

"Computers are useless.  
They can only give you  
answers."

- Pablo Picasso

# To Borrow, Buy, or Build:

## Essential Topics in Pathology Informatics

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# “All I am asking for is...”



# Identifying the needs

## Goal

Minimum

Optimistic

## Deadline

Absolute

Desired

## Users

## Justification

## Current Workflow

Patient Care

Simplest use case

Financial

Most complex use case

## Desired Workflow

## Data Variables

# Can We “Borrow”?

Is there an existing system that can help reach the goal?

Better be aware of all existing systems in the institution

Who maintains it?

Can we use it too?

Are modifications required?

How much will it cost?

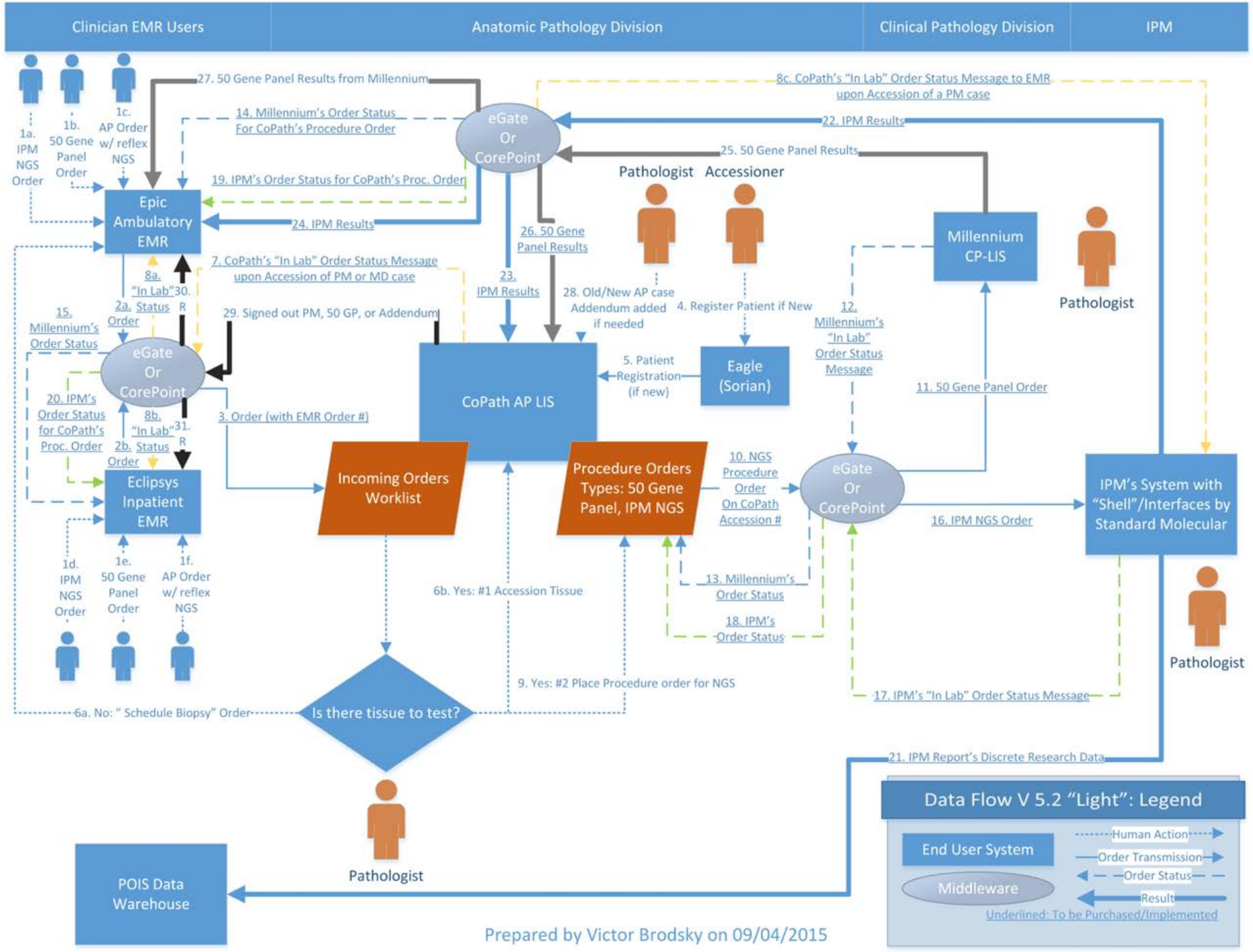
How long will it take?

# Genomic Orders & Results

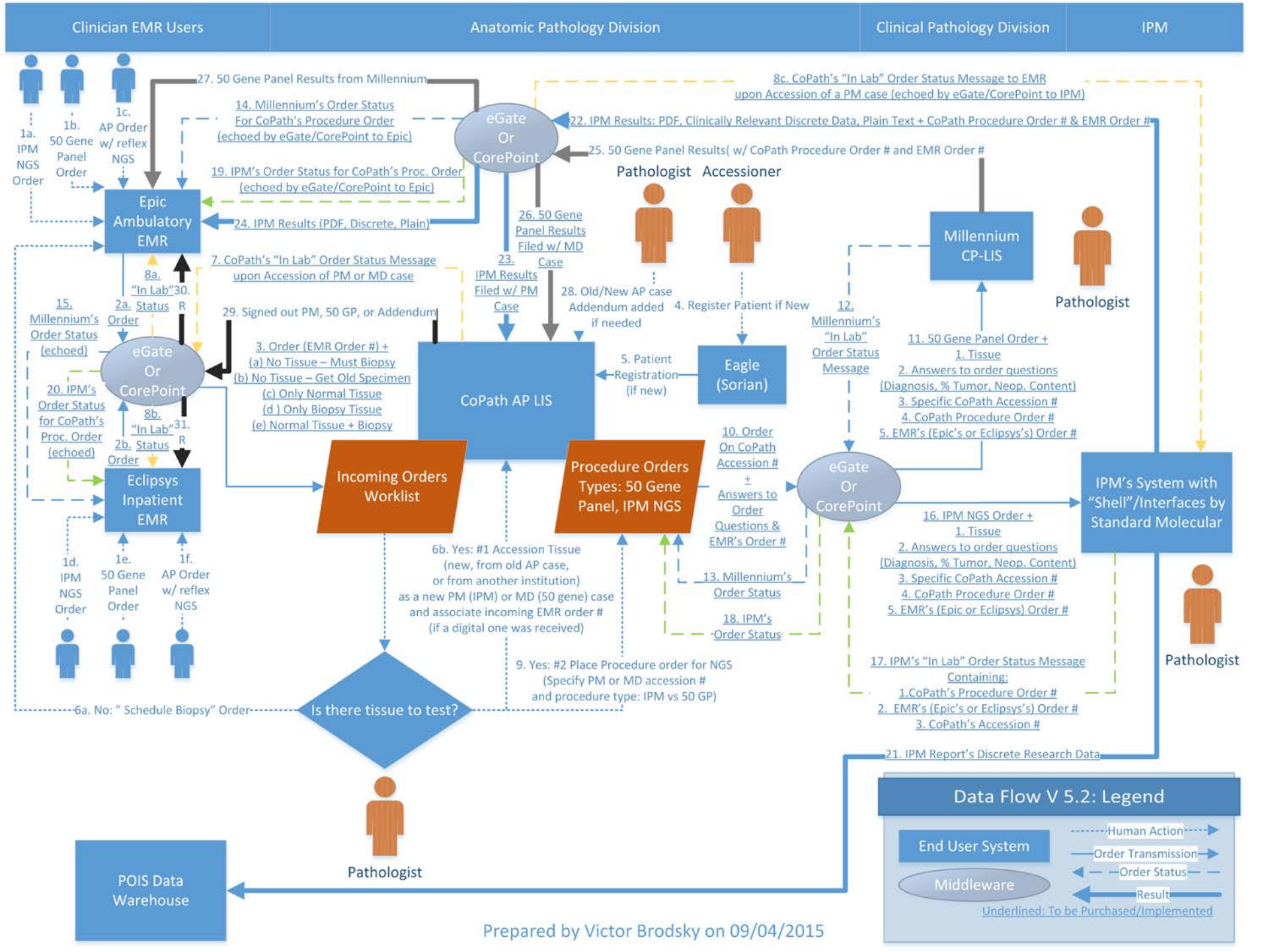
Orders: EMR -> LIS

Results: LIS -> EMR

"The trouble with doing something right the first time is that nobody appreciates how difficult it was." - Walt West

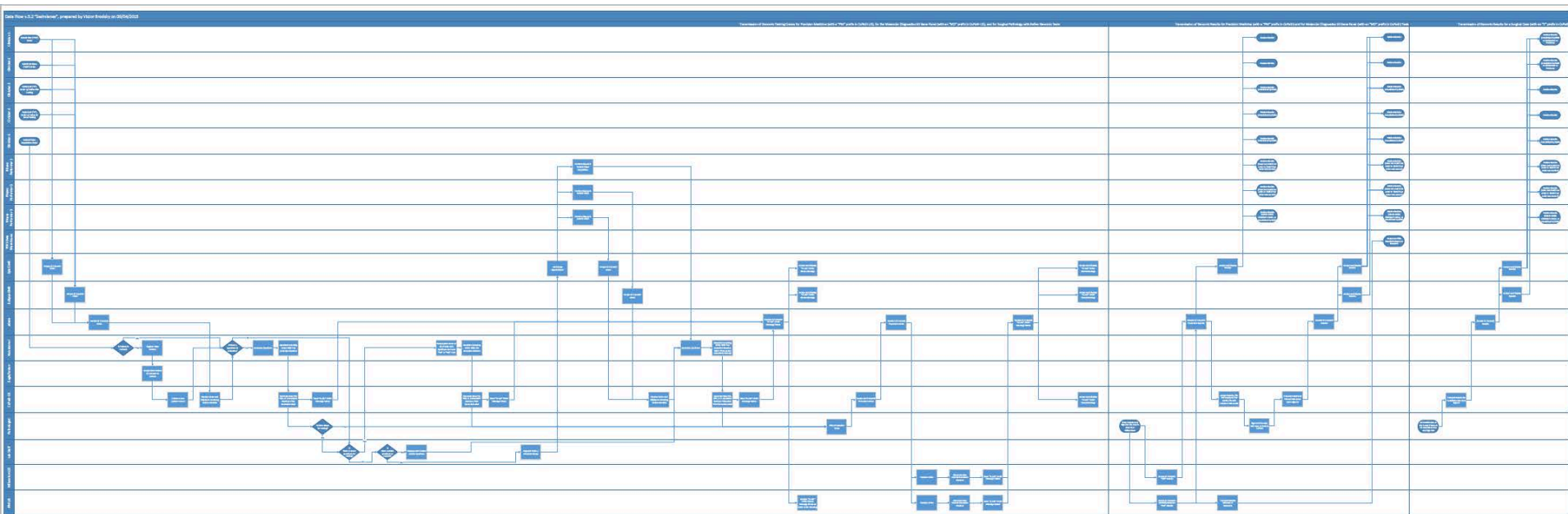






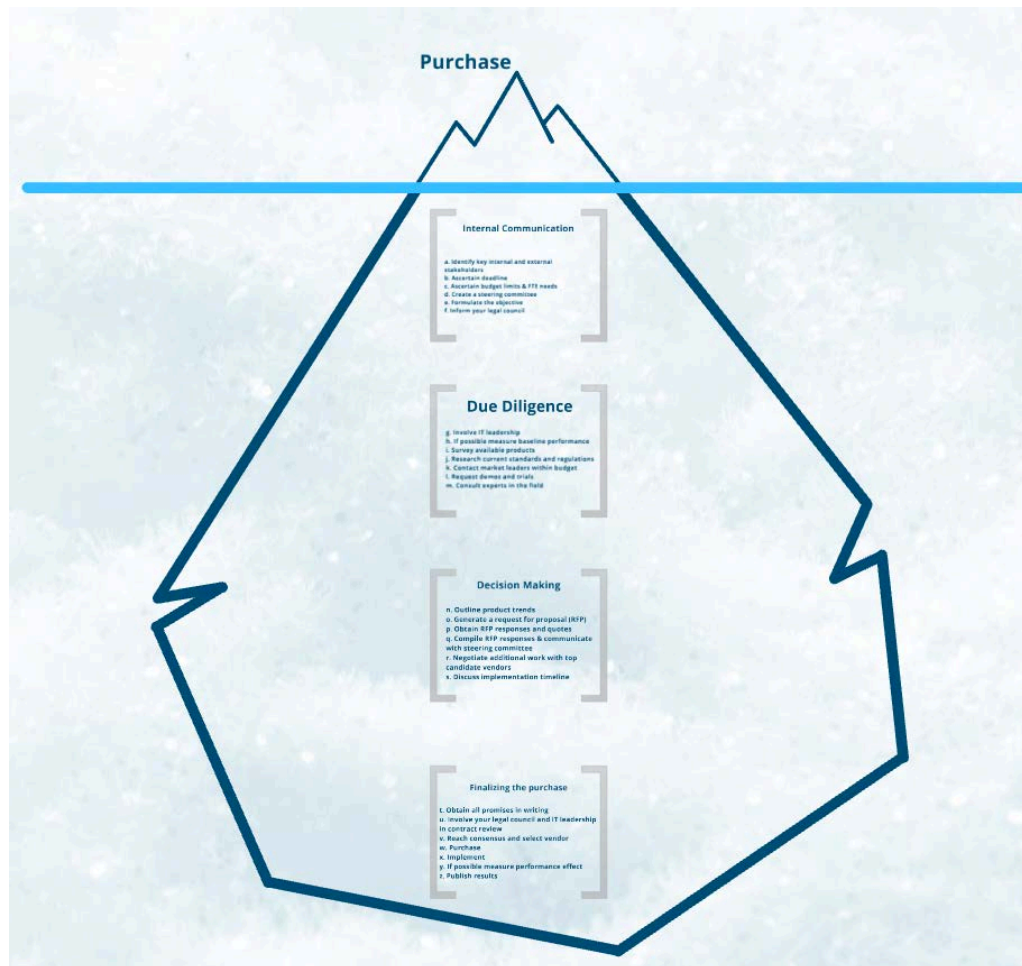
# Swimlanes!

(Powerpoint can't show you this image)





# Part Deux: Just buy it!



# Internal Communication

- a. Identify key internal and external stakeholders
- b. Ascertain deadline
- c. Ascertain budget limits and FTE needs
- d. Create a steering committee
- e. Formulate the objective
- f. Inform your legal council

# Due Diligence

- g. Involve IT leadership
- h. If possible, measure baseline performance
- i. Survey available products
- j. Research current standards and regulations
- k. Contact market leaders within budget
- l. Request Demos and trials
- m. Consult experts in the field

# Decision Making

- n. Outline product trends
- o. Generate a request for proposal
- p. Obtain RFP responses and quotes
- q. Compile RFP responses & communicate with steering committee
- r. Negotiate additional work with top candidate vendors
- s. Discuss implementation timeline

# Finalizing the purchase

- t. Obtain all promises in writing
- u. Involve your legal council and IT leadership in contract review
- v. Reach consensus and select vendor
- w. Purchase
- x. Implement
- y. If possible, measure performance effect
- z. Publish results



# E.G.: Whole Slide Imaging

Establishing a scanning service

40,000 slide collection

Goal: Interface to the LIS

- LIS Barcode on the slide links it to the case

- Users can “click out of the LIS to the Image”

- PACS gets populated with patient information

- PACS can export a region of interest back to the LIS

TMA module for annotation

Image Analysis Software (to count nuclei, etc)

# Tissue section scan speed

“Industry standard” =  $1.5 \times 1.5\text{cm} = \underline{2.25\text{cm}^2}$

$11,736,466,666 \text{ pixels} = 108,335 \times 108,335$

$108,335 \times 0.22 \text{ microns/pixel at “40x”} =$

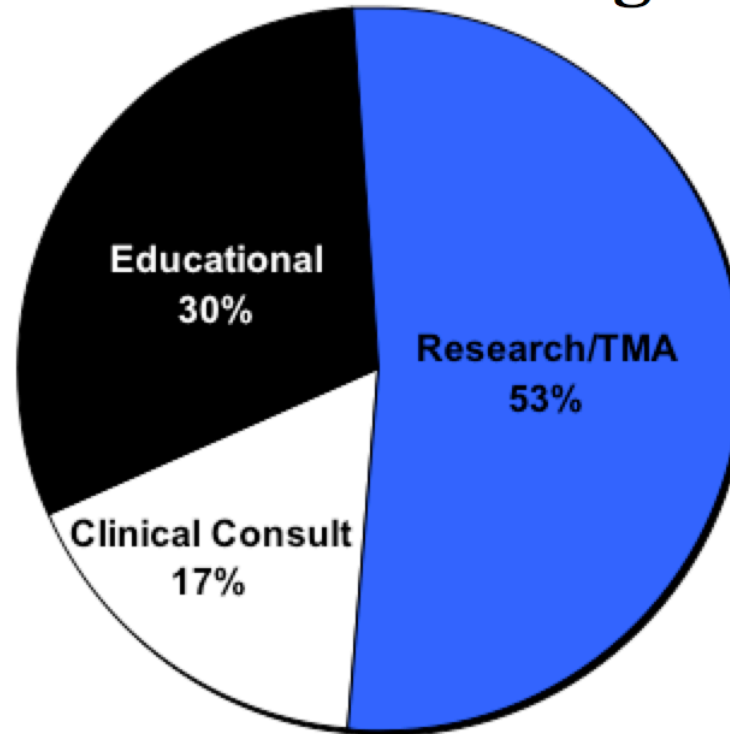
$2.38337\text{cm} \times 2.38337 = \underline{5.68 \text{ cm}^2}$

Factor of **2.5246**

# Overall Scanner Use

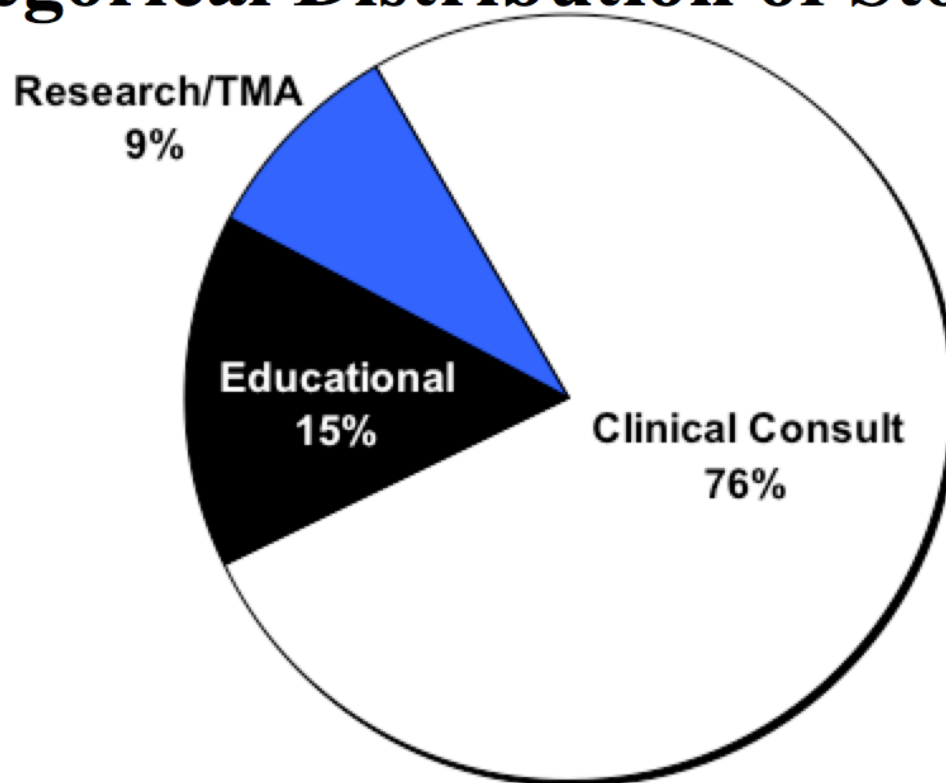
- Out of all consult cases received, 43% were scanned.
- The cases contained an average of 9.40 slides each.
- 1 to 12 slides were scanned per case.
- Average 1.98 slides scanned per case.

## Slide Utilization During Logons



**Figure 4.** Users were surveyed on their utilization of scanned slides for education, clinical consult, or research purposes and their responses were correlated to their logon data. Of 1053 logon events, 178 logon events (17%) were to access clinical consult cases, 321 logon events (30%) were for educational slides, and 554 logon events (53%) were for research/TMA slides.

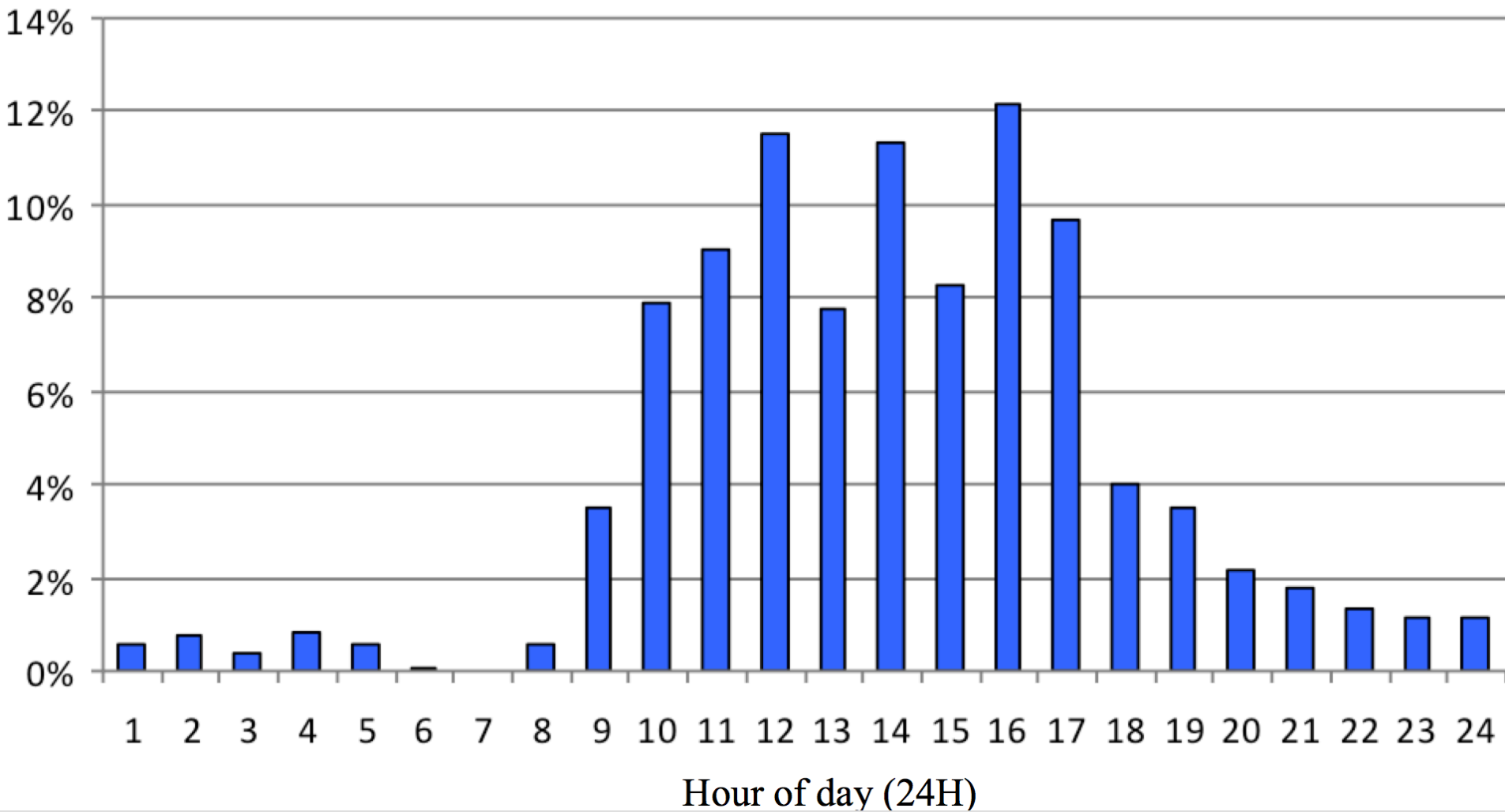
## Categorical Distribution of Stored Slides



**Figure 5.** Clinical consult slides comprise the majority of scanned slides (76%), followed by educational slides (15%). Research slides composed only 9% of stored slides.



**Figure 6. Percentage of logon events by hour of day**



# Imaging – True Purpose

10% to 30% discrepancy between different surgical pathologists among cases where the appearance of tissue warranted obtaining another pathologist's opinion<sup>10</sup>

Neuropathologists disagree with their own previous diagnosis 25% to 48% of the time<sup>11</sup>

“Error rates in the order of 30% in radiology plain film reporting have consistently been found.”<sup>12</sup>

<sup>10</sup>Gupta D, Layfield LJ. Prevalence of inter-institutional anatomic pathology slide review: a survey of current practice. Am J Surg Pathol. 2000 Feb;24(2):280-4.

<sup>11</sup>Mittler MA, Walter BC, Stopa EG, Observer reliability in histological grading of astrocytoma stereotactic biopsies. J Neurosurg. 1996 Dec;85(6):1091-4.

<sup>12</sup>A.Vohrah, J. C. (2003). "Clinical governance: two years experience of reporting discrepancy review of Diagnostic Radiography and Imaging (5): 27–32.

# CPath

## Systematic Analysis of Breast Cancer Morphology Uncovers Stromal Features Associated with Survival (Beck, AH)

“We applied the C-Path system to microscopic images from two independent cohorts of breast cancer patients [from the Netherlands Cancer Institute (NKI) cohort,  $n = 248$ , and the Vancouver General Hospital (VGH) cohort,  $n = 328$ ]. The prognostic model score generated by our system was strongly associated with overall survival in both the NKI and the VGH cohorts (both log-rank  $P \leq 0.001$ ). This association was independent of clinical, pathological, and molecular factors.

**Three stromal features were significantly associated with survival, and this association was stronger than the association of survival with epithelial characteristics in the model. These findings implicate stromal morphologic structure as a previously unrecognized prognostic determinant for breast cancer.”** – November 9<sup>th</sup>, 2011

# Distributional Semantics

Zellig Harris: Meaning is derived from co-occurrence frequency with other [words]

- 2011 Google launches Search by Image
- 2012 Google Launches Goggles
- 2013 Google launches Photo Search
- 2014 GaussianFace face recognition algorithm outperforms humans

# Test your might



Source: <http://arxiv.org/abs/1404.3840>



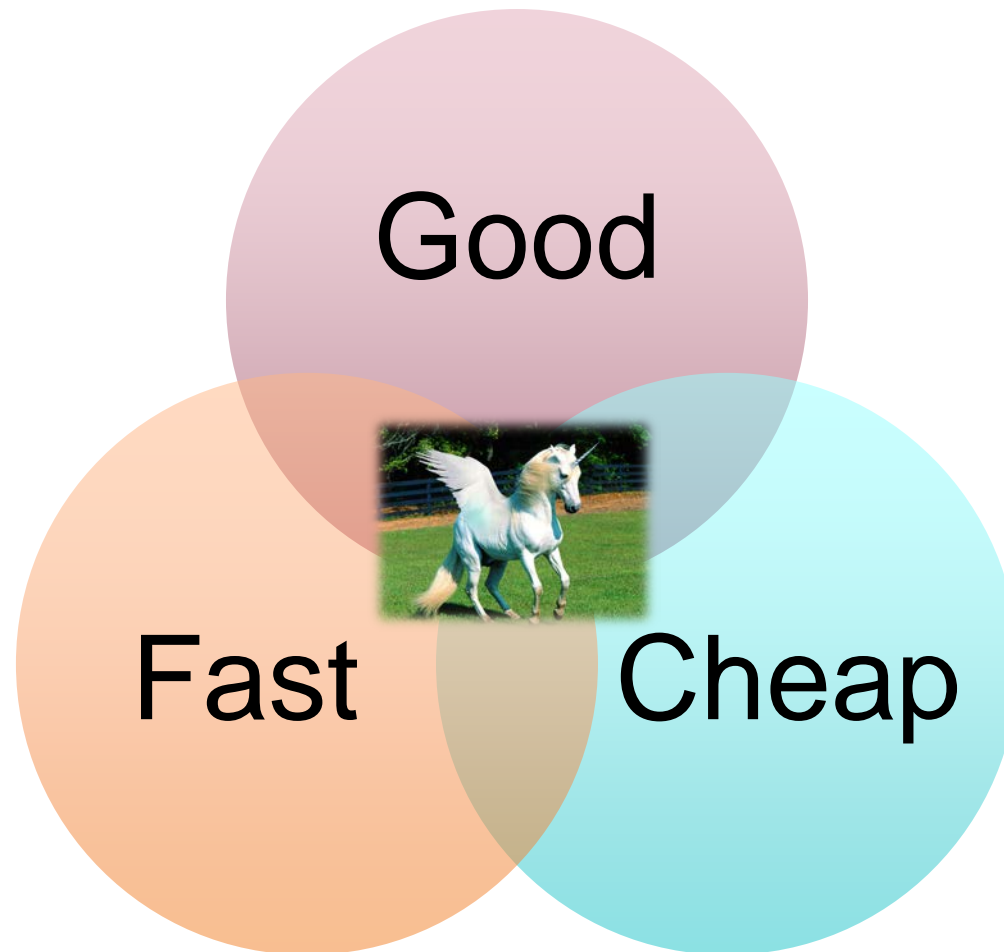
# Build!!! (...?)

(if there is nothing to borrow, and nothing to buy... or if you think you can do it better)

Reward: You will get exactly what you want...

Risk: ...if you are willing to wait and spend the money

# Pick any two...



# Minimal needs for building

An Architect / Product Manager

Developers (ideally at least 2)

Quality Assurance Specialist (Bug Testing)

Live, Test, and Dev environments

- Server Hardware and/or VM licenses

- Software platform licenses (OS/Database/IDE/Git/etc)

- Hosting of the server

# Don't forget...

"Another flaw in the human character is that everybody wants to build and nobody wants to do maintenance." - Kurt Vonnegut

and

"Only the paranoid survive." - Andy Grove

# Minimal needs for building

An Architect / Product Manager

Developers (at least 2)

Quality Assurance Specialist (Bug & Security Testing)

System Administrator

Live, Test, and Dev environments

Server Hardware and/or VM licenses

Software platform licenses (OS, Database, IDE, etc)



# ORDER

A platform for developing clinical, research, administrative, and educational software

# Why?

Clinical software market is stagnant and the products are mediocre and expensive

- Perceived high barrier to entry

- Customers unwilling to switch (long implementations, fear of young products)

- Lack of stimuli for competition

Research software is expensive; nonexistent for Precision Medicine workflows

Educational software does not integrate with either clinical or research software

# Strengths: Platform

## Server hardware:

- 4 processors, 40 cores

- 512GB ECC RAM

- 30TB of Storage RAID – 350MB/s read, 255MB/s write

## Network

- 10 Gigabit connection

## Operating System

- Windows Server

## Database: Microsoft SQL Server

# Strengths: Infrastructure

Backed up nightly

Operating System is supported by central IT  
and patched regularly

Database is administered by the IT DBA team

Protected by a Firewall

Accessible via VPN from anywhere

Can collect submitted forms from non-VPN  
users

# Strengths: Core

## Language

- PHP: OS Independence

  - Used by Facebook

- ORM: Database independence

- Active Directory Integration

  - Log in with your Institutional Account or a local one

- Accessible from any browser

  - No Installation required

  - Easy to issue updates

  - Responsive-oriented design (accessible from mobile devices – tablets, phones)

# Strengths: Foundation

Automatic logout after idle timeout (HITRUST)

Role-based permissions & Access Requests

Time displayed based on user's time zone

Language preference for the interface

Built to be multi-institutional

Frictionless submission of new menu terms

Dictionary /Synonym /Hierarchy Management

Enterprise data model that accepts conflicts

Event Logging

# 6 sites in 3 years w/ 1 dev

Scan Order Management

Employee Directory and Management

Online Fellowship Applications & Candidate Evaluation

Deidentifier

Vacation Requests

Call Log Book



# ASCP & AMIA Abstracts

The development team comprised 1.2 FTEs; the PI dedicated 0.2 of his time, spending 60% of it on software testing. The project took 451 days and contains 1999 files with **379,620** LOC (averaging **670**/week). In total, 377 issues were documented, of which 325 were resolved, and 49 remained outstanding at launch; 204 (54%) were classified as bug, 163 (43%) as enhancement, 3 (1%) as proposal, and 7 (2%) as task. The top two priority flags assigned to bugs and enhancements were “blocker” and “critical”. The average TC for all issues was **29** days (**13** for bugs, and **52** for enhancements) with a median of 9, and SD of 59.2. “Blocker” was used 24 times: 19 (79%) for bugs with a TC of **3.4**, and 5 (21%) for enhancements with a TC of **6.6**. “Critical” was used 221 times: 139 (62.9%) for bugs with a TC of **12**, and 78 (35.3%) for enhancements with a TC of **39.2**. (...3-6x)

# ORDER: Now Open Source

Source Code:

<https://github.com/victorbrodsky/order-lab/>

# Project Management

Never stand in a way of a project

Under-promise and over-deliver

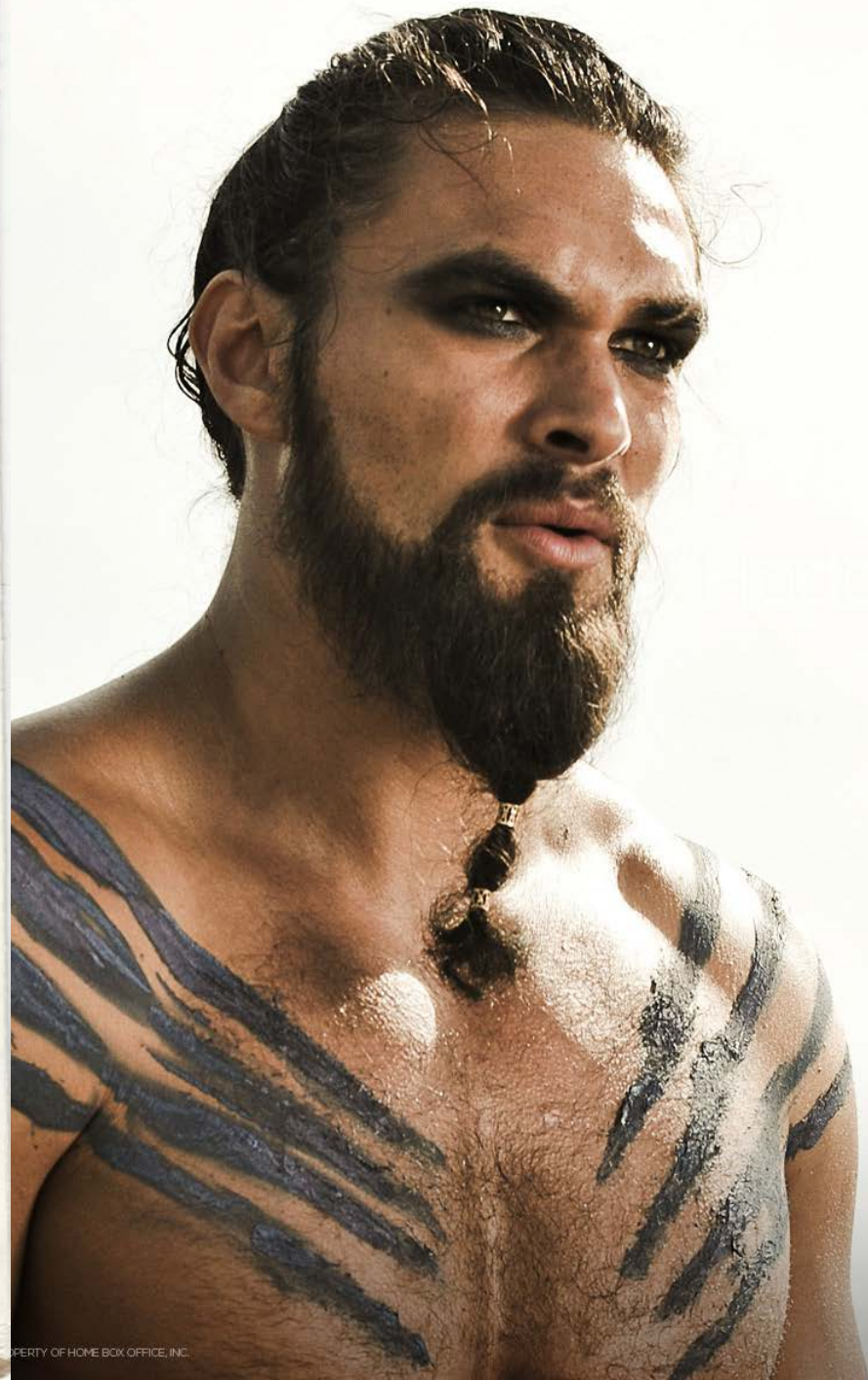
Hold regular meetings

Plan for the worst and maintain documentation

Only two justifications: money and care quality



*БРОДСКИЙ Б.М.*



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# Thank You!

"The future will be better tomorrow" - Dan Quayle



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