My Adventures with TCP/IP Port Security and RACF on z/OS

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Long Live the Mainframe

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- All products, trademarks, and information mentioned are the property of the respective vendors.
- Mention of a product does not imply a recommendation.
- Always test new profiles on a non-production system.
- Only you can prevent IPLs!
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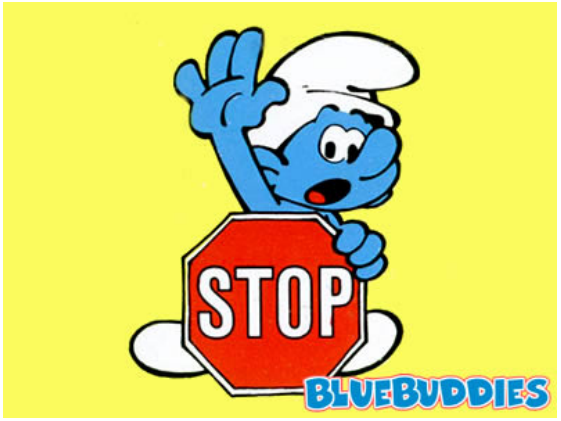


Agenda

- So what is a port anyway?
- Why Port Security with RACF
- EZB.PORTACCESS Profile Syntax
- SAFNAME Design
- Port Reservation Syntax
- Planning & Implementation Strategy
- SERVAUTH Class Activation
- Unreserved Ports – TCP & UDP
- Auditing Port Access
- Required PTFs
- Additional Resources
- Summary

What is a Port?

- An IP address is used to route the message to your computer. Once it arrives there, TCP uses the port number to know which program like ftp or email to hand it to

- From a SERVAUTH perspective…
  - Any mainframe program binding to
  - and/or listening on a TCP or UDP Port
  - SYS1.TCPIP.PROFILE

- For VTAM binds see VTAMAPPL
  - http://www.stuhenderson.com/appnsec1.pdf
  - Stu Henderson & Peter Hager

Why Port Security with RACF?

Native TCPIP

- Reservation by Jobname
- Can be spoofed
  - Unless JESJOBS profiles protecting jobnames
- Violations not well logged
- Unreserved ports not easily controlled
- Low Ports *possibly* protected with RESTRICTLOWPORTS
  - PORT JOBNAME reservation takes precedence
  - Did I mention JESJOBS?!

RACF

- Reservation by SAFNAME
- Cannot be spoofed
  - RACF profile **FINAL** answer
- Successes or Violations logged to SMF (type 80)
- Unreserved ports easily controlled
- Low Ports **ALWAYS** protected with RESTRICTLOWPORTS
  - EZB.PORTACCESS profiles take precedence

EZB.PORTACCESS Profile Syntax

EZB.PORTACCESS.*sysname*.*tcpname*.*safname*

Qualifier	Description	Recommendation
sysname	Local SMF ID	• Use * unless need for per system segregation
tcpname	TCPIP started task jobname	• Use * unless multiple stacks
safname	Esoteric name coded in port reservation	• Can be generic • 1 – 8 characters • First Position Not Numeric without PTF UI27609 z/OS V2R1 • First Position Never 0 (zero) • RFE 75935

Netaccess Statement SAF Names

APAR PI36695 PTF UI27609 for z/OS V2R1

http://www-01.ibm.com/support/docview.wss?crawler=1&uid=isg1PI36695

Applies to NETACCESS, PORT, PORTRANGE, VIPADYNAMIC & VIPARANGE

SAFNAME Design

- Use known protocol name as SAFNAME
  - HTTP, HTTPS, LDAP, LDAPS
  - … if appropriate
- Use generics in profile, as appropriate
  - HTTP*, LDAP*
  - … if appropriate
- Relationship
  - 1 or more port reservations to RACF profile
  - Use Wisely
- Enhance SERVAUTH SAFNAME Netaccess
  - Allow 0 in first position
- http://www.ibm.com/developerworks/rfe/execute?use_case=viewRfe&CR_ID=75935

Port Reservation Syntax – Single

- An example of reserving an individual port with SAF

```
PORT
;Port  Protocol  Jobname   SAF    SAFName
80     TCP       *         SAF    HTTP ;webserver
389    TCP       *         SAF    LDAP
```

  - With SAFNAME, jobname only needed to distinguish between two different port listeners

```
636 TCP LDAPDIR BIND 192.168.0.8 SAF LDAPD   ; LDAPDIR
636 TCP LDAPPKI BIND 192.168.0.9 SAF LDAPPKI ; LDAPPKI
```

Port Reservation Syntax – Range

- Reserve Port Ranges

```
PORTRANGE
;Portrange    Length    Protocol  Jobname   SAF     SAFName
1000          51        UDP       *         SAF     OMEGAMON
```

  - Reserves 1000 through 1050 for Omegamon

- Use Only One
  - Reserve Individual Port
  - Reserve Port Range

Single Port Overrides Range

- Reserve Same Port Collisions
  - Different SAFNAME
  - Only Single Port Reservation Used

- ICH408I
  - Call Security!
  - Update SYS1.TCPIP.PROFILE
  - OBEY Command or IPL

Example: TN3270 – RACF Profile

- **`EZB.PORTACCESS.*.*.TN3270`**
  - UACC always NONE
  - Permit TN3270 STC user ID with READ
  - AUDIT ALL(READ)
    - Audit all port access attempts; failures and successes
    - Exclude FTP data port from SAF

- WARNING
  - Use wisely as an implementation strategy
  - Anything can bind to or listen

Example: TN3270 – Reservation

```
PORT 23   TCP    TN3270
```

- Non-SAF uses jobname
- Without JESJOBS, submitting a jobname of TN3270 would allow any program to bind to port 23

```
PORT 23   TCP        *          SAF TN3270
```

- With SAF
  - Jobname unnecessary
  - Only use jobname where needed

Port 20 – Why Use SAF?

- All users of unencrypted FTP need access
- z/OS FTP Client may bind & listen on 20 ➔ active FTP connections
- Ideally unencrypted FTP phased out
  - Especially for PCI compliance

- Classic Jobname & RESTRICTLOWPORTS ➔ Less Secure

```
20  TCP     OMVS          NOAUTOLOG
```

  - JOBNAME on PORT statement ➔ RESTRICTLOWPORTS overridden
  - Always bind to port 20 if jobname matches OMVS
  - OMVS jobname associated with any job that uses z/OS UNIX services

  - JESJOBS SUBMIT.*nodename.jobname.userid*
    - Control whom can start a batch job
  - OPERCMDS MVS.START.STC.mbrname.jobname
    - Control whom can start a given job name on the START command
  - FACILITY class BPX.JOBNAME
    - Control which users can use _BPX_JOBNAME environment variable

Port 20 – Making the World A Safer Place

- SERVAUTH does not support RACF-DELEGATED…yet ☺
  - Request For Enhancement (RFE)
    - https://www.ibm.com/developerworks/rfe/execute?use_case=viewRfe&CR_ID=75166
  - Please VOTE! Your Vote Matters!

- Redbook Update Coming Soon
  - IBM z/OS V1R13 Communications Server TCP/IP Implementation: Volume 4 Security and Policy-Based Networking
  - http://www.redbooks.ibm.com/redbooks/pdfs/sg247999.pdf

RESTRICTLOWPORTS & UID(0)

Port Authority

- UID(0)
- BPX.SUPERUSER
- SAF

RESTRICTLOWPORTS

- Access Granted
- Access DENIED
- Access Granted
  - Even For Low Ports
    - < 1024

Implementation Strategies

Use WARNING

- Use WARNING mode
- Consume Type 80s

- Con:
  - Anything can bind any program to ports
- Pro:
  - Captures all port access over time

Parse NETSTAT commands

- Write a REXX parsing NETSTAT CONN & PORTLIST output

- Con:
  - Will not see all port usage
  - Snapshot in time
- Pro:
  - No port exposure assuming JESJOBS active

Planning – Gather Information

- Evaluate running STCs and their ports
  - NETSTAT CONN ➔ What is Listening
  - NETSTAT PORTLIST ➔ How it is Reserved
    - **REMINDER**: SERVAUTH EZB.NETSTAT.**
  - REXX EXEC compare reservations vs. usage
- Create Spreadsheet of Port Listeners & SAF*names*
- Partner with Network/VTAM Engineer
  - TCPIP profile changes
  - Weekend IPLs
- Update Software Parms
- Implement one system at a time
  - development, test and then production
- REMEMBER: Only **you** can prevent IPLs!

Planning – Implementation

- Build EZB.PORTACCESS profiles
  - No effect until SYS1.TCPIP.PROFILE Updated
  - TCP Ports – OMPROUTE READ 
- Update port reservations to call SAF
- Activate via IPL or TCPIP OBEY
  - Large number of STCs ➔ IPL
  - OBEY command is dynamic
    - Cycle Started Tasks
    - Excludes FTP

Planning – Intermittent Listeners

- NETSTAT CONN
  - Shows ports in use *now*
  - Not every port is in constant use by its listener
- Find *intermittent* port listeners
  - **`WARNING AUDIT(ALL(READ))`**
    - **`EZB.PORTACCESS.*.*.UNRSVTCP`**
  - Mine SMF records
  - Midnight Logons – Optional, Bring a Friend!
- Update TCPIP profile Port Definitions
  - **`RDEFINE SERVAUTH EZB.PORTACCESS.*.*.SAFname`**
  - **`PERMIT EZB.PORTACCESS.*.*.SAFName class(SERVAUTH) access(READ) ID(STC UserID)`**
- IPL
- Rinse, Recycle, Repeat ...

SERVAUTH Class Activation

- Activate SERVAUTH Class
  - IBM Class Descriptor Table (CDT)
  - **`SETR classact(SERVAUTH) audit(SERVAUTH) raclist(SERVAUTH) generic(SERVAUTH)`**
    - RC of 4 class but be mindful of SYS1.TCPIP.PROFILE
      - SERVAUTH profiles for DVIPA
      - **`EZD1313I -REQUIRED SAF SERVAUTH PROFILE NOT FOUND `*`RACF profile name`***

- **`RDEFINE RACGLIST SERVAUTH OWNER()`**
  - IPL will **not** refresh in-storage RACF profiles
  - Ensure Sysplex Consistency for RACF
  - By Product…Performance Improvement
  - **`SETR classact(RACGLIST) audit(RACGLIST)`**
  - **`SETR RACLIST(…) REFRESH`** Builds RACGLIST profiles

Required PTFs – Apply FIRST

- Spurious SAF (RACF) Violations from use of UDP Sockets
  - APAR PI18153 PTF UI8700 for z/OS 1.13
  - APAR PI18151 PTF UI9430 for z/OS 2.1
  - Use of UDP Ephemeral ports causes random security violations
  - http://www-01.ibm.com/support/docview.wss?uid=isg1PI18151

- ABEND S0C4 IN EZBXFUT6
  - APAR PI07541 PTF UI13629 for z/OS 1.13
  - APAR PI08351 PTF UI14006 for z/OS 2.1
  - PORT UNRSV TCP * SAF SAF*name*
  - Mapping via SRCIP to a DVIPA with sysplexports defined
  - Does not have permission to the SAF resource
  - http://www-01.ibm.com/support/docview.wss?uid=isg1PI08351

Unreserved Ports TCPIP PORT Syntax

- **`PORT UNRSV TCP * SAF`** **UNRSVTCP**
  - Prevent TCP port listeners ➔ **TCP default**
- **`PORT UNRSV UDP * SAF`** **UNRSVUDP**
  - Prevent UDP port listeners & **binds** ➔ **UDP default**

- Stop Unauthorized Port Use
  - Goal: Emtpy ACLs
  - **`AUDIT(ALL(READ)) UACC(NONE)`**

- Consideration: Dynamic Ephemeral UDP ports
  - See Required PTFs

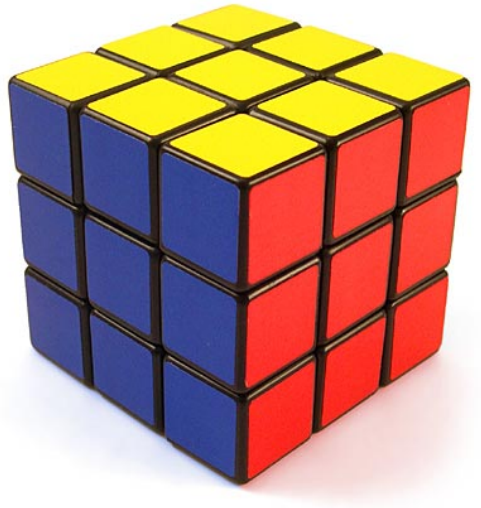
Unreserved Ports RACF Profile Syntax

- Build SERVAUTH Profiles
  - **EZB.PORTACCESS.*.*.UNRSVTCP OWNER(…) UACC(NONE) WARNING AUDIT(ALL(READ))**
    - Permit all STCs in the Beginning
  - **EZB.PORTACCESS.*.*.UNRSVUDP OWNER(…) UACC(NONE) WARNING AUDIT(ALL(READ))**

- Read SMF, Read SMF, Read SMF
  - Logstring Your New BFF
- Reserve Port in SYS1.TCPIP.PROFILE
- Adjust Software Parms, If Necessary
- Obey / IPL
- *Cautiously* Restrict Access

UDP Unreserved Ports – SOLVED

- Applications Need Dynamic Ephemeral UDP Ports
- STC wants to send E-Mail
- STC opens UDP Ephemeral port on demand
  - SMTP
- Triggers SAF call unless…
  - PTF UI8700 for z/OS 1.13
  - PTF UI9430 for z/OS 2.1



TCP Unreserved Ports – Omegamon

- Binds ports to loopback (127.0.0.1)
  - New PTF under development
  - New Parm KDE_LOOPBACK_POOL
  - Needs 1,000 ports, but wait there's more!

- Multiples of 4096 + a base number
- 1918 + (n * 4096) = Agent Port Number
  - Where N = The startup agent number.
- 1918 – Base Port, always assigned to hub or remote TEMS (Omegcms)
- 1920 – IBM Tivoli Monitoring Service Console (assigned to first agent to start up, OMEG*)
- 6014 – MVS Agent
- 10110 – CICS Agent
- 14206 – Network Agent

TCP Unreserved Ports – Omegamon

```
•    6014 TCP * SAF OMEGAMON ; OMEGAMON
•   10110 TCP * SAF OMEGAMON ; OMEGAMON
•   14206 TCP * SAF OMEGAMON ; OMEGAMON
•   18302 TCP * SAF OMEGAMON ; OMEGAMON
•   22398 TCP * SAF OMEGAMON ; OMEGAMON
•   26494 TCP * SAF OMEGAMON ; OMEGAMON
•   30590 TCP * SAF OMEGAMON ; OMEGAMON
•   34686 TCP * SAF OMEGAMON ; OMEGAMON
•   38782 TCP * SAF OMEGAMON ; OMEGAMON
•   42878 TCP * SAF OMEGAMON ; OMEGAMON
•   46974 TCP * SAF OMEGAMON ; OMEGAMON
•   51070 TCP * SAF OMEGAMON ; OMEGAMON
•   55166 TCP * SAF OMEGAMON ; OMEGAMON
•   59262 TCP * SAF OMEGAMON ; OMEGAMON
•   63358 TCP * SAF OMEGAMON ; OMEGAMON
•   PORTRANGE  1900  51 TCP *       SAF OMEGAMON
•   PORTRANGE  1900  51 UDP *       SAF OMEGAMON
```

TCP Unreserved Ports – z/OS FTP Client PTF

- If Passive FTP fails, z/OS FTP Client attempts Active connection by default
  - Active connection Binds & Listens on…
  - Random TCP port! ICH408I!

```
ICH408I USER() GROUP() NAME()
EZB.PORTACCESS.SYSTEM.TCPIP.UNRSVTCP CL(SERVAUTH)
INSUFFICIENT ACCESS AUTHORITY
FROM EZB.PORTACCESS.*.*.UNRSVTCP (G)
ACCESS INTENT(READ    )  ACCESS ALLOWED(NONE    )
```

- APAR PI29994 PTF UI26945 for z/OS 1.13
  - http://www-01.ibm.com/support/docview.wss?uid=isg1PI29994
- APAR PI36683 PTF UI27396 for z/OS 2.1
  - http://www-01.ibm.com/support/docview.wss?uid=isg1PI36683

- New FTP.DATA Parm:
  - **PassiveOnly TRUE**
- Add Existing Parm too:
  - **FWFRIENDLY TRUE**

TCP Unreserved Ports – WAS Port Scans

- PM96838
  - Available for WAS v7.0, v8.0 and v8.5
  - Optionally disable port activity checking when a server is created
  - **com.ibm.ws.management.suppressPortScan=true**
    - JVM argument is added to suppress port check
  - Note that when this is in effect, ports in use by other applications will not be detected and could lead to port conflicts.
- PI40568
  - Still under construction
  - Tentative GA of September 2015

TCP Client Bind Security – WHENBIND

- Purpose: Call SAF for all TCP client binds
  - Client needs to request an ephemeral port by binding to port 0
- Why?
  - Do you really trust a TCP client to be in control of what port it can use?
- **`PORT UNRSV TCP * SAF UNRSVTCP WHENBIND`**
  - WARNING **RECOMMENDED**
  - **`RDEFINE SERVAUTH EZB.PORTACCESS.`*`SYSNAME`*`.*.UNRSVTCP WARNING UACC(NONE) AUDIT(ALL(READ))`**
    - i.e. One system at a time
  - Read SMF…Parse LOGSTRING for Port
- Plan of Attack: One Software product at a time

TCP WHENBIND – Challenges

- SAS
  - E-mail engine uses ports
  - TCP_EPH_MAP_ENABLED=**0** ➔ zero
  - TKMVSENV DD
    - hlq.TKMVSENV(TKMVSENV)

- VPS
  - Remove parm ➔ TCPHOSTS

- FTP with TLS
  - Must reserve data port

Implementation Strategy

- Apply required PTFs
- Activate SERVAUTH class (RACGLIST too!)
- Known TCP & UDP Ports – Phase 1
  - Profiles in WARNING as appropriate
- “Midnight Madness” Port Listeners – Phase 2
- Secure Unreserved UDP ports – Phase 3
- Secure Unreserved TCP ports – Phase 4
  - Goal: Empty ACLs for Unreserved ports
- Secure Unreserved TCP client binds – Phase 5
  - Because we shouldn’t trust TCP software to be in control of ports

Auditing Port Access

```
22Nov14 12:14:31.11 OMEGC ZOS1 RACF ACCESS success for OMEGC: (READ,READ) on SERVAUTH
EZB.PORTACCESS.sysname.TCPIP.OMEGAMON

Jobname + id: OMEGCMS  STC12345

Class       : SERVAUTH Resource: EZB.PORTACCESS.ZOS1.TCPIP.OMEGAMON

Access used : READ      Profile: EZB.PORTACCESS.*.*.OMEGAMON

Log string  : TCPIP PORT ACCESS CHECK PORT 01000
```

- RACF Final Port Authority
- All Port Usage Logged Type 80
- LOGSTRING contains port number
  - TCP / UDP Not Specified
  - RFE
    - https://www.ibm.com/developerworks/rfe/execute?use_case=viewRfe&CR_ID=68402

To Infinity And Beyond – What's Next?

- Would it be even **better** if SERVAUTH would validate the intended use of the port?
  - INSERT AUDIENCE AGREEMENT HERE ☺

- Today
  - If RACF grants access
  - then the Port is Yours

- Tomorrow
  - Validate Port Being Used As Intended
  - https://www.ibm.com/developerworks/rfe/execute?use_case=viewRfe&CR_ID=75168

Additional Resources

- Techdocs Library – Using SERVAUTH to Protect TCP Port Usage
  - http://www-03.ibm.com/support/techdocs/atsmastr.nsf/WebIndex/WP100673
- Techdocs – Undesired PortAccess Violations
  - http://www-01.ibm.com/support/docview.wss?rs=852&uid=swg21237916
- Port Access Control Chapter
  - z/OS Communications Server: IP Configuration Guide
  - http://www-01.ibm.com/support/knowledgecenter/SSLTBW_2.1.0/com.ibm.zos.v2r1.halz002/security_tcpip_resrcs_ports.htm
- SERVAUTH Class profiles used by TCP/IP
  - EZB.PORTACCESS syntax
  - http://www-01.ibm.com/support/knowledgecenter/SSLTBW_2.1.0/com.ibm.zos.v2r1.halz002/security_tcpip_resrcs_saf.htm

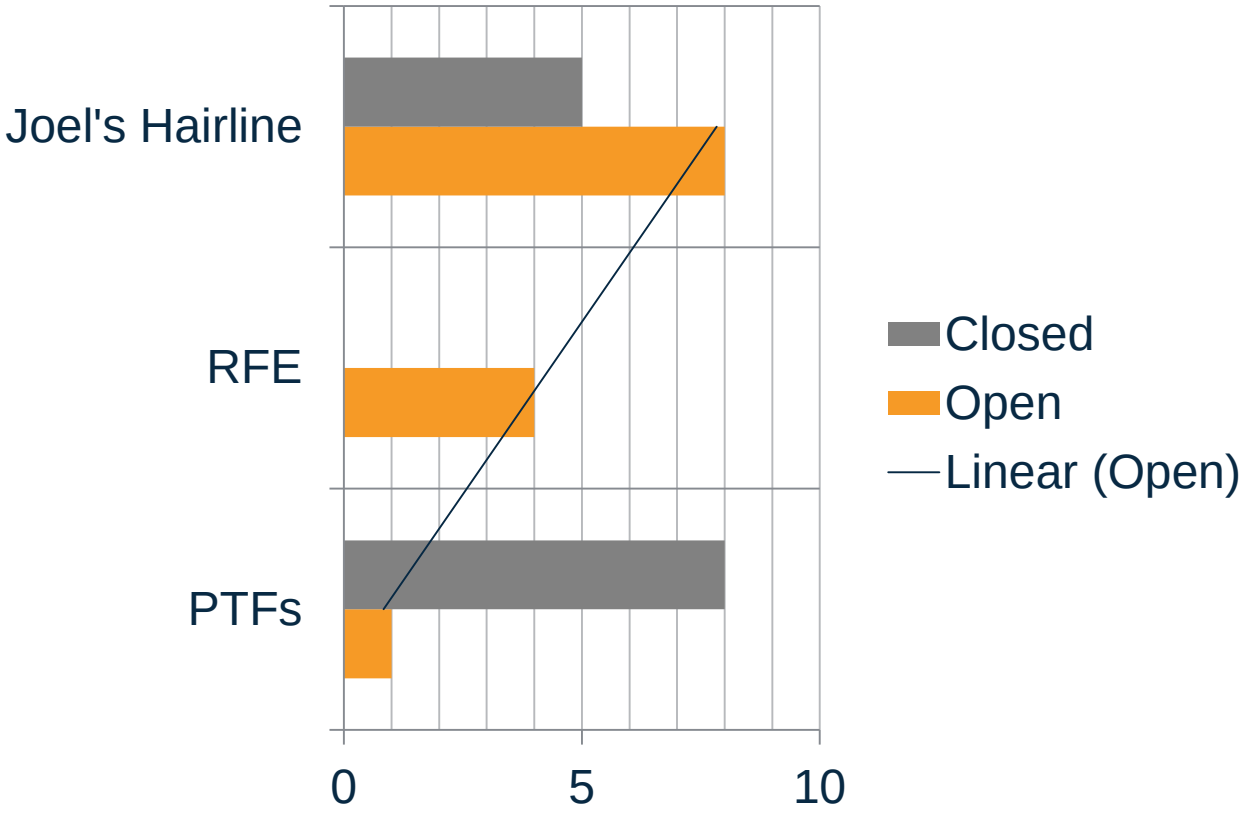
Even more Useful Resources

- IBM z/OS V1R13 Communications Server TCP/IP Implementation: Volume 4 Security and Policy-Based Networking
  - http://www.redbooks.ibm.com/redbooks/pdfs/sg247999.pdf

- RESTRICTLOWPORTS parameter
  - https://www-01.ibm.com/support/knowledgecenter/SSLTBW_2.1.0/com.ibm.zos.v2r1.halz002/security_tcpip_resrcs_unresvd_ports_low.htm

- TCPIP PROFILE Port Assignments
  - http://www-01.ibm.com/support/knowledgecenter/SSLTBW_2.1.0/com.ibm.zos.v2r1.halz001/profiletcpipportassignments.htm

Some Statistics



Summary

- Try not. Do…or do not. There is no try!
  - Master Yoda
- How do you tackle any project? One small step at a time…
- Protecting Ports is of Paramount Im**PORT**ance
  - Securing with RACF
    - prevents spoofing
    - logs port usage (success & failures) to SMF
- Requires Proper Planning
- Close partnership with Network Engineer
- Coordinate TCPIP Profile & RACF Changes
- IPL during maintenance windows
- Fix ICH408Is and:
  - Recycle STC or possibly IPL
- Port Security Engaged!

My Thanks To…

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- Hayim Sokolsky
- Todd Valler
- William Vender
- Bruce Wells

- IBM Omegamon Level 2 & Level 3
- IBM z/OS Comm Server/TCPIP Level 2 & Level 3
- IBM zSecure Level 2 & Level 3
- IBM WAS Level 2 & Level 3

- And the Adventure Continues to Boldly Go Where No Port Has Gone Before …

- **DISCLAIMER:** No ports were harmed in the making of this presentation…perhaps shaken & stirred but they were not permanently damaged. ☺

Questions?

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