



Network Troubleshooting

The Inter-hospital
EchoPACS Case

By Tak Fan

About Me

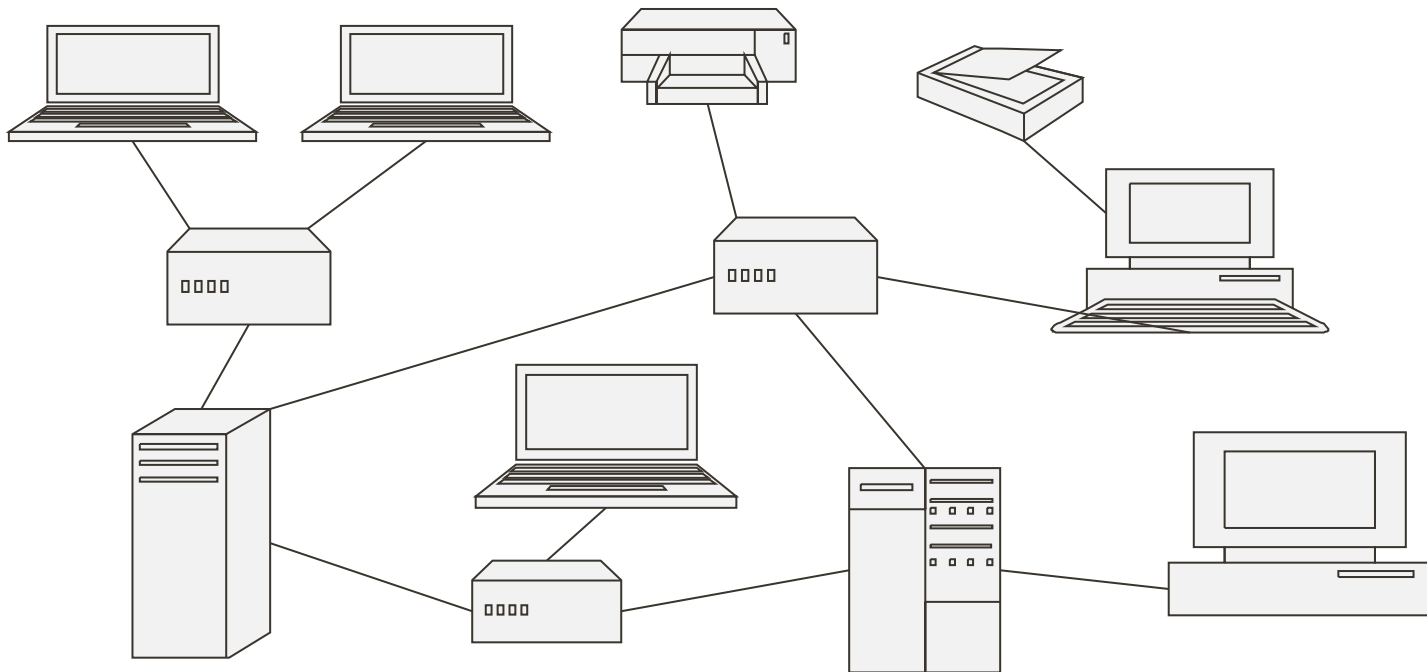
Tak Fan

- UoT Graduate, Centennial Graduate
- Approaching 5 years professional experience
- UHN/SHS Biomedical Engineering dept.
- Work with ultrasound and x-ray modalities
- So I'm here to share my personal and professional experience

Network Basics

What is a Network?

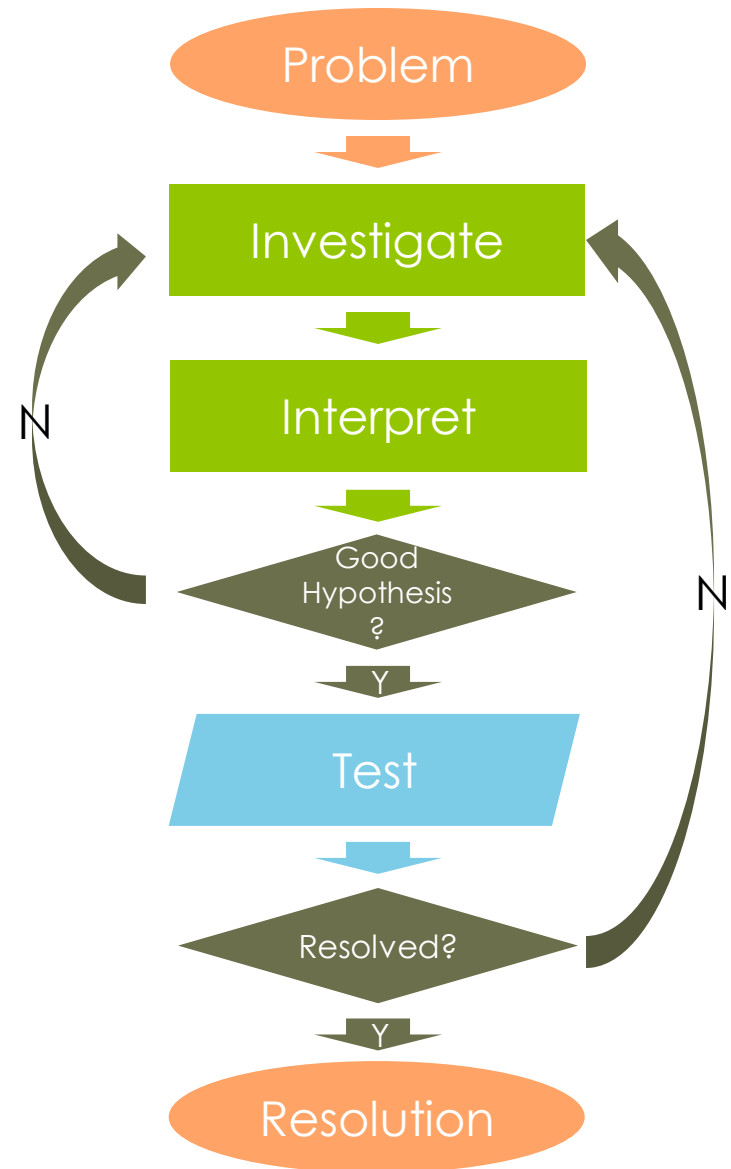
- A system of interconnected things [devices]



Troubleshooting

Step by Step

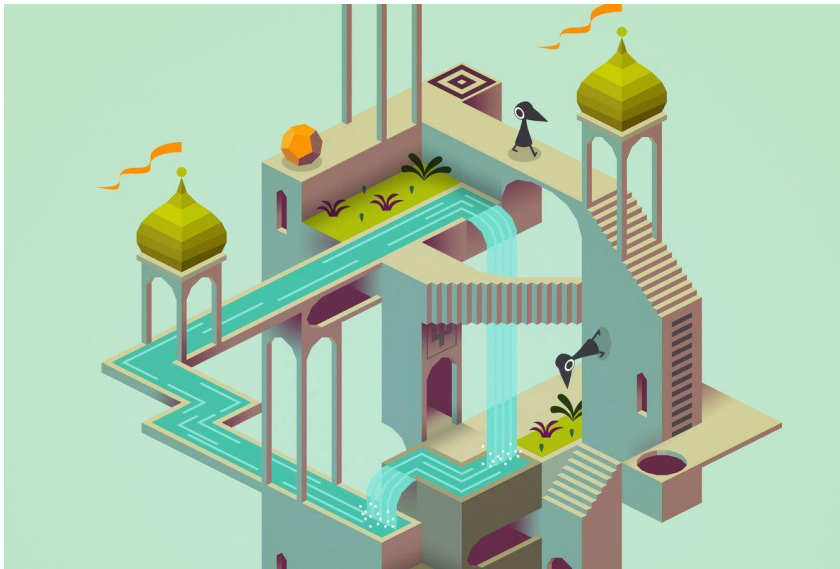
- Investigate
- Interpret
- Hypothesize
- Test
- (Review)



Troubleshooting

Methodology

- No perfect way to troubleshoot
- Decide case-by-case



Screenshot of Monument Valley, © Ustwo Games

Troubleshooting

Some methods include

Experience

- Essentially knowing the answer

Replicating/Functional Test

- See where the problem goes

Theory-crafting

- If x then y because z

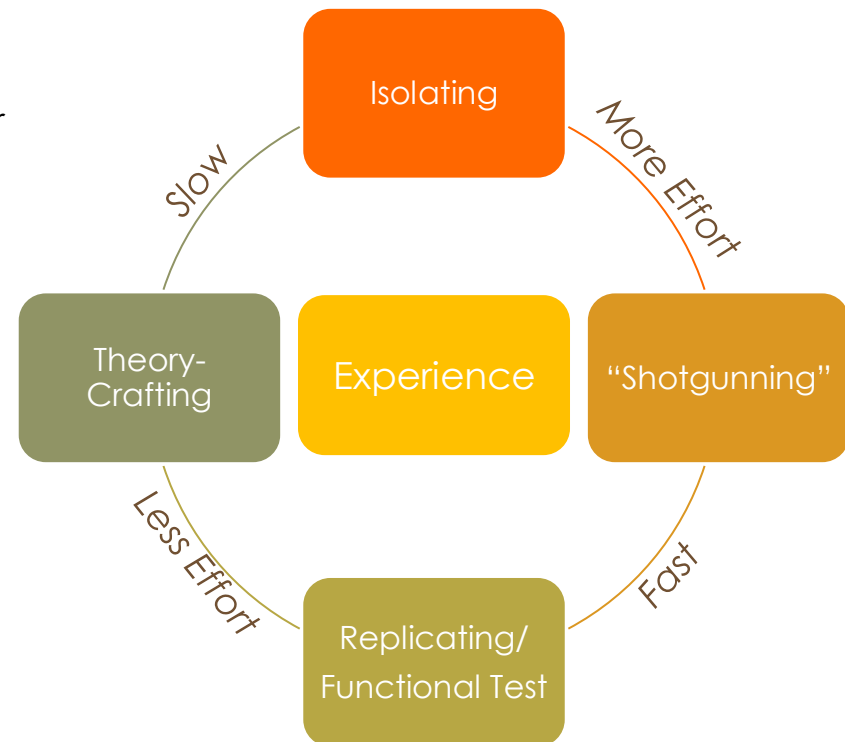
Isolating

- Divide and conquer

“Shotgunning”

- Quick semi-random checks

- Be creative! (but also cautious)



Methodology

Replication

- Very often you start with Replication
- Make sure you have a problem
- It's fast and usually very low effort
- It gives you a platform to stand on and base your ideas around
- You might see something the users did not

Methodology

Isolation

- Divide and conquer
- In hospitals, networking systems are divided among different departments

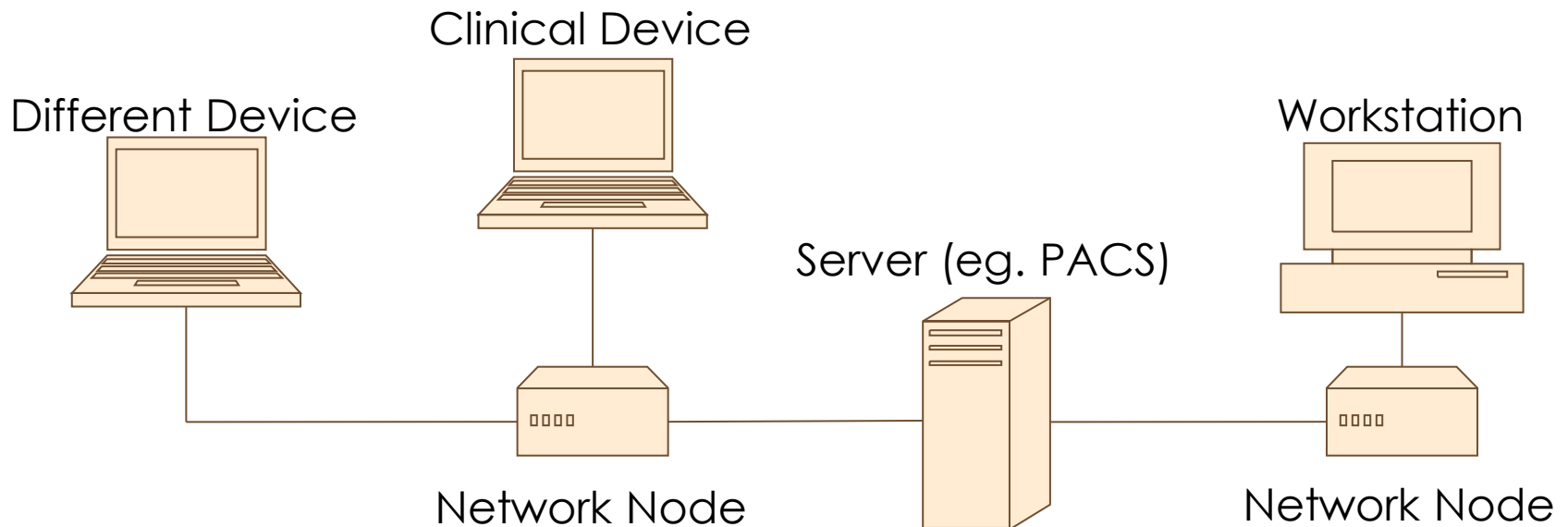


- Thus very likely to try to **Isolate**

Methodology

Isolating – Client or Network?

- Simplify the network
- Is the issue local to the device?
- Is there another similar device and does it work?
- Do you have a network connection?



Isolating

Client Verification – Connected?

- Hardware Based
 - Network cable attached / Wi-fi working
 - Network jack is in a good condition
 - Network Tester (+cable verification)
- Software Based
 - Ipconfig for network address
 - Ping = on the network

```
C:\WINDOWS\system32\cmd.exe
C:\Users\tak>ipconfig

Windows IP Configuration

Wireless LAN adapter Wi-Fi:

    Connection-specific DNS Suffix  . : uhn.ca
    Link-local IPv6 Address . . . . . : fe80::4113:1082:97f5:4fd5%5
    IPv4 Address. . . . . : 10.141.29.15
    Subnet Mask . . . . . : 255.255.0.0
    Default Gateway . . . . . : 10.141.0.1

Ethernet adapter Bluetooth Network Connection 2:

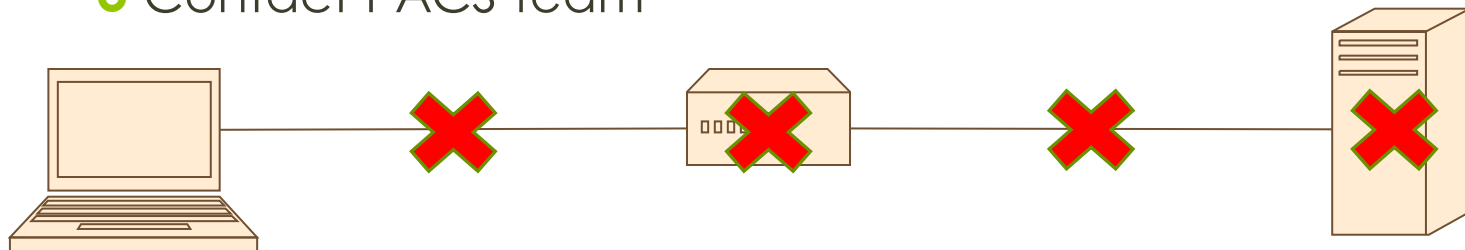
    Media State . . . . . : Media disconnected
    Connection-specific DNS Suffix  . :

C:\Users\tak>ipconfig
```



Isolating Network Verification

- Is it an intermittent issue?
 - Could be static IP conflict (Ping your IP)
 - Try DHCP if possible
- Is the network down or congested?
 - Connect a laptop
 - Contact IT
- Is the server down or rejecting?
 - Dicom ping
 - Downtime/backup Server works?
 - Contact PACS team



Methodology

Theory-crafting and “Shotgunning”

- A bit of **theory** is necessary
 - Some people like to sit and think on problems
 - Saves the trouble of physical labour
 - Ask a coworker and talk it over with a coffee
- Or Vice-versa you can “**shotgun**”
 - Often quick for simple problems
 - Luck is a skill too (if you don't have any other ideas)

Theory-Crafting OSI Model/Theory

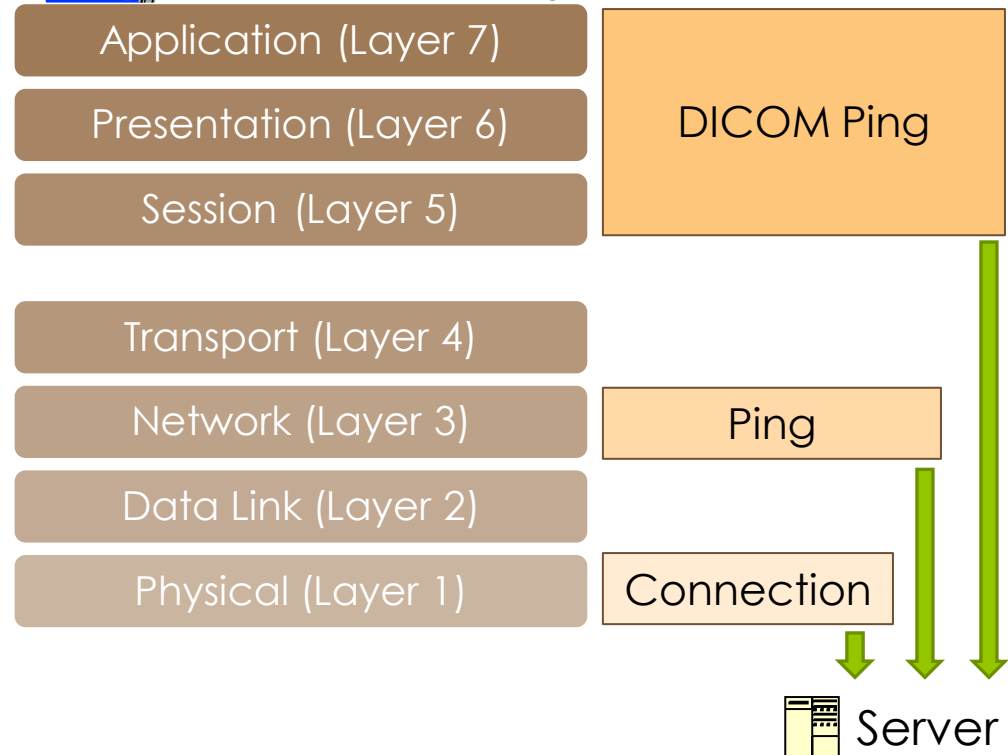
- Clients follow OSI Model



Connection = IP/Networked

Ping = Connected with destination

DICOM Ping = Authorized for services



Methodology

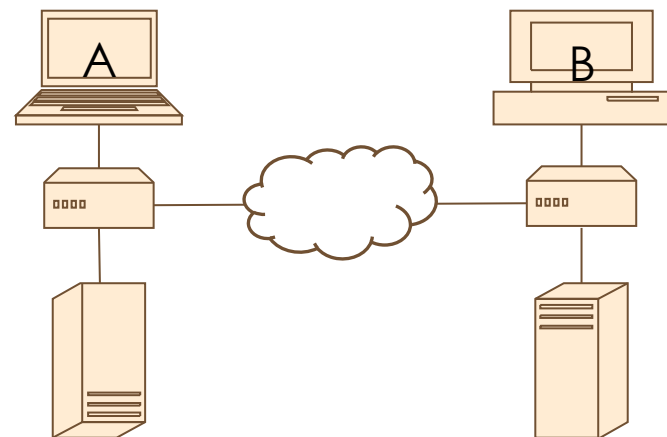
"Shotgunning"

- Restart the system, who knows when it comes to software!
- Sometimes you just look at the network cable in the back and it's broken
- I get these hunches with some users...

Case Study

The Inter-hospital EchoPACS Case

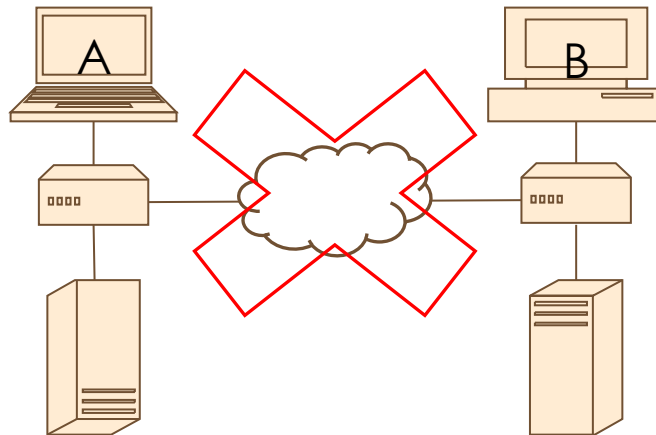
- EchoPACS is a GE software application that manages Ultrasound Echocardiogram studies
- Stores on ImageVault
- These are loaded onto hospital computers
- Studies are often sent between hospitals
 - (eg. Surgery referrals)



Case Study

The Problem

- EchoPACS workstation could not send an echocardiogram to another hospital (PACS)



Problem

Investigate

Interpret

Good Hypothesis ?

Y

Test

Resolved?

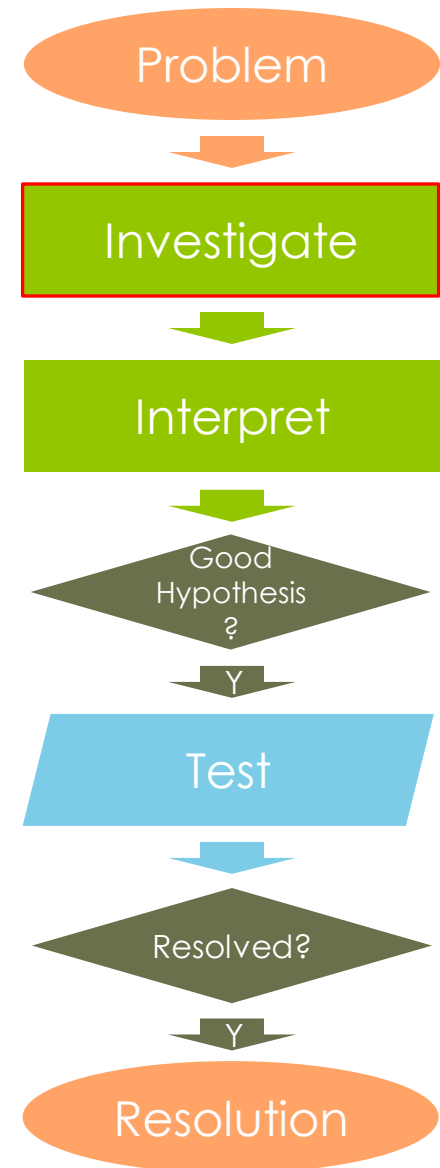
Y

Resolution

Case Study

Investigate

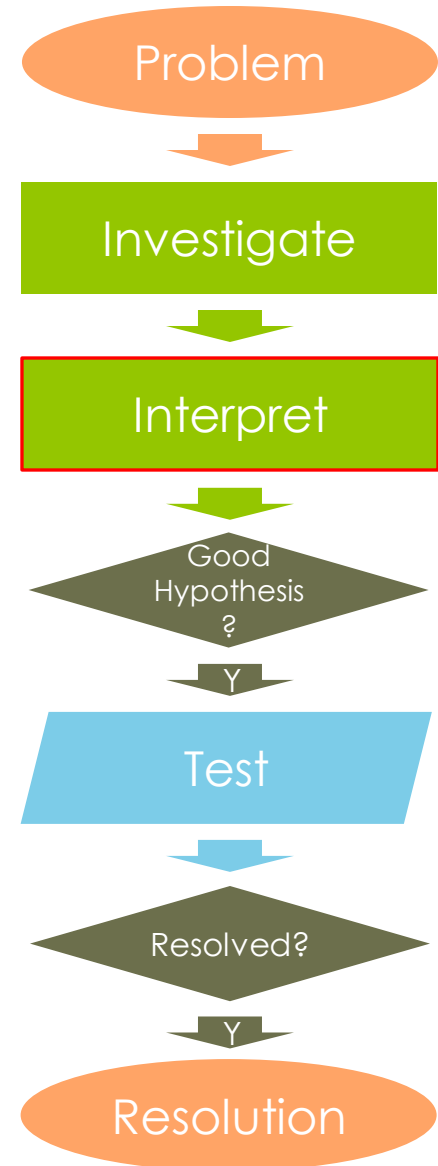
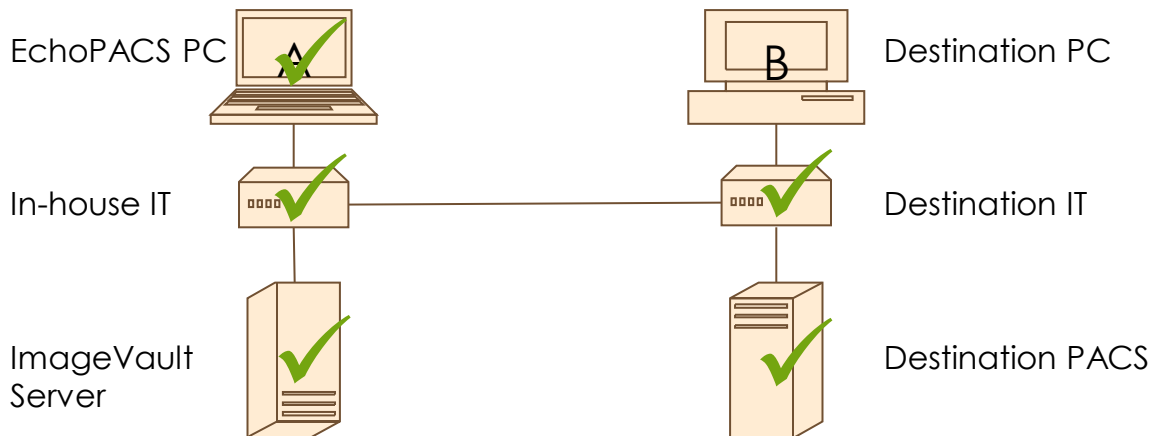
- Replicated and confirmed issue
- Manager confirmed destination PACS says they don't have issues
- Studies were sent just a week ago
- Can the problem be isolated?
 - Only one PC set up to send
 - Communicates with ImageVault
 - No problems internal to hospital



Case Study

Investigate

- In theory, everything should be working



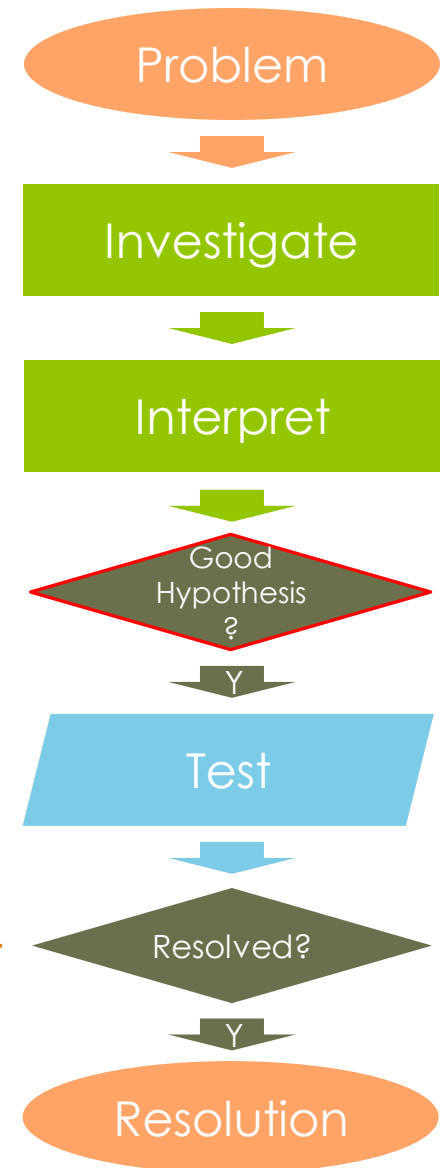
Case Study

Some Hypotheses

“The destination PACS is not working. There's a disconnect or rejection.”

“The hospital IT must be not routed or blocking outgoing traffic.”

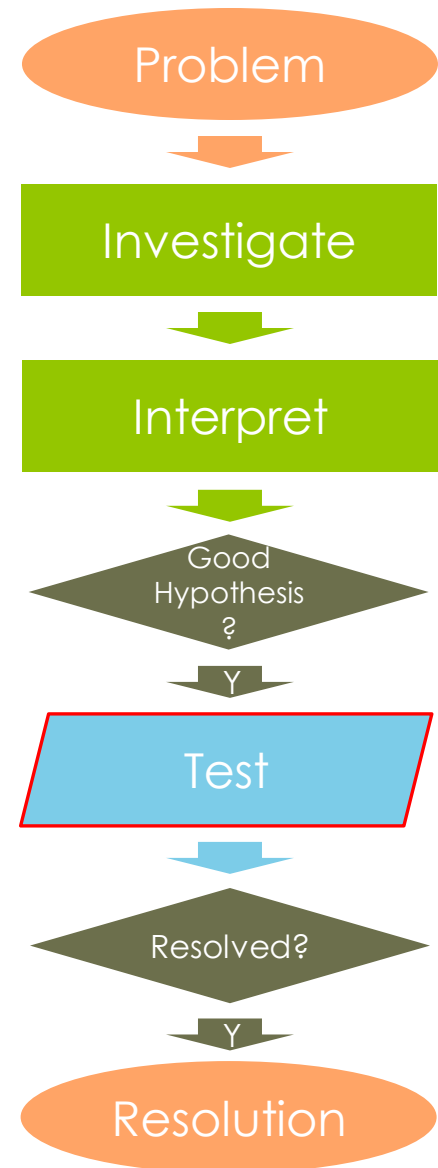
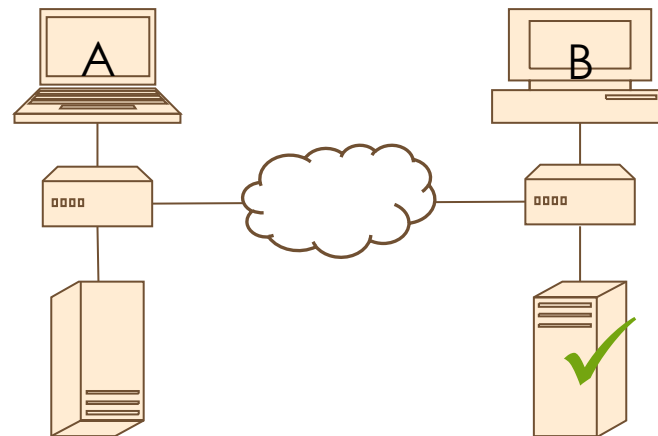
“The system doesn't work. Must be a software issue.”



Test

Is it the Destination PACS?

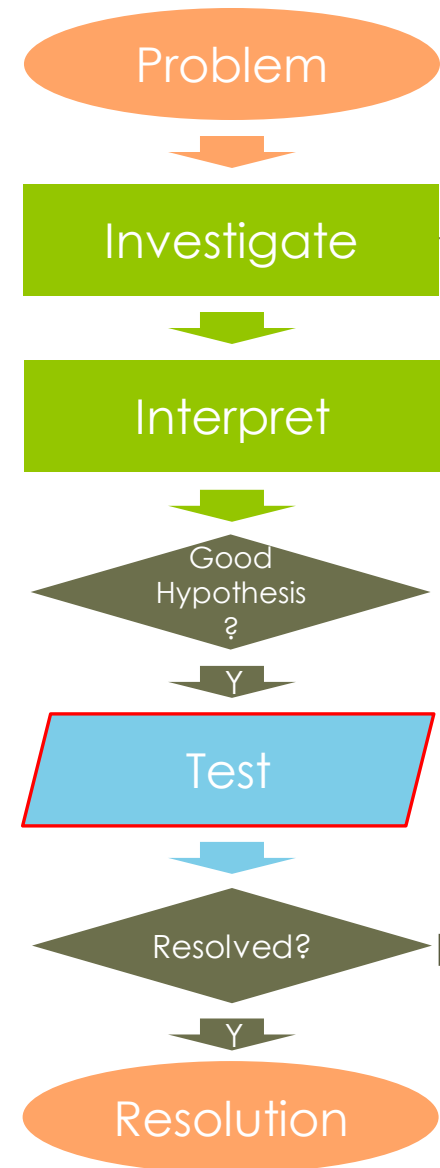
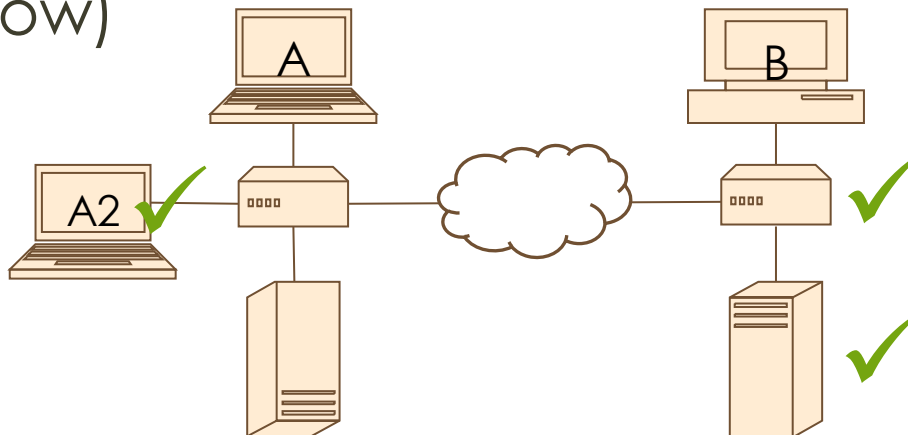
- Ping; OK
- DICOM PING; OK



Test

Is it the Destination PACS?

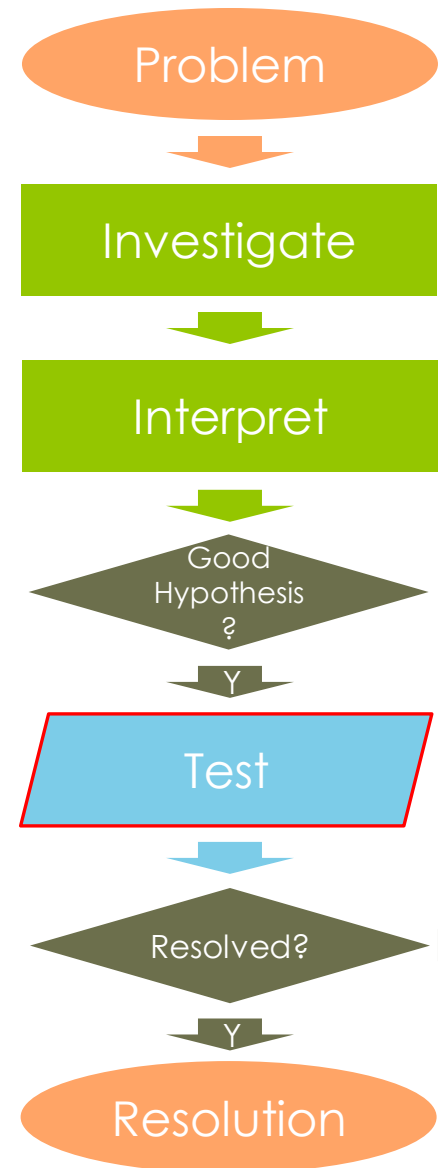
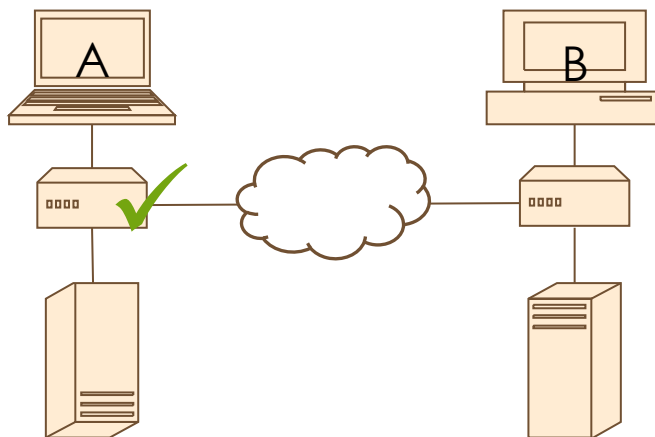
- In fact they were able to help set up another EchoPAC workstation so we could test it further
- And that workstation could send images (at least we're OK for now)



Test

Is it the In-house IT?

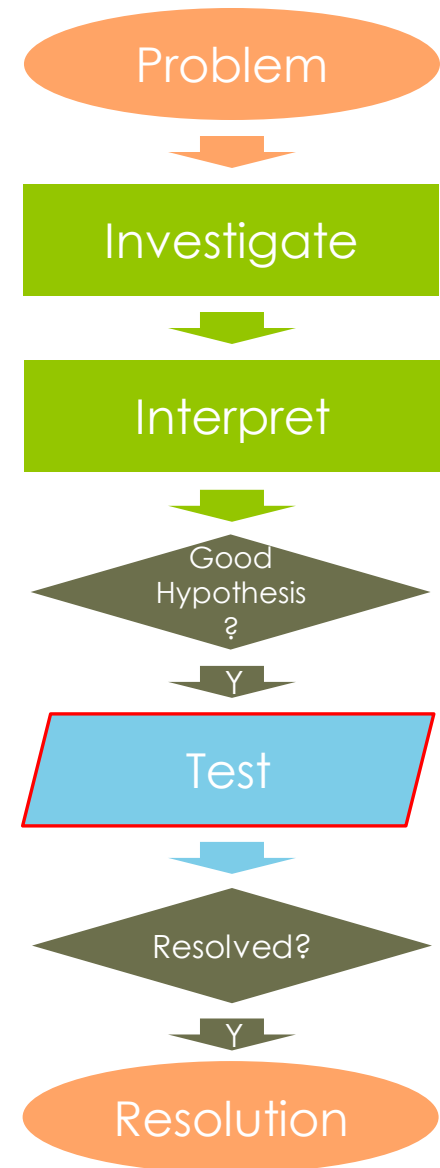
- In-house IT had been making a lot of network changes recently
- “No, it’s your end”, “OK.. thx ☹️”



Test

Is it the system's fault?

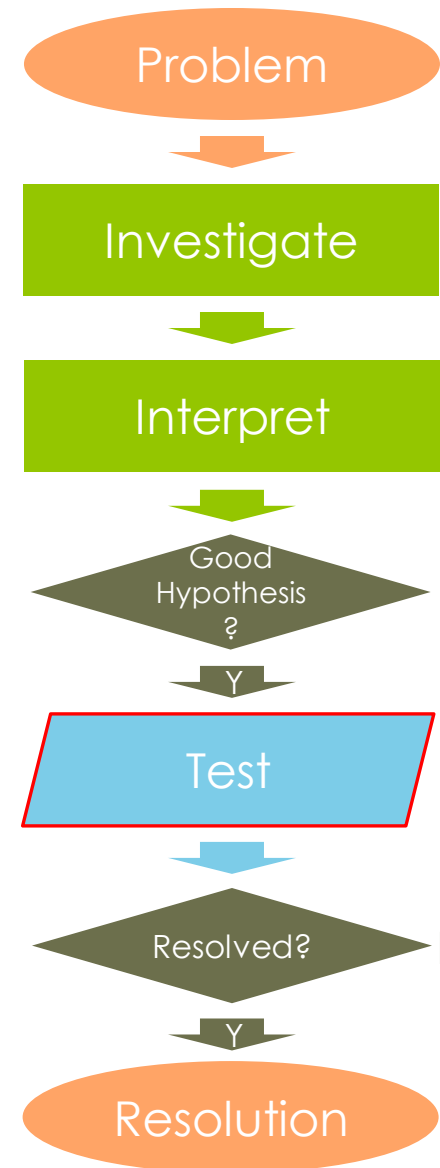
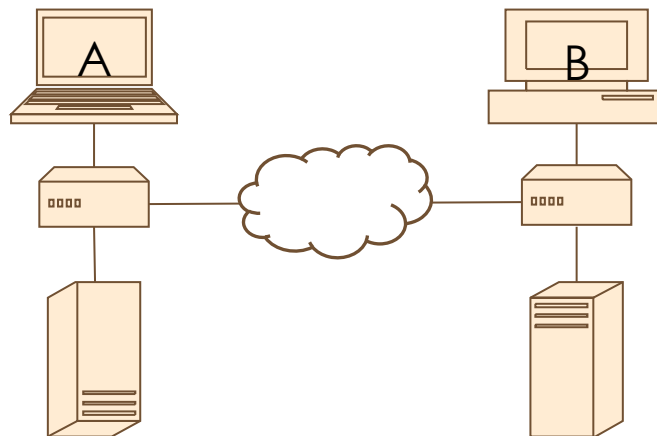
- Everything is working except sending outside the hospital
- Maybe it's a network configuration issue
 - "Dataflows" (network configuration profiles)



Test

Is it the system's fault?

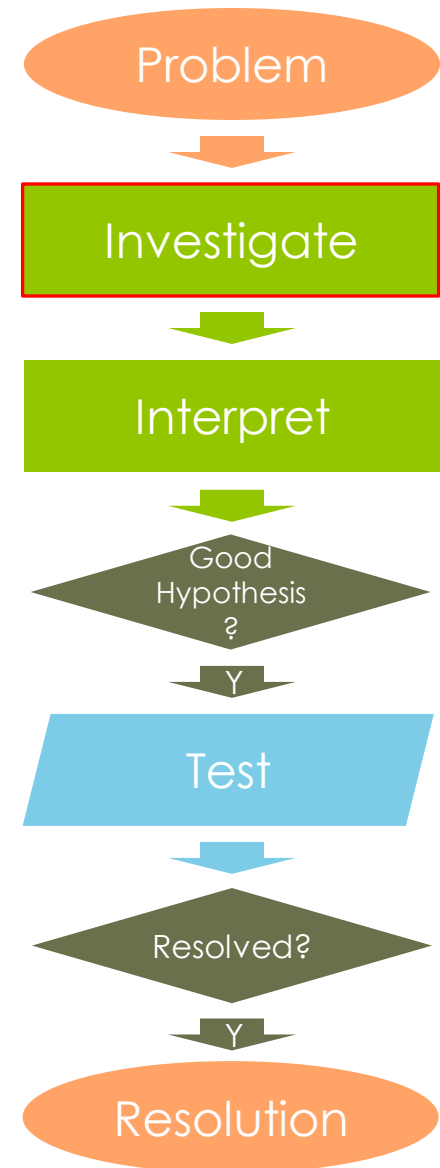
- I comb over all the network configurations, they seem correct
- Load a correct configuration
- Software was reloaded 4 weeks ago
- Could not send from local or remote



Investigate

What now?

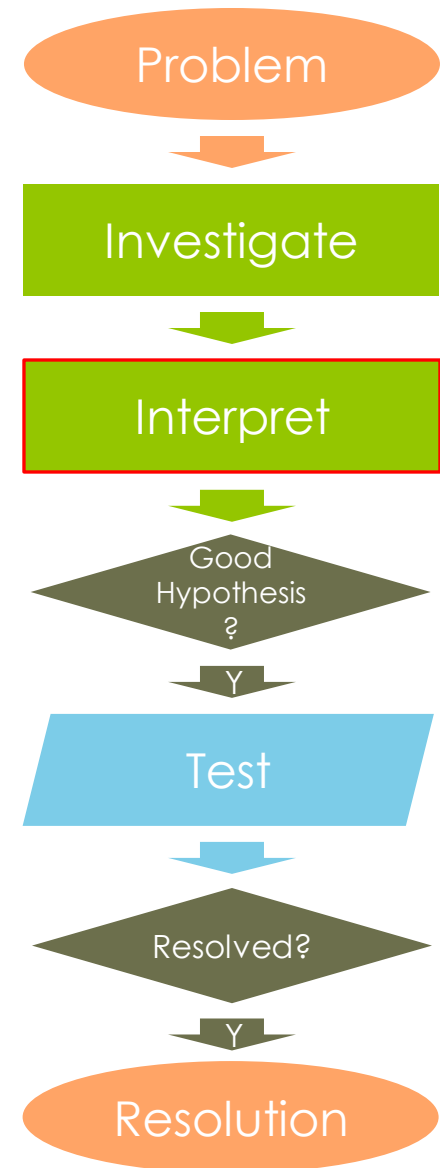
- Continue Investigating
- Life line – Call a “friend”
- I contacted GE who forwarded me to remote help.
- They were able to track the studies sent
- There was a flagged error in their logs
- “Not enough memory in spooler”???



Interpret

Spooler Out of Memory

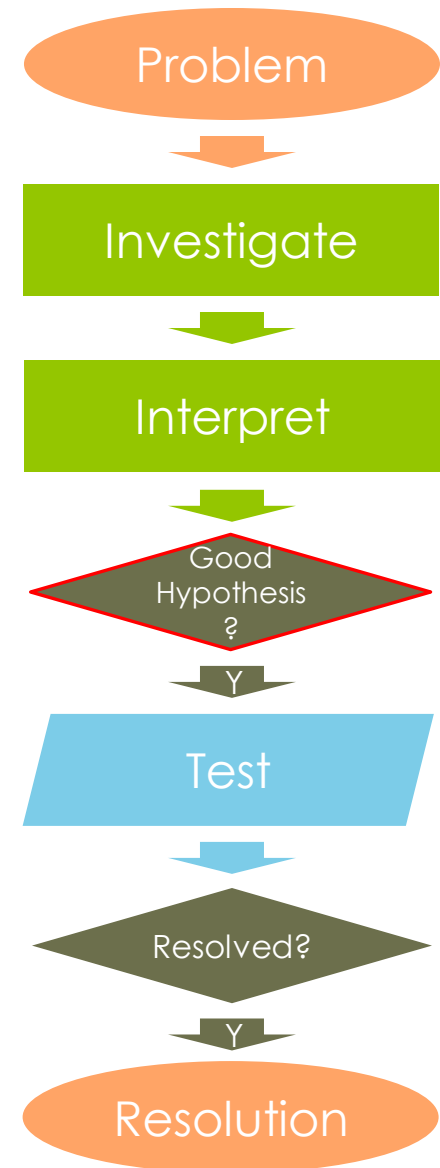
- Maybe... there is not memory in the spooler to queue up studies thus they cannot process
- But...
 - The hard drive wasn't full
 - The system sends internally on the hospital network without problems



Hypothesis

Clear the spooler?

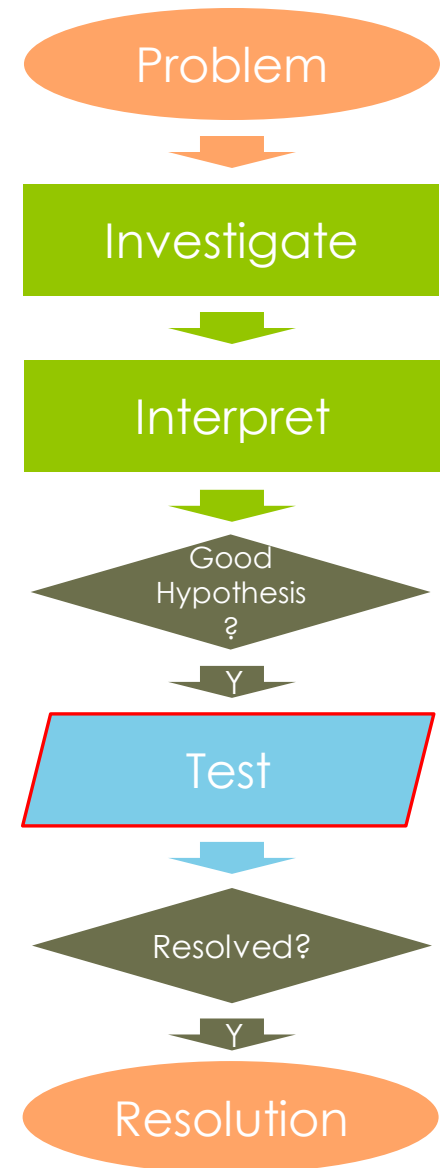
- If there is not enough memory to process the studies, then clearing up space might allow them to send
- Is it good (logical)? No, but I'm desperate
- (Remote support wasn't 100% certain either)



Test

Clear the Spooler!

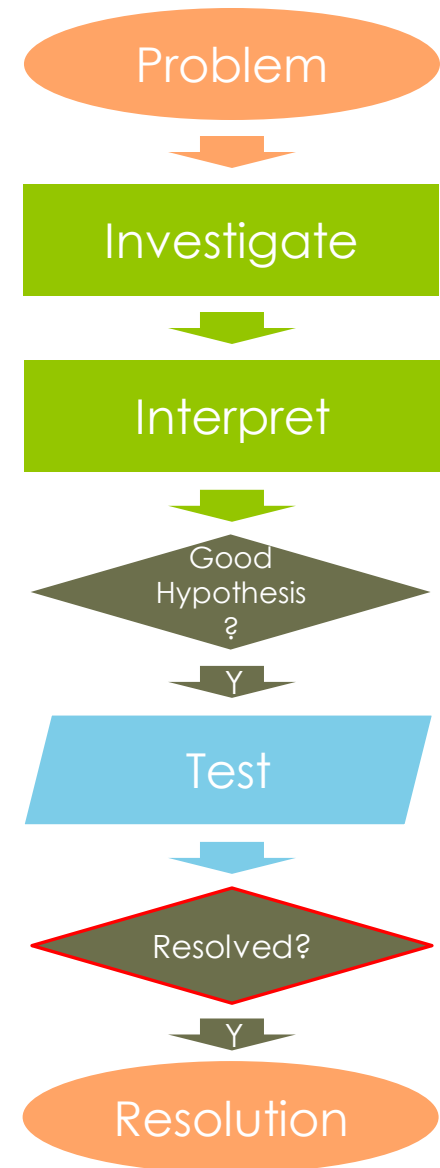
- Shotgun away!
- We deleted the 50 gb of old studies from the last 4-5 years



Resolved?

Sent a Study

- Sent! (Finally...)
- It turns out, that folder is a DICOM only spooler that would only be utilized for DICOM Servers (like the destination PACS)
- And there is a memory cap around 50GB
- That's just how it's programmed



Review

What did I learn?

- Be resourceful
- Leave no stone unturned
- You don't know, until you know...
(Always keep learning!)