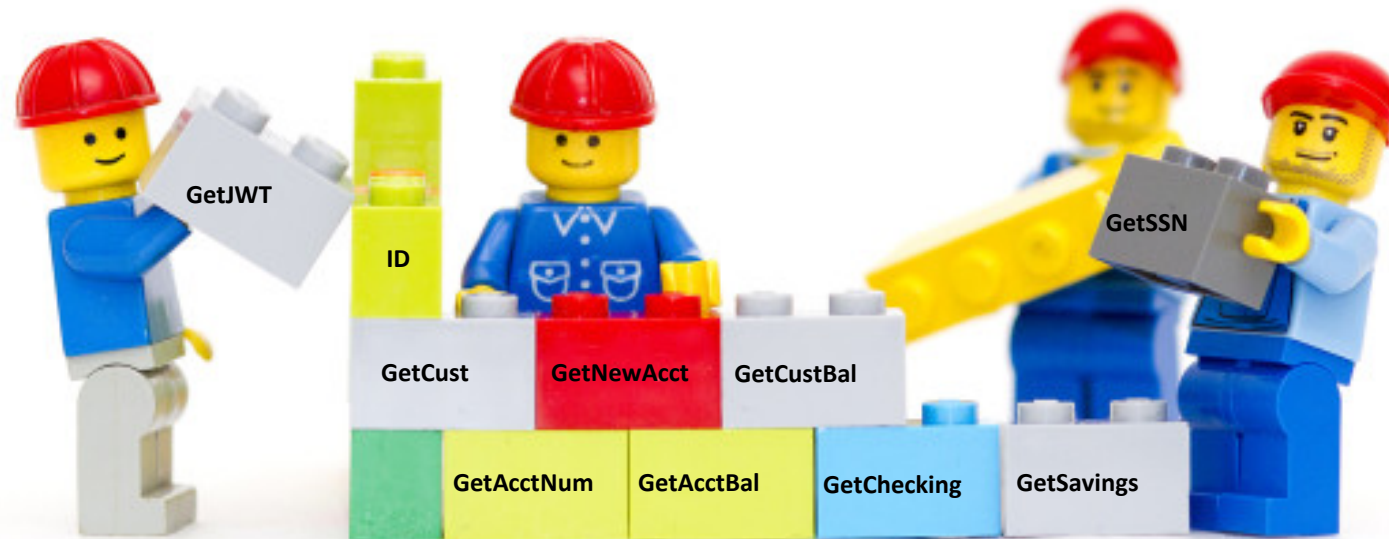
You have now ordered your dinner as single APIs, however you want your order to come out together. For that to happen the kitchen and/or the waiter will need to collect the output from the single APIs and combine them into one complete order. This allows all of your order to arrive at the same time with only 1 trip required to/from the kitchen.

# Today's Business Needs

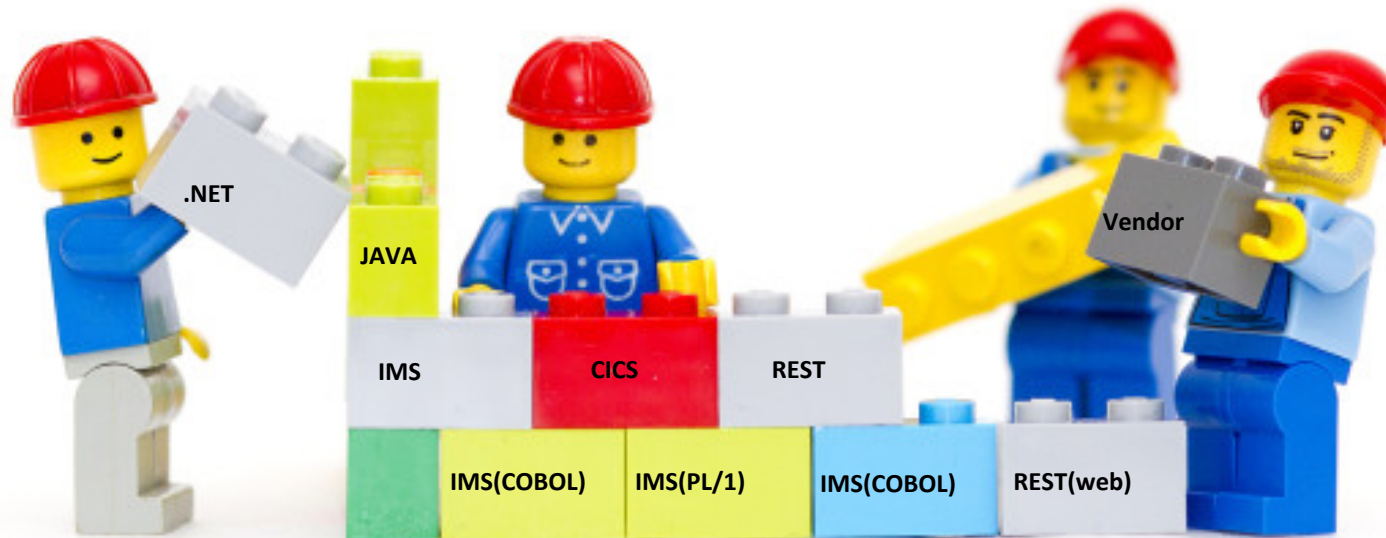
- **Build and deploy API's rapidly**
- **Web self-service, mobile/cloud, BYOD**
- **Real-time access to enterprise data residing on any platform**
- **Integrated views of related information**
- **Customer and business focused IT**
- **Industry standards**
- **Integration between mainframe & distributed systems**



# APIs are building blocks...



# APIs are building blocks...



# Lessons Learned, War Stories, Successes



*"It is fine to celebrate success, but it is more important to heed the lessons of failure."* - Bill Gates



# 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 (PL/1)
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

```
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);
```

# CICS or 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 too 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

# CICS and/or 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

# 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	<i>Conversational rollback</i>
Pseudo-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 (multiple parts of MFS screen)	May be variable Length in one request	



## Even Uglier...

### Null Termination x'3F' (IMS MFS)

Ex. 03 LAST-NAME PIC X(20). | 'RIVERS ' D9C9E5C5D9E2404040404040404040404040404040

To: 'RIVERS ' D9C9E5C5D9E23F'

XML: <lastName>RIVERS3#A2<lastName>

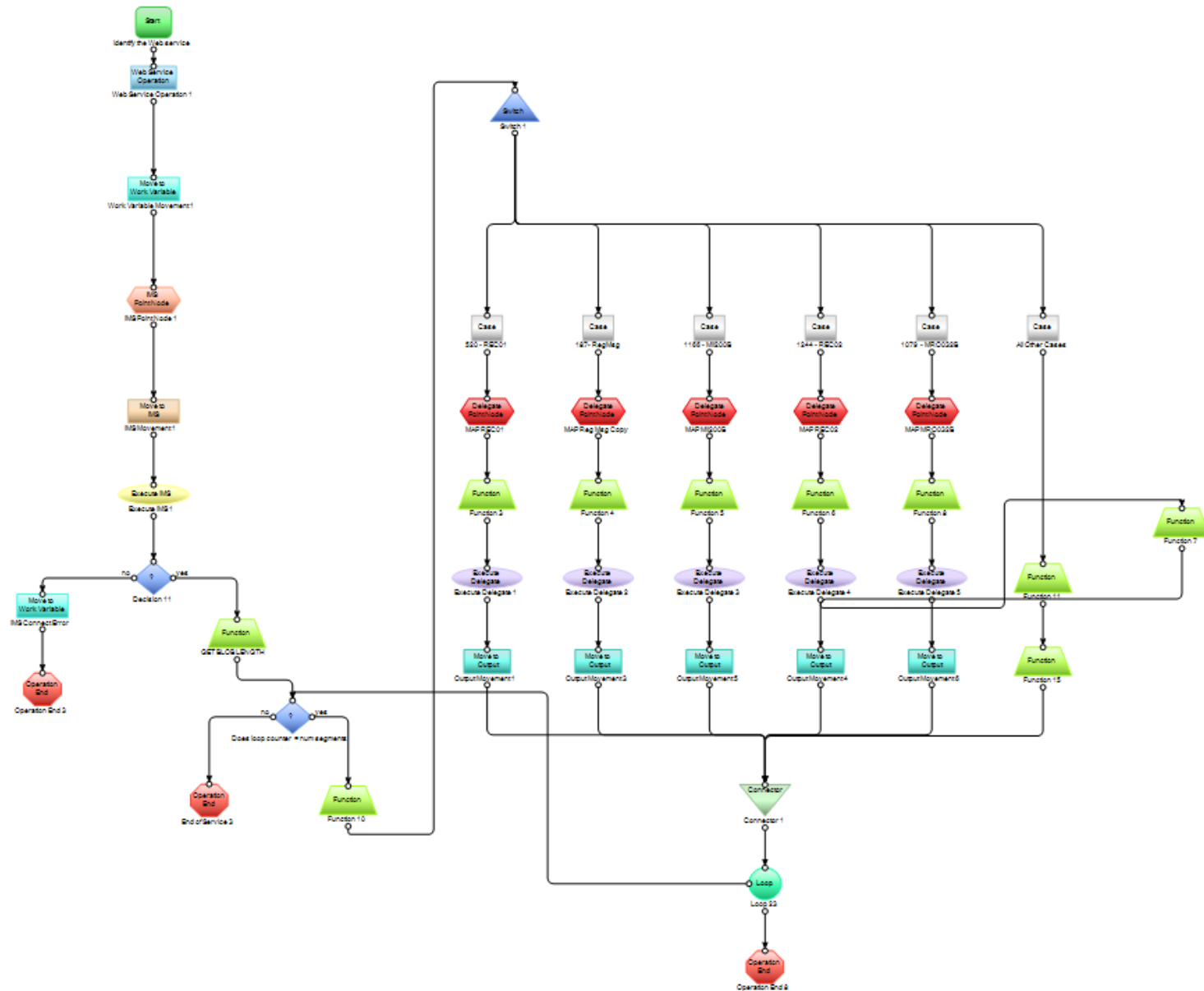
### Null Termination x'00'

Ex. 03 NAME PIC X(20). | 'RIVERS DUSTY ' D9C9E5C5D9E24040400000C4D9E2E3E8

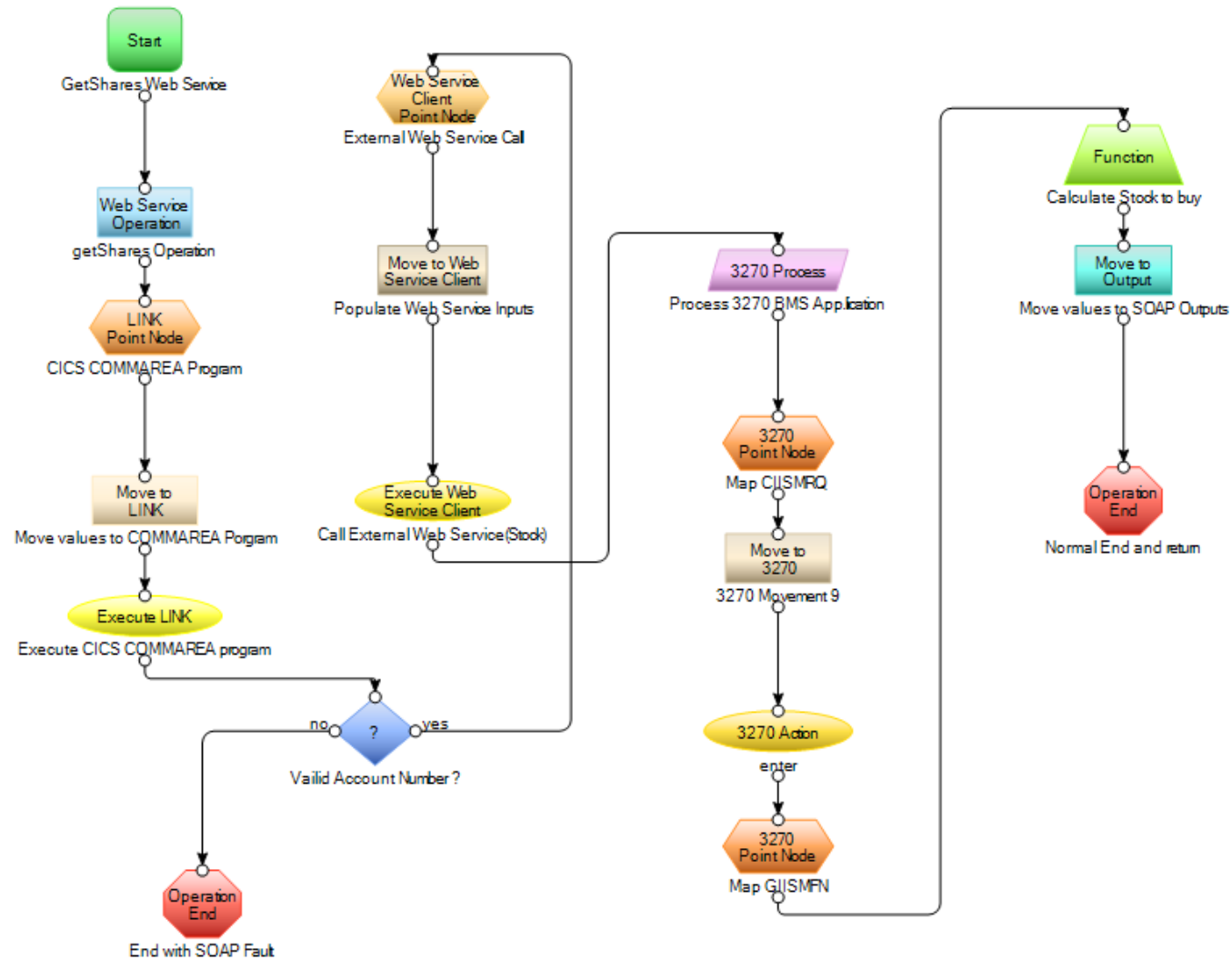
To: 'RIVERS ' D9C9E5C5D9E2'

XML: <NAME>RIVERS<NAME>

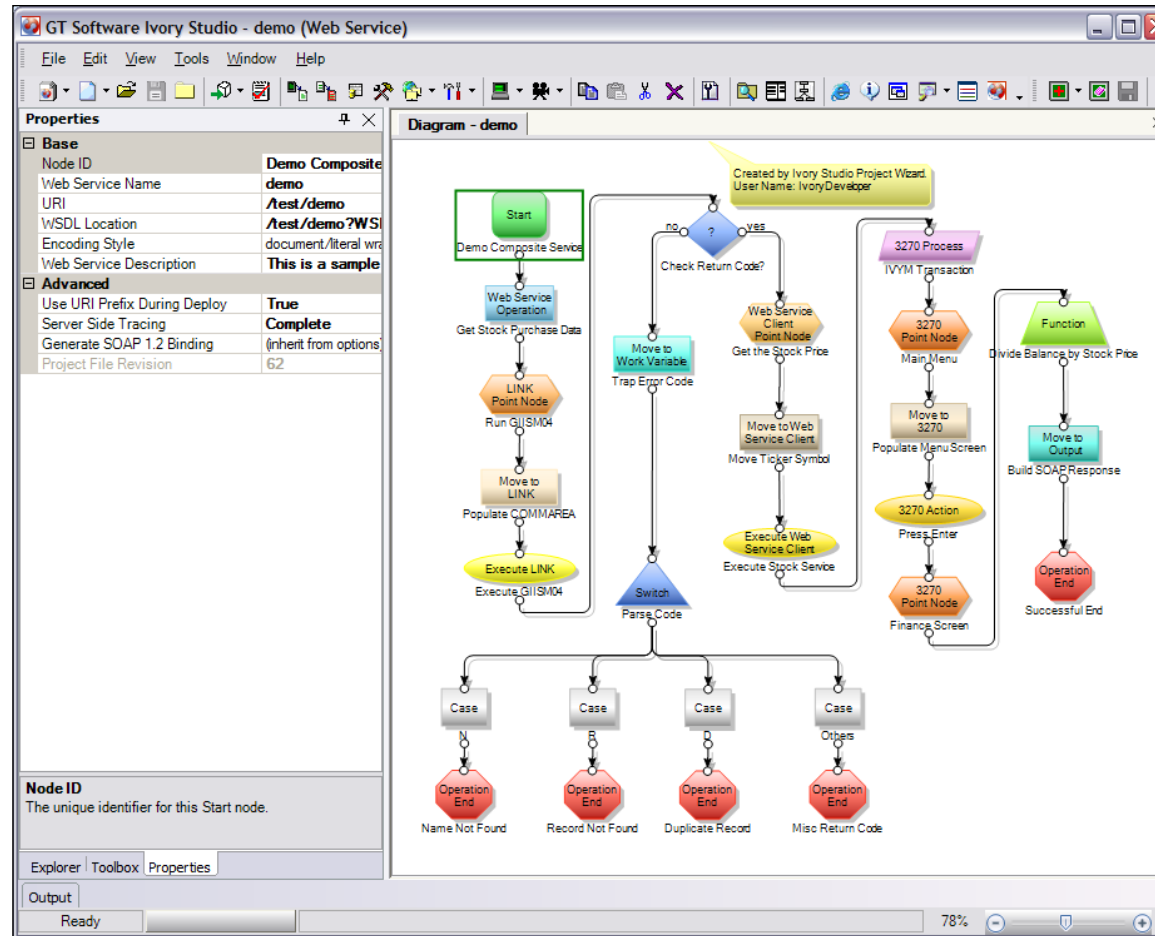
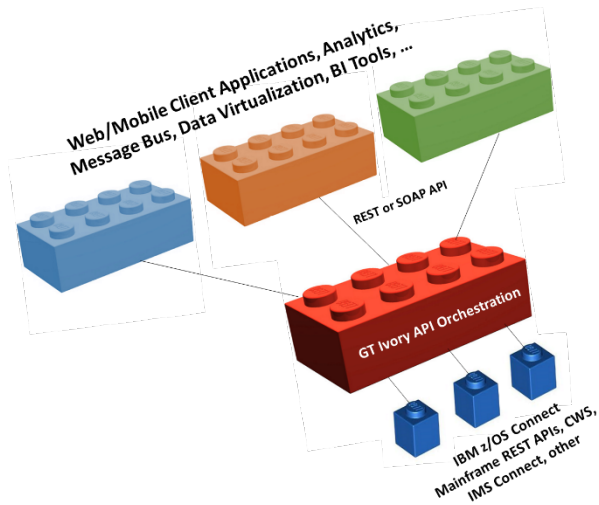
# Intelligent API Workflow for Mainframe Transactions



# Composite API Workflow for Business Processes



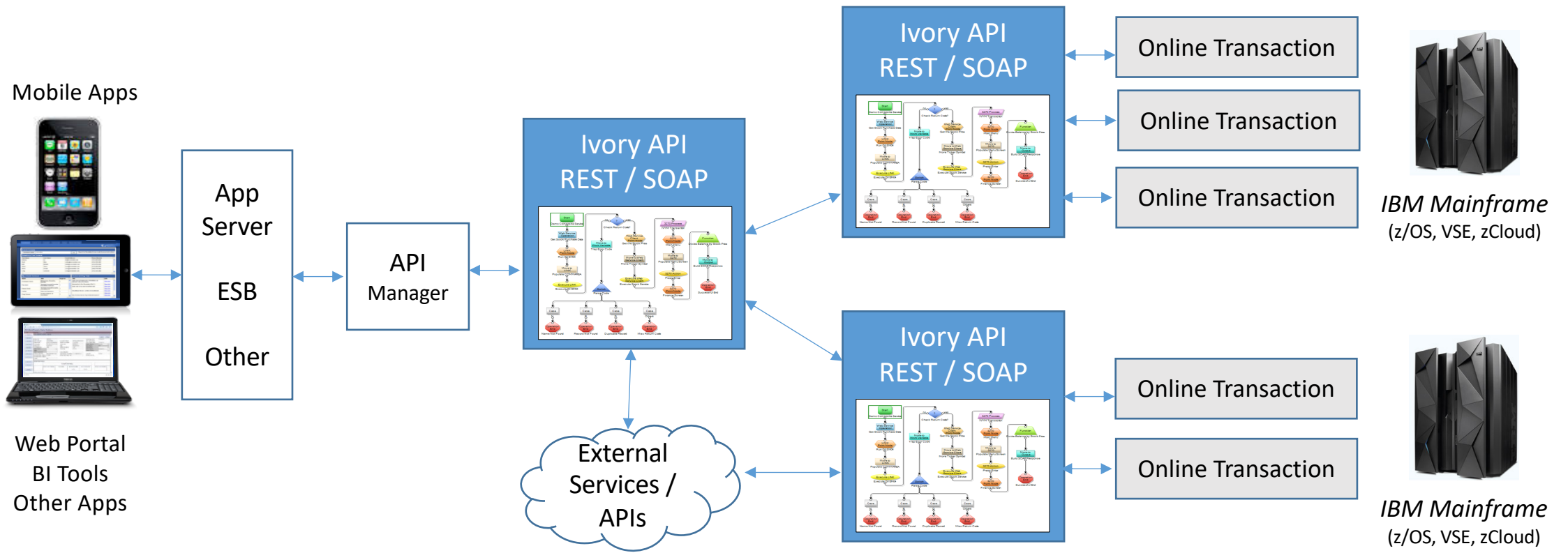
# GT Ivory Service Architect®



## Intelligent Composite API:

- Multiple transactions
- Multiple data sources
- External web services and APIs
- Conditional Logic
- Error handling
- Governance and security
- Drag-and-drop (no coding) SDK
- Shared 'business' APIs across consumers
- No 'low level' coding and management of mainframe connectors
- Easy, fast, and agile development

# GT Ivory® Mainframe APIs



# GT Ivory<sup>®</sup> Deployment Options



**zOS Started Task /  
CICS**

GT Ivory  
Server



**IFL  
(Linux on z)**

GT Ivory  
Server

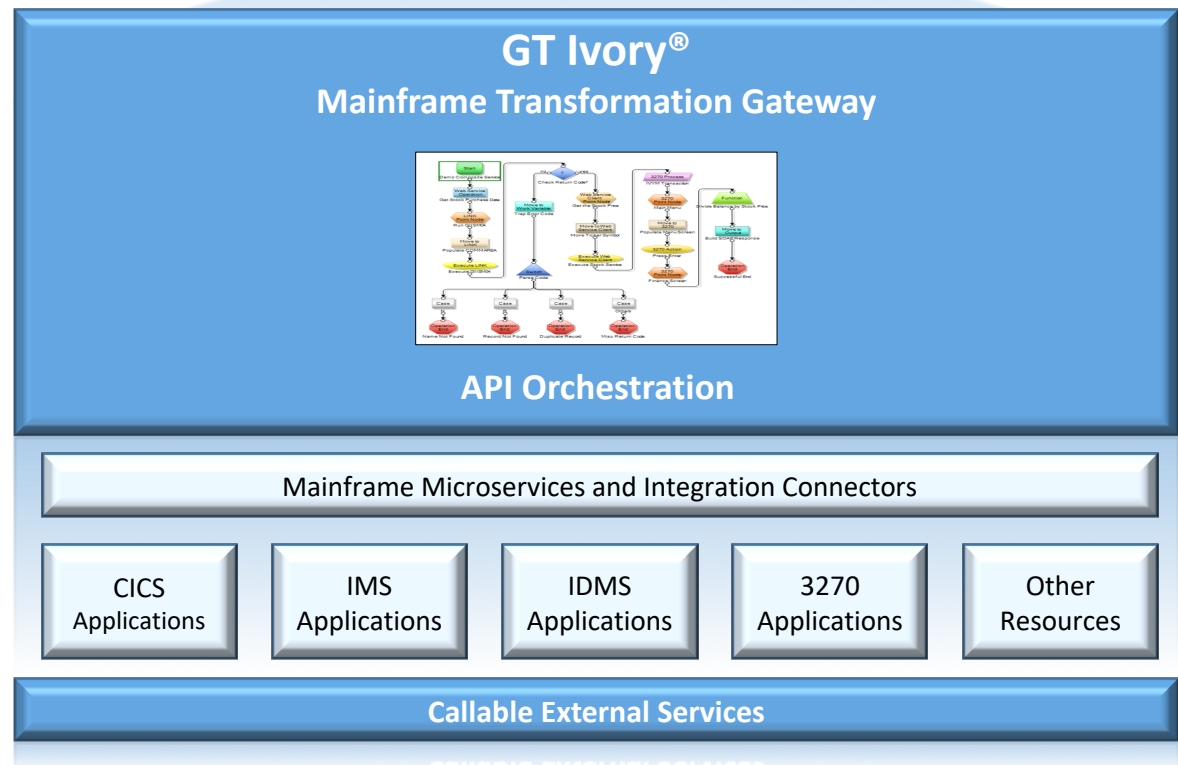
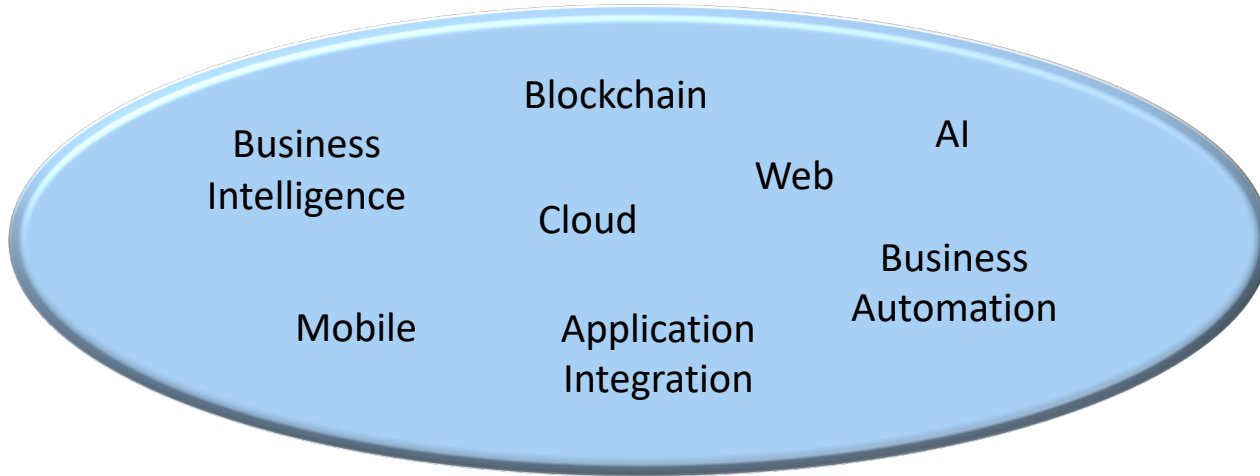


**Windows or Linux  
Server**

GT Ivory  
Server



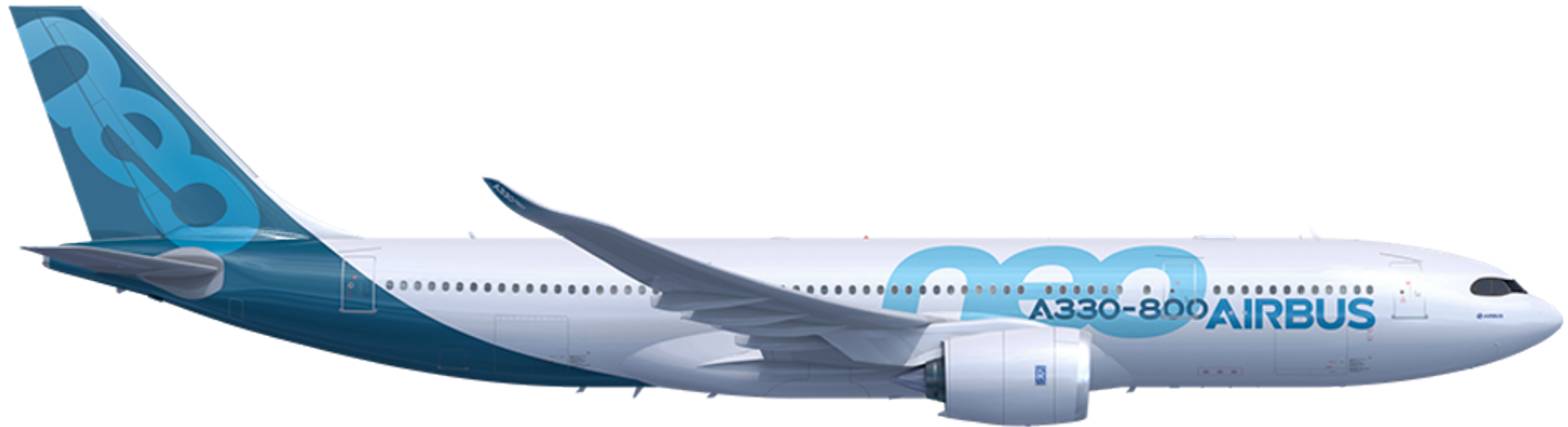




-  **Zowe**
- DB2 REST
- z/OS Connect
- IBM DVM



# GT Ivory® at One of the World's Largest Airlines



# SCEPTRE

- SCEPTRE stands for System Computerized for Economical Performance, Tracking, Recording, and Evaluation (airline technology)

[https://www.acronymfinder.com/System-Computerized-for-Economical-Performance%2C-Tracking%2C-Recording%2C-and-Evaluation-\(airline-technology\)-\(SCEPTRE\).html](https://www.acronymfinder.com/System-Computerized-for-Economical-Performance%2C-Tracking%2C-Recording%2C-and-Evaluation-(airline-technology)-(SCEPTRE).html)

- IMS Mainframe
- Cobol
- Enterprise Solution
  - Line Maintenance
  - Base Maintenance
  - Planning
  - Finance
  - Engineering
  - Configuration Management/Records
  - Supply Chain
- Utilizing Web Front Ends

## Airlines Technical Operations

- 130 IT applications supporting one of the largest airlines in the world
- Mechanics, supply chain, engineering, purchasing, planning
- Maintenance performed worldwide
- Over 10,000 Aircraft Maintenance Technicians

# Environment

- IMS TM & IMS DB
- Ivory Service Architect(API creation & orchestration)
- Github (source version control)
- Jenkins (automation)
- .NET , Java, Node.js , COBOL
- Linux (Red Hat) , JBOSS
- Tomcat



# Mobile Application on Tablets & Smartphones

An Airline X

Aircraft Detail [History](#) [Admin](#)

Nov 17, 2015 15:12 GMT Dusty Rivers Help ▾

Nose #  Find A/C

[Advanced Search](#)

## Entry Page Technical Operations

To get started, enter a nose number into the search box on the left



# Nose Number Conflict Resolution

Aircraft Detail History Admin

Nose Find A/C

Advanced Search

**Nose Number Conflict: 200**

Please choose from the following aircraft:

	Aircraft	Reg #	Fleet	Engine
Select	200	6200	MD80	JT8D-219
Select	200	00UU	B757	RB211-535

# Aircraft Tail Number Selected

An Airline X
Aircraft Detail
Discrepancies
Manuals
Apps
History
Admin
Nov 17, 2015 15:19 GMT
Dusty Rivers
Help

Advanced Search

AIRCRAFT  
200

EQUIPMENT  
B757 ETOPS

MAINT. PROGRAM  
US

REGISTRATION  
N200UU

ENGINE  
RB211-535

NAA LOGBOOK  
YES

More

### Aircraft Routing

FLIGHT 0886  
CUN → CLT

DEP GATE	DEP	ARR	ARR
C10	15:19 16 NOV GMT -5	18:23 16 NOV GMT -5	D2

13m

DLY  
FLIGHT 0835  
CLT → SJU

DEP GATE	DEP	ARR	ARR
D2	10:15 17 NOV GMT -5	14:56 17 NOV GMT -4	D12

GND: 15h 52m

FLIGHT 0836  
SJU → CLT

DEP GATE	DEP	ARR	ARR
D12	15:50 17 NOV GMT -4	18:42 17 NOV GMT -5	D7

GND: 0h 54m

FLIGHT 1798  
CLT → PHL

DEP GATE	DEP	ARR	ARR
D7	20:05 17 NOV GMT -5	21:38 17 NOV GMT -5	A20

GND: 1h 23m

FLIGHT  
PHL

DEP GATE	DEP	ARR	ARR
A20	09:50 18 NOV GMT -5		

GND: 12h 12m

ORIGIN	GATE	DEST	GATE	FLT	STD	ETD	OUT	OFF	STA	ETA	ON	IN	GND
CLT	D2	SJU	D12	0835	09:55	10:15	-	-	14:31	14:56	-	-	15h 52m

### Discrepancies

57 MIC Items
22 MONs
33 SADs
2 SILs

MIC #	ATA	TTG	DEF CODE	STA	LAST UPDT	DISCREPANCY TITLE
3139798	5310		MON	CLT	15Nov15	FUSELAGE SKIN DENT FRAME STA 760 ON STRINGER 25L
1943953	7220		MON	PHL	21Oct15	# 1 ENG. INLET HAS DEBONDED ACOUSTIC PANEL AT O330 POSITION AFT L...
6801187	5330		MON	BFM	25Aug15	(REF. LP#6800753) CREATE MONITOR FOR EXT FUSELAGE SKIN DOUBLER R...
5031125	5740		MON	CLT	22Aug15	ACCOMPLISHED TYPICAL REPAIR 57-40-05A, HOWEVER THIS TYPICAL REPA...
7294833	5330		SAD	BWI	21Aug15	DENT FOUND AFT OF RADOME AND FOWARD OF NOSE GEAR DOOR
6801175	5330		MON	BFM	21Aug15	REF SAD LP#7294833. FUSELAGE STATION 207.37 BETWEEN S27L AND S28 L H...
6801166	5330		MON	BFM	20Aug15	REF SAP LP#6800937 EXT FUSELAGE SKIN BETWEEN STA 560-580 & 5-27R /S...
6800943	5330		SAD	BFM	20Aug15	EXTERNAL FUSELAGE SKIN AFT OF R4 DOOR BETWEEN BS1681 AND BS1701 A...
6800937	5330		SAD	BFM	20Aug15	EXTERNAL FUSELAGE SKIN BET. BS 560 AND 580, S27R AND 28R HAS A D ENT
6053514	5330		SAD	MCN	20Aug15	DENT EXTERNAL FUSELAGE SKIN BS 1520 BETWEEN STRINGERS 3R & 4R
4844833	5310		MON	PHX	20Aug15	CREATE A MONITOR TO REPEAT HFEC INSPECTION EVERY 620 FC PER EA N...
0010936	5510		SAD	BOS	20Aug15	DMG #: 0007 ORIG MACH NBR: EA: OM7: 000000 DMG-LOC: LEN: 1.3" DEP...
6800997	5740		SAD	BFM	18Aug15	#6 L/E SLAT 47" FROM I/B END AND 4" FROM T/E WEDGE EXTERNAL HAS D...
6800995	5740		SAD	BFM	18Aug15	#6 L/E SLAT 7", 14" FROM I/B AND 6.5" FROM T/E WEDGE HAS 2EA DEN T.

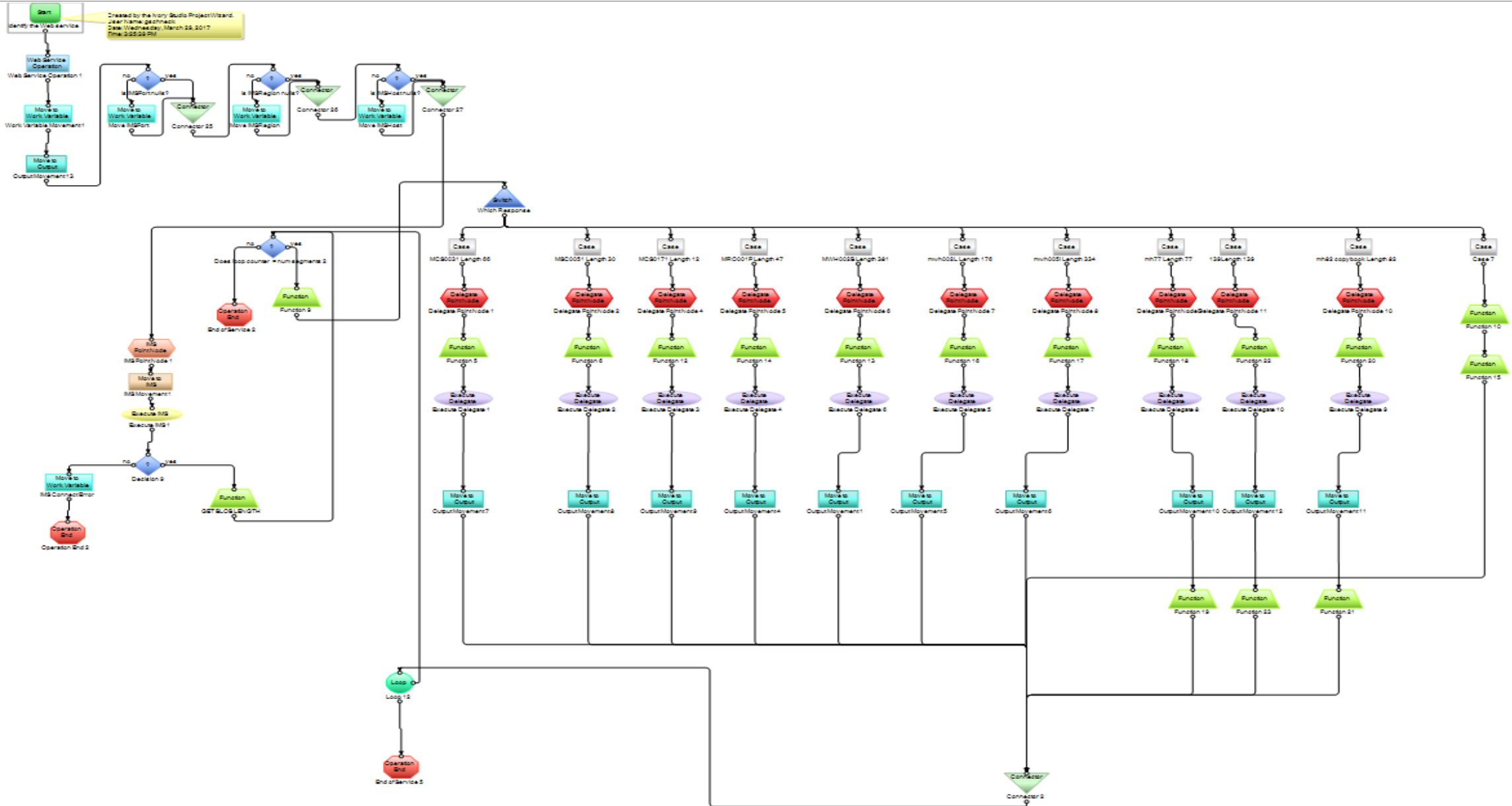
# Legacy Application Complexities

- Multiple copybooks
- Multiple paths
- Conversational
- Multiple code design patterns
- Embedded screen logic

# 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

# Ivory API Orchestration... No Coding!!!



# Financial

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

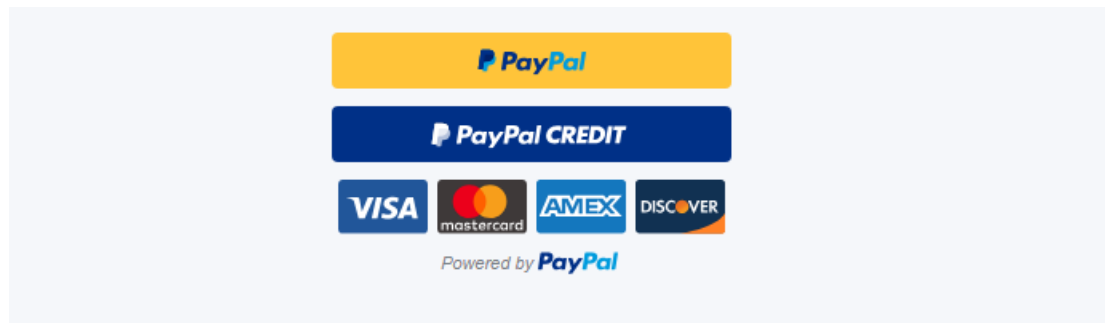




- IMS systems of record
- Outbound calls to Google resources
- Outbound calls to Credit resources
- Outbound calls to Account Control Website
- Inbound API calls to existing IMS Trans with no code change with orchestration
- ATM system inbound API's(SOAP then REST)



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



**WORLD-CHECK™**  
REDUCING RISK THROUGH INTELLIGENCE



## Volumes (Financial Customers)

Approx. 2,000,000 to 2,400,000 web service calls day(inbound)

- At peak hour ( eg. 10-11am ) we have up to 280,000 web service calls
- At peak minute we have up 6,400 web service calls
- At peak seconds we have up to 135 web service calls

Approx. 700,000 to 1,000,000 callable service calls day(Outbound)

- At peak hour ( eg. 10-11am ) we have up to 100,000 callable calls
- At peak minute we have up 2,000 callable calls
- At peak seconds we have up to 45 callable calls

Another Customer 700,000 to 1,000,000 web service calls per day



# Insurance Company

- Mid-size Property and Casualty insurer
- Headquartered in the Midwest for 115 years
- 2400+ Employees
- Processes about 10 million transactions weekly

- CICS systems of record
- Multiple Outbound calls to 3<sup>rd</sup> Party Geocode
- Calls to Legacy DB (DB2)
- CICS Links to multiple programs
- 3<sup>rd</sup> Party Lookup
- MVR Proof of Insurance
- Business Owner Policy Questionnaire
- Locate Your Rep
- Other applications
- VB Front End




# Java Web App

Name	Phone Number
PROFT, JONATHAN STUART	444-6985

US Based Insurance Company

### Employee Details

Employee Name: PROFT, JONATHAN STUART  
Work Phone: 444-6985  
Mail Code: J-301  
Job Title: IS-SYSTEMS DEV III  
Supervisor: TIESEL, THOMAS J  
Department: APPLICATION DEV & SUPPORT  
Location: JAB 3RD FLOOR  
Employee ID: 112061  
Send Email  
IS Account: Information Services  
Cost Center: 5233-APPLICATION DEV & SUPPORT  
External Phone: 507-444-6985



+ Hierarchy  
+ Direct Reports

# Ivory Server



# COBOL

```
LINKAGE SECTION.  
01 DFHCOMMAREA.  
   COPY TT000004.  
  
PROCEDURE DIVISION USING DFHCOMMAREA.  
  
1000-SEARCH-DATA.  
  
   PERFORM 3000-CALL-PEOPLE-SEARCH  
   THRU 3000-EXIT.  
  
1000-PROGRAM-EXIT.  
   GOBACK.  
  
   COPY TT000002.
```

```
SELECT  
FROM  
WHERE ((:SA-STA-CD = 'L')  
OR  
(:SA-STA-CD = 'A' AND  
ACY_IND = 'Y'))  
AND  
((:SA-CRT1-TYP = '00')  
OR  
(:SA-CRT1-TYP = '04' AND  
ACT_CD = :SA-CRT1-VAL-ACT)  
OR  
(:SA-CRT1-TYP = '08' AND  
:SA-CRT1-COP = 'E' AND  
UPPER(ACT_DES) = UPPER(:S  
OR  
(:SA-CRT1-TYP = '08' AND  
:SA-CRT1-COP <> 'E' AND
```


## Leading Aptitude Testing Company

- U.S headquartered, non-profit assessment vendor
- Develop and administer 50 million aptitude tests annually
- 180 countries —9,000 locations



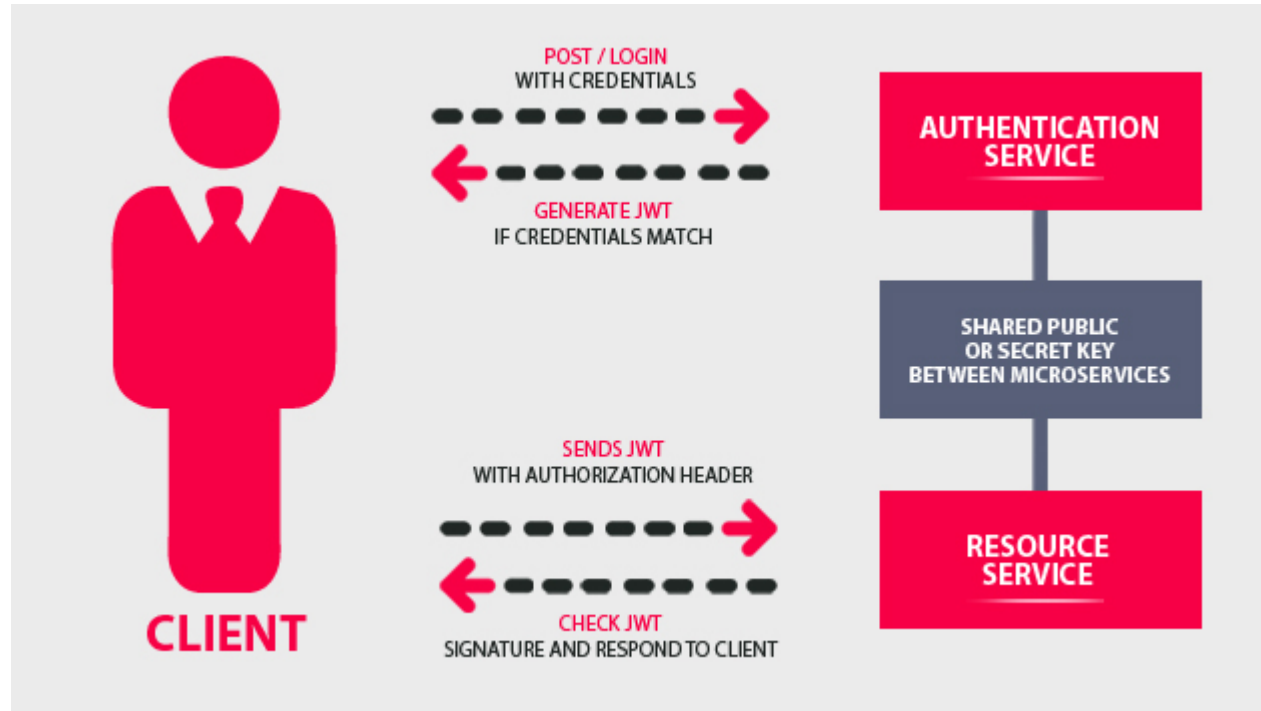
- CICS systems of record
- Multiple Outbound calls to Google Geocode
- Calls to Legacy DB (IDMS)
- CICS Links to multiple programs
- Outbound Calls for External Credit Card Processing
  - Immediate Credit Approval
  - Two Large Back-End Online Systems
  - Real-time Communication with Third-Party Credit Card Processor
- Ability to process funds for payment
- Ability to track candidate's scheduling, testing, and scoring
- Both were green screen systems and would use same interface
- Neither coded to support encryption, SSL security and WS security tokens — a requirement for credit card processing.
  - Encrypted Security to meet PCI Compliance

# What Have Customers Asked For...

- JWT
- Calling out to distributed Clients (with orchestration)
- API Repositories (which one)
- DevOps
-  **Zowe**
- DB2



# JWT (JSON Web Token)



# JWT

## Encoded

```
eyJhbGciOiJIUzI1NiIsInR5cCI6IkpXVCJ9.eyJzdWIiOiIxMjM0NTY3ODkwIiwibmFtZSI6IkpvaG4gRG9lIiwiaWF0IjoiYkdWV9.TJVA95OrM7E2cBab30RMHrHDcEfxjoYZgeFONFh7HgQ
```

## Decoded

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

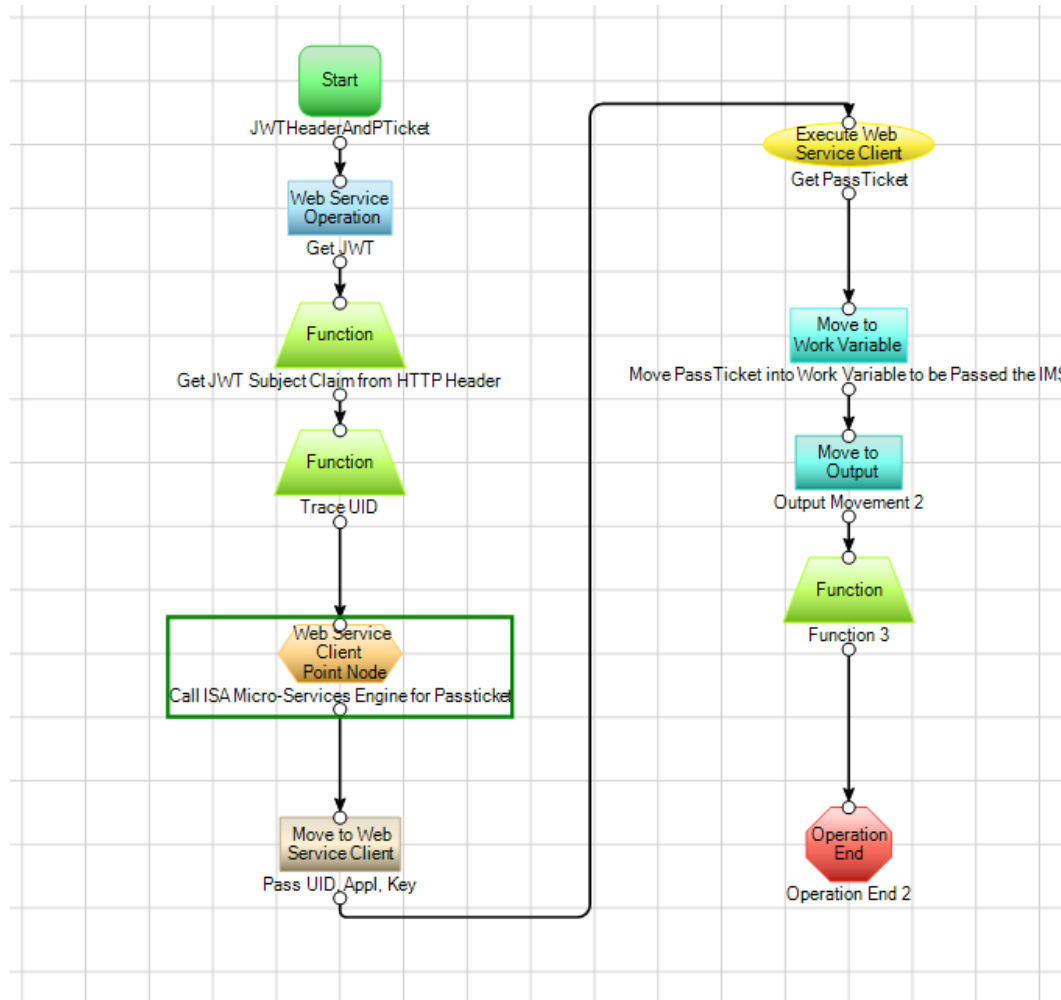
Header

Payload

Signature



# JWT Sample



# 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?

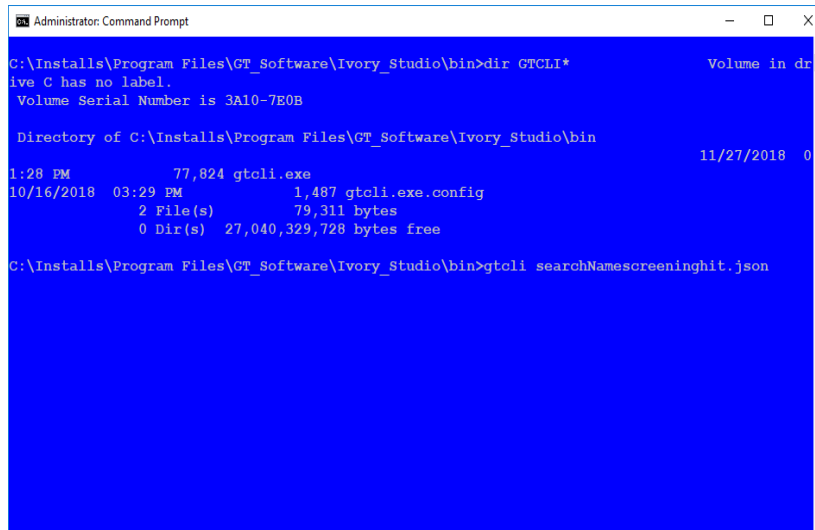
- Generation of Callable Service Interface (Call) for COBOL / PL/I
- Processing of all TCPIP Services for Target Service
- Dynamic Marshaling / Parsing of all XML and/or JSON

# Callable (Outbound) Services

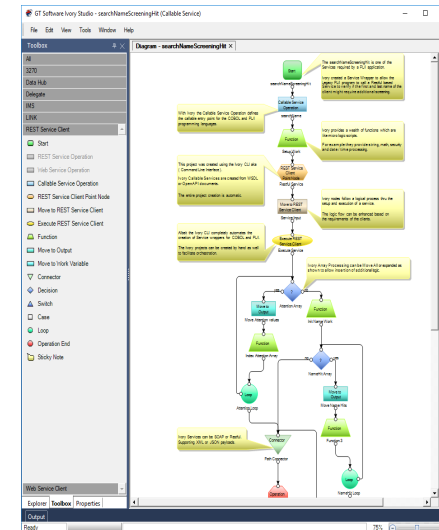
- **Command-Line Interface**

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



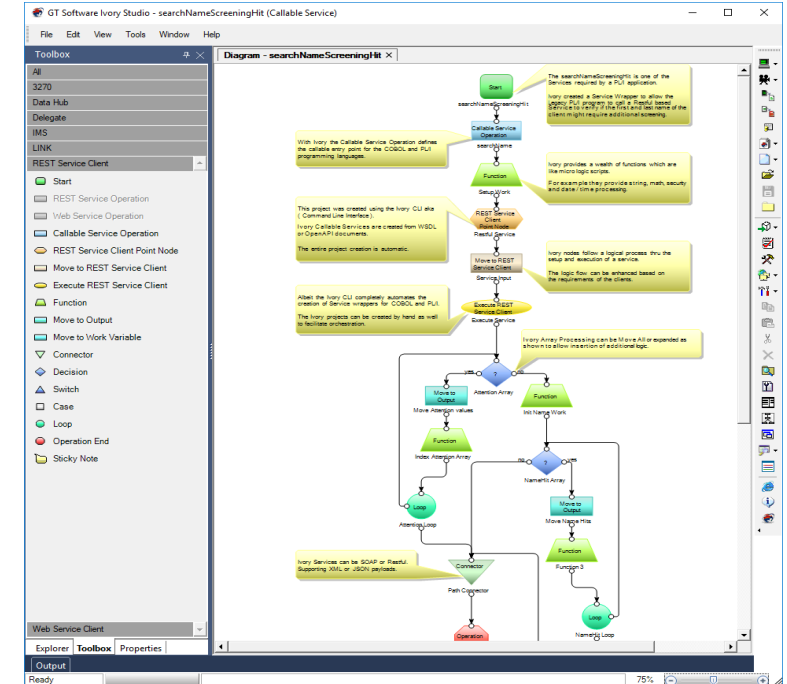
Ivory Studio



# 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



# Callable (Outbound) Services

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

PL/I  
CALL

```
PLI_IVORY_EXAMPLE x NameHits
1 .....
2 .....
3 ..... /* ***** */
4 ..... * GIISCLX module is called to set the context root. .... *
5 ..... * ***** */
6 ..... CONTEXT_ROOT = '/rest' || '00'X;
7 ..... CALL GIISCLX(IVORY_TOKEN, IVORY_CALL_CONTEXT,
8 ..... CONTEXT_ROOT);
9 .....
10 .....
11 ..... /* ***** */
12 ..... * GIISCLX module is called to Access the Web Service .... *
13 ..... * ***** */
14 ..... SOAP_RETURNCODE = 0;
15 ..... CALL GIISCLX(IVORY_TOKEN, IVORY_CALL_PROCESS,
16 ..... IVORYH, IVORY_LENGTH);
17 .....
18 ..... /* ***** */
19 ..... * On Return the return code provides status of call .... *
20 ..... * ***** */
21 ..... RC = PLIRETV();
22 ..... IF RC ^= 0 THEN
23 ..... ELSE
24 .....
25 ..... /* ***** */
26 ..... * On Good return the Web Service Data is returned.... *
27 ..... * ***** */
28 .....

```

REST/JSON SOAP/XML

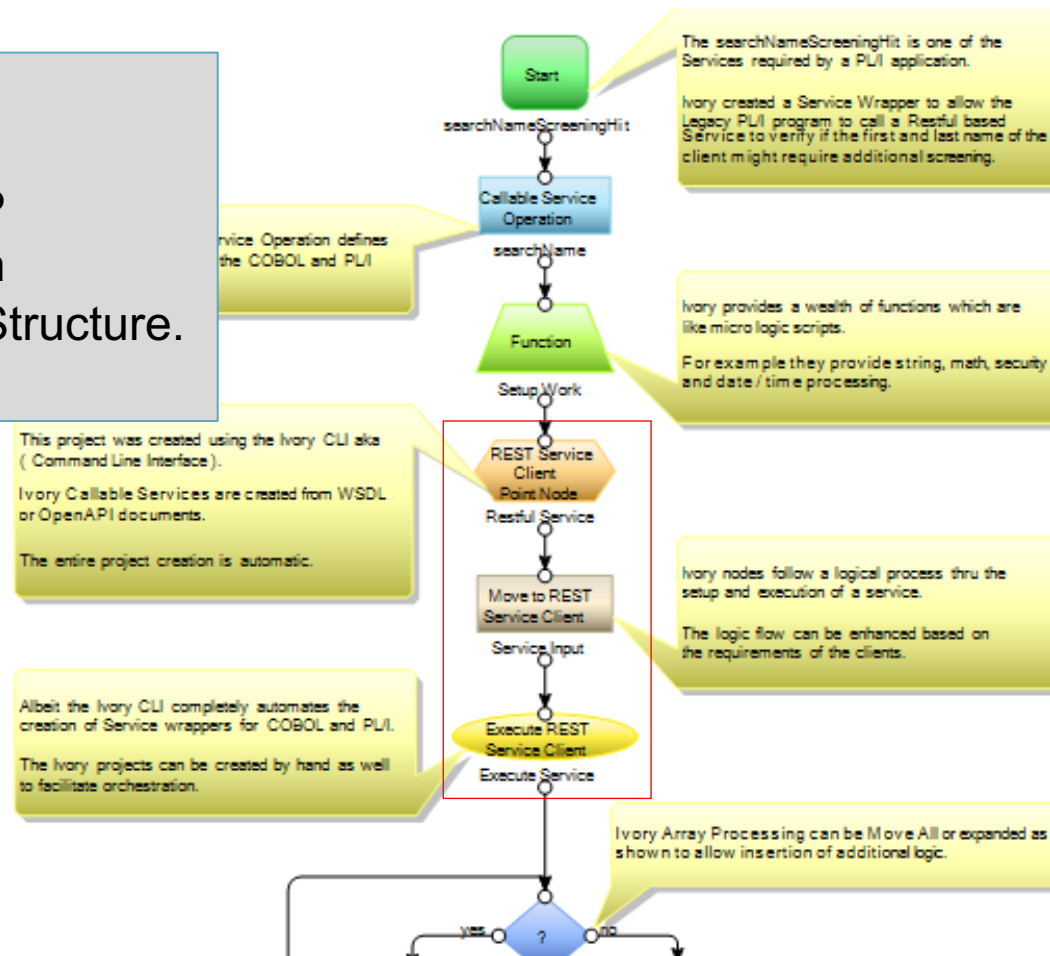
```
Open Files
PLI_IVORY_EXAMPLE NameHits x CL1.txt
1 ..... /* Generated by Ivory
2 ..... * Project searchNameScreeningHit
3 ..... * Date Thursday, December 6, 2018
4 ..... */
5 .....
6 ..... 05 SEARCHNAMESCREENINGHIT_3_ORESPONSEPAYLOAD ,
7 ..... 10 ATTENTION (20) ,
8 ..... 15 ATTENTIONCD CHAR(30),
9 ..... 15 EXPARAMLIST (10) CHAR(30),
10 ..... 15 LOGENTRY ,
11 ..... 20 LOGID CHAR(30),
12 ..... 20 LOGENTRYID CHAR(30),
13 ..... 10 NAMESCREENINGHIT (20) ,
14 ..... 15 CATEGORY CHAR(30),
15 ..... 15 DATEOFBIRTH CHAR(17),
16 ..... 15 DOMICILECD (10) CHAR(30),
17 ..... 15 NAME CHAR(30),
18 ..... 15 NAMEPOOL CHAR(30),
19 ..... 15 NAMEPOOLCD CHAR(30),
20 ..... 15 NAMERECORDREFERENCE CHAR(30),
21 ..... 15 NATIONALITYCD (10) CHAR(30),
22 ..... 15 PERCENTAGEOFRELEVANCE BINARY FIXED(15),
23 ..... 15 RISKCATEGORY CHAR(30),
24 ..... 15 RISKLEVEL BINARY FIXED(31),
25 ..... 15 SUBCATEGORY CHAR(30),
26 .....
27 ..... 05 BUSEX ,
28 ..... 10 EXCD CHAR(30),
29 ..... 10 VALIDATIONERROR (1) ,
30 ..... 15 VALIDATIONERRORCD CHAR(30),
31 ..... 15 PARAM (1) ,
32 ..... 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.



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.

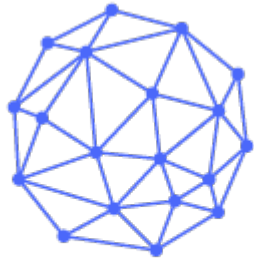
# Security

- RACF, ACF2, Top Secret
- WS-\*
- SAML
- SOAP Header
- HTTP/S
- JWT(JSON Web Token)
- Pass Tickets

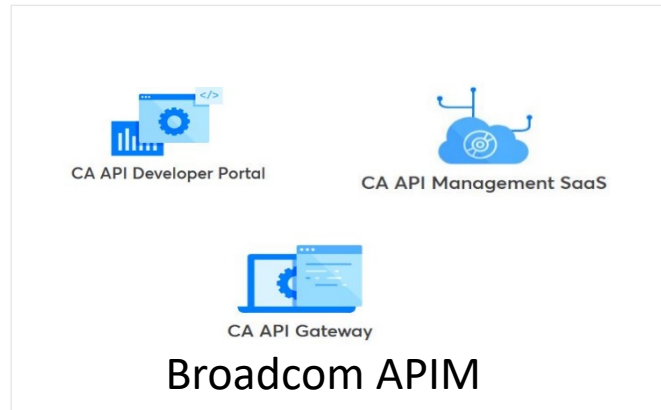
IMS Connect	
Host	@@WKHOST;
Port	@@WKPORT;
Datastore	@@WKDATASTORE;
Use Secure Connection (Java Server Only)	False
Authenticate	<b>Use Work Variables</b>
User ID Work Variable	<b>WKUSERID</b>
Password Work Variable	<b>WKPASSWORD</b>
User Exit	GIIIMSC2 (Default)
Commit Mode	CM1 (Send then Commit)
Synclevel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



# API Management

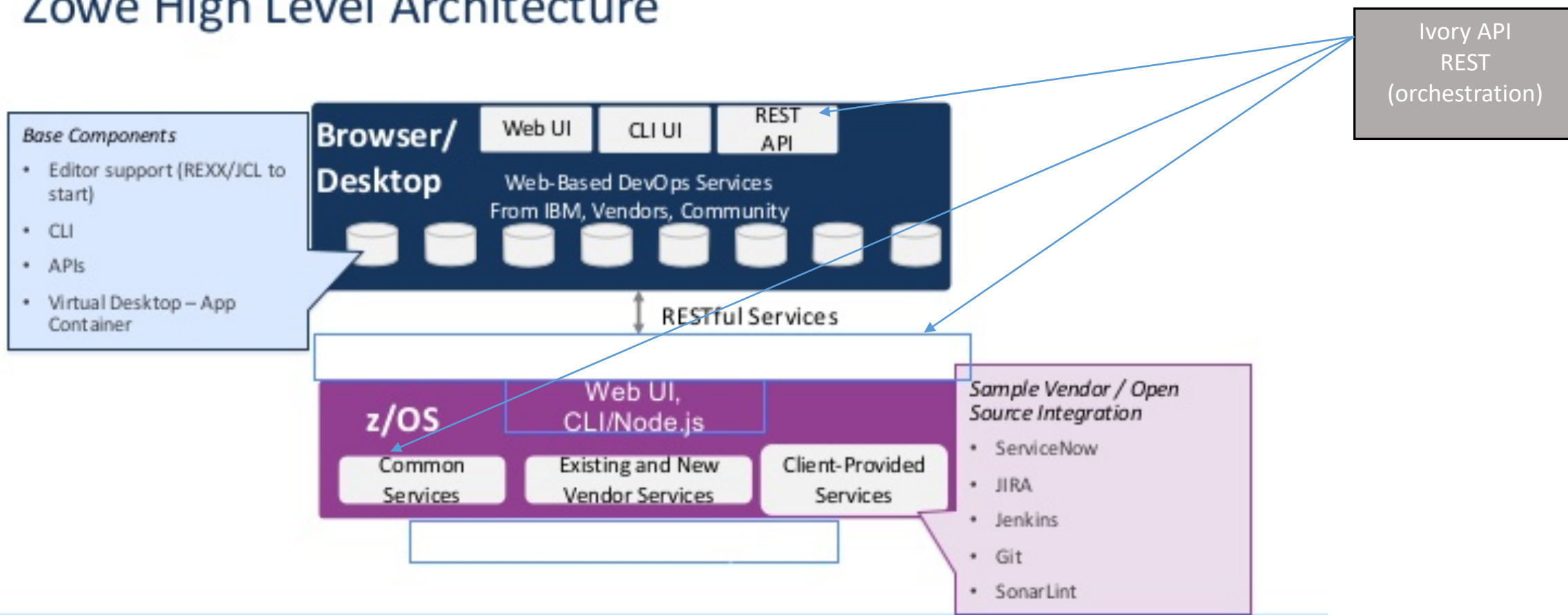


IBM **apiconnect**

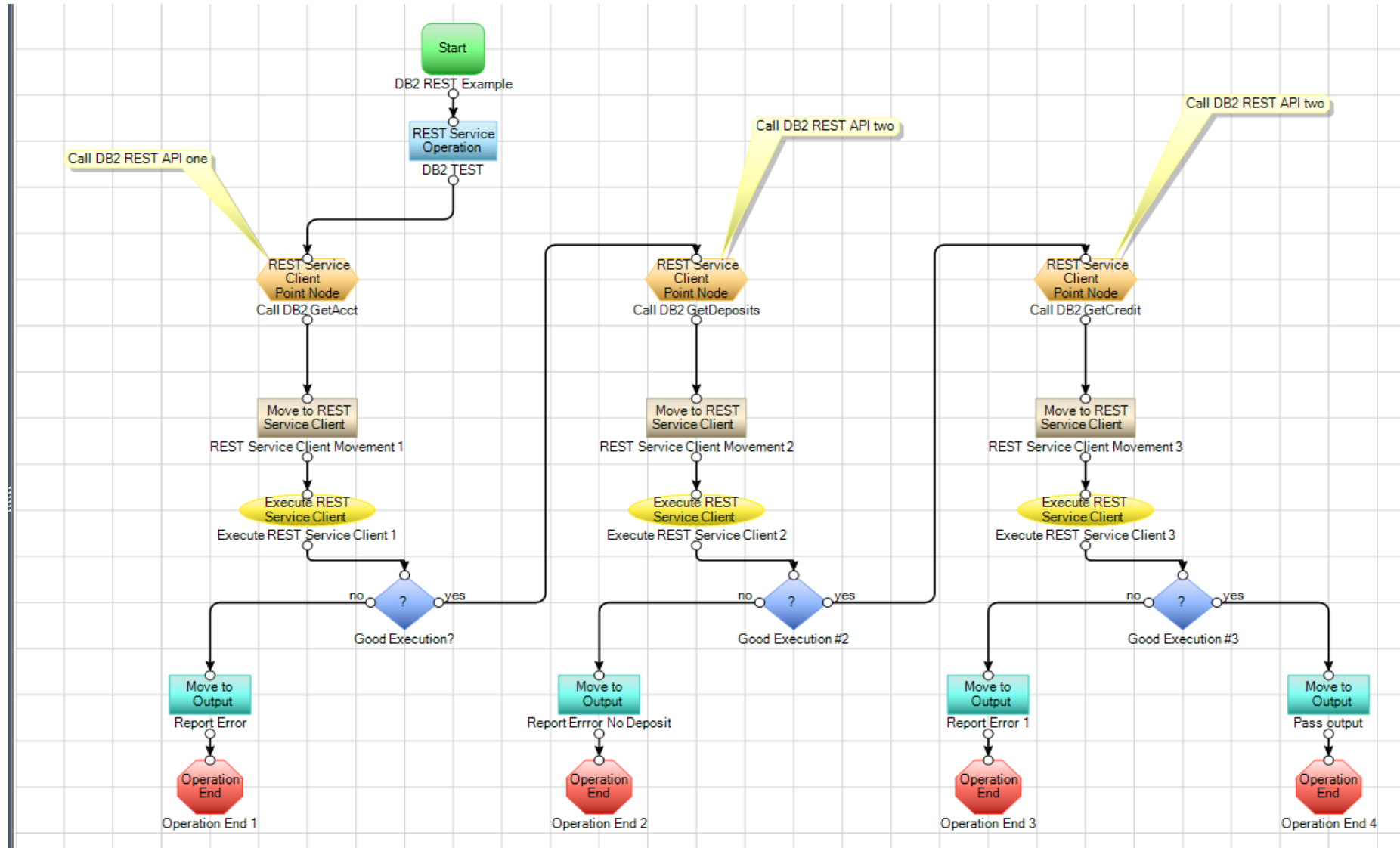




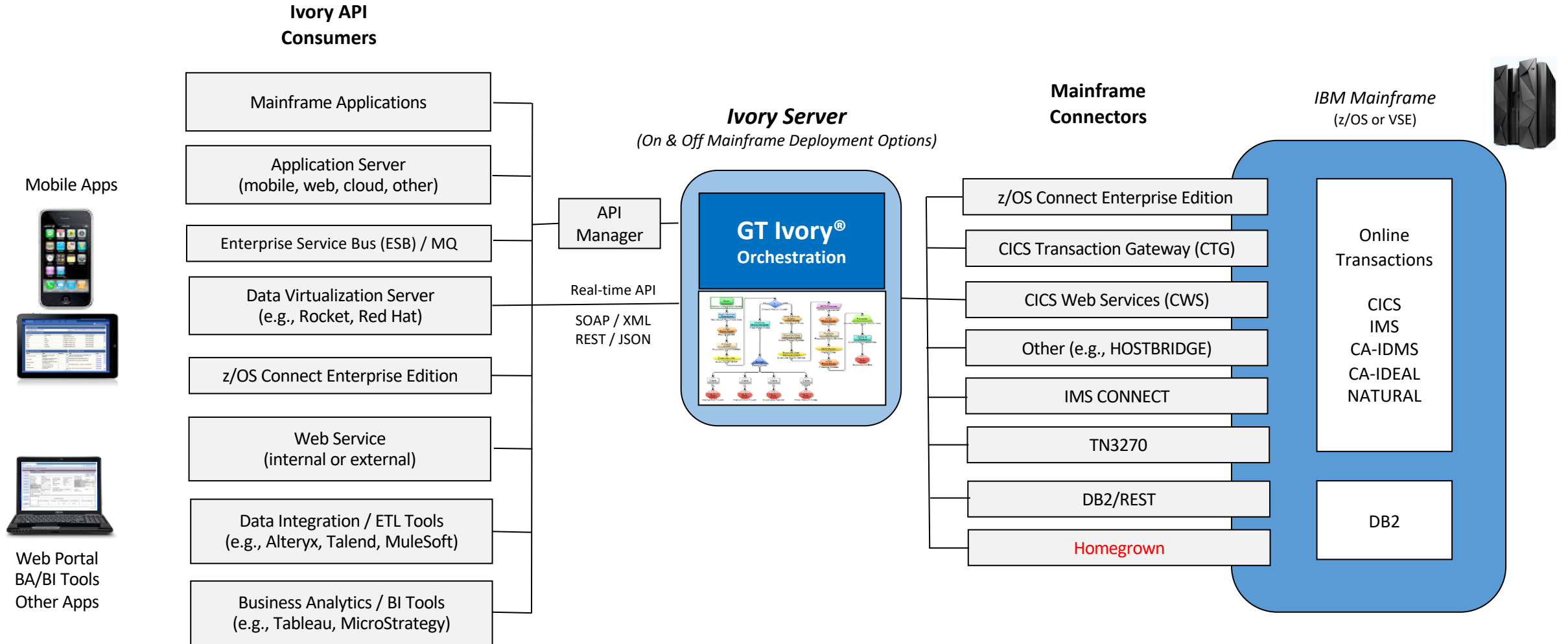
### Zowe High Level Architecture



# DB2 REST



# GT Ivory Orchestration Uses



# GT Software Inc

- Headquartered in Atlanta, Georgia
- More than 35 years of market leadership
- Focused on real-time mainframe integration for strategic business initiatives
- Broad experience across all mainframe and distributed environments
- Worldwide cross-industry customers and strategic partnerships

[www.GTSoftware.com](http://www.GTSoftware.com)





CICS



IMS



**H** **a** **p** **p** **y**  
**B** **i** **r** **t** **h** **d** **a** **y**

