Microsoft SDL Threat Modeling

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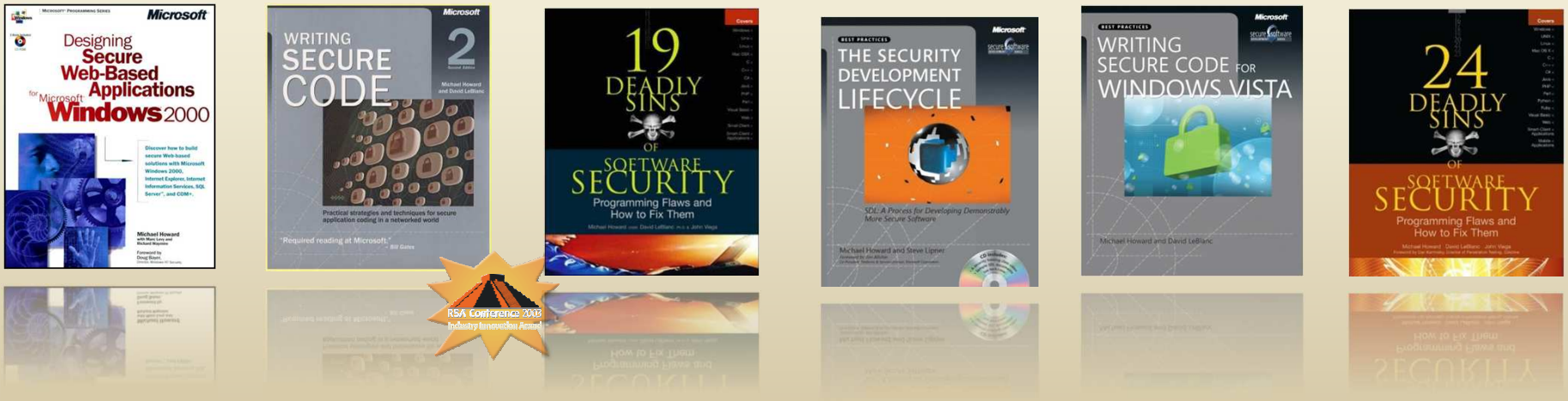
Who Is This Guy?

- mikehow@microsoft.com
- Microsoft employee for 17 years
- Always in security
- Worked on the SDL since inception



Overview

- Introduction
- Goals of Threat Modeling
- The approach
- Exercise
- Learning resources

Threat Modeling Basics

- Who?
- What?
- When?
- Why?
- How?

Who

- Building a threat model
  - Dev owns DFD (diagram)
  - Test owns ID threats (analyze)
  - PM owns overall process
- Customers for threat models
  - Your team
  - Other feature, product teams
  - Customers, via user education
  - ‘External’ QA resources like pen testers
  - Security Advisors

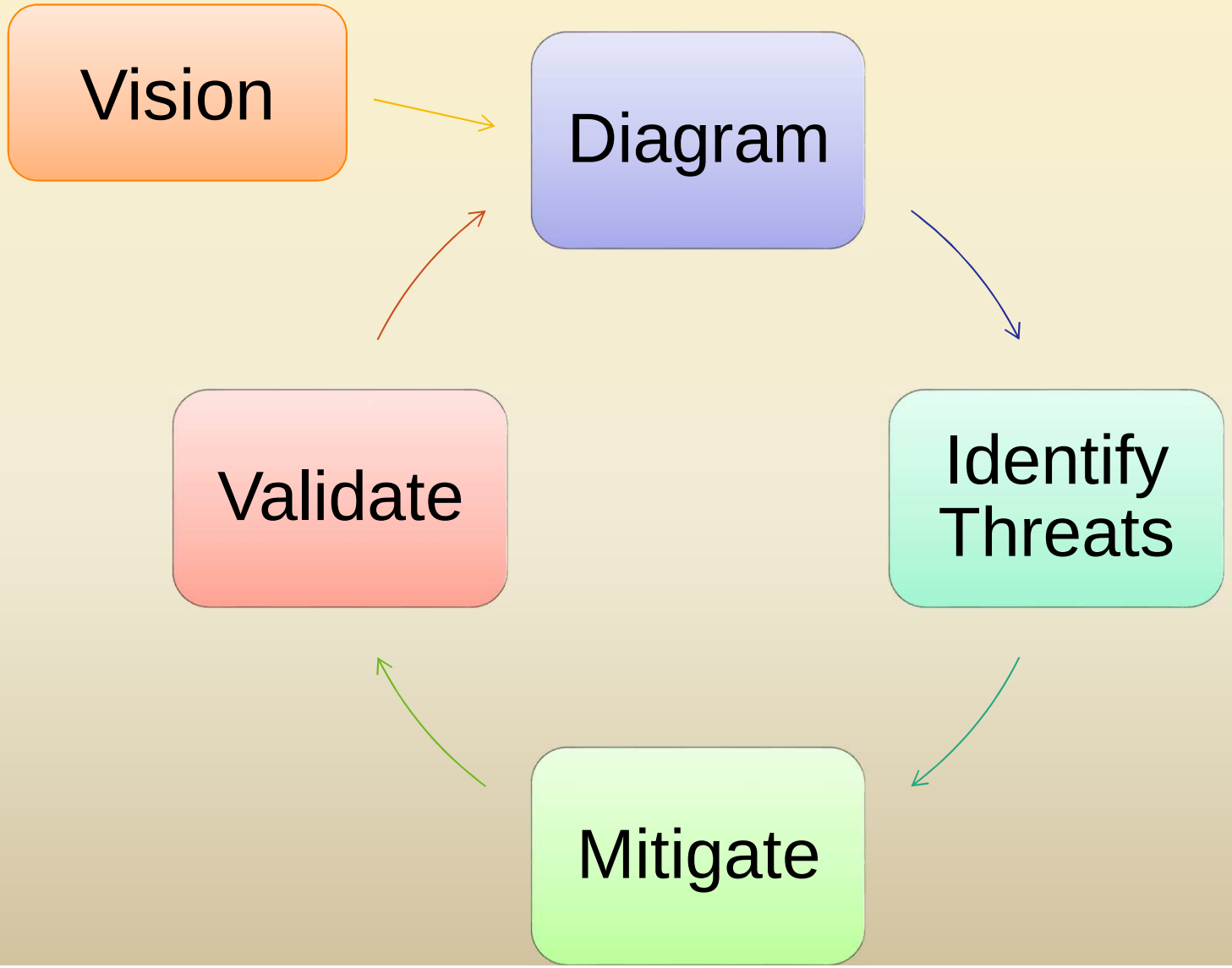
What

- Reason about, document and discuss security in a structured way
- Threat model & document
  - The product as a whole
  - The security-relevant features
  - The attack surfaces
- Assurance that threat modeling has been done well

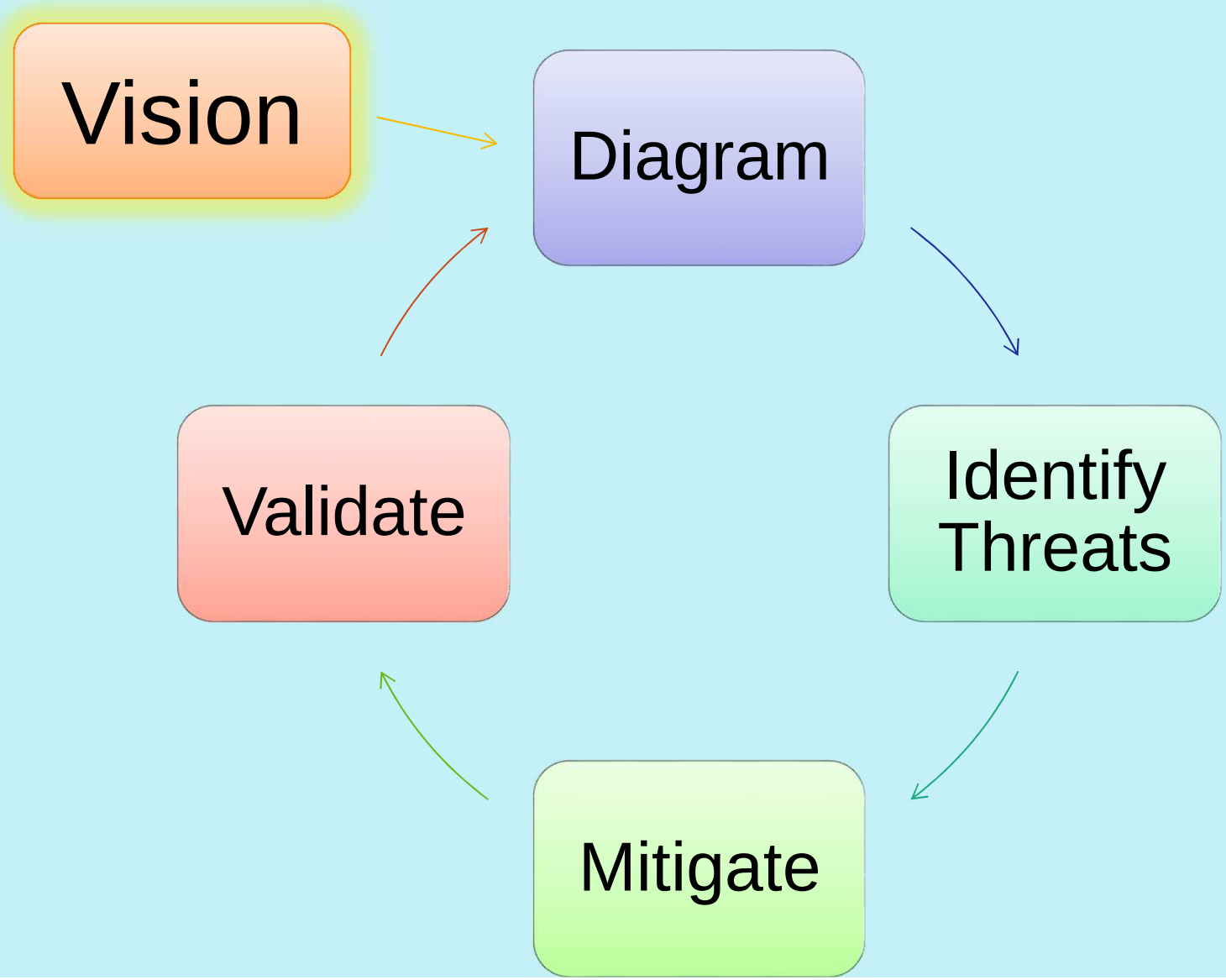
Why Threat Model

- Produce software that's secure by design
  - Improve designs the same way we've improved code
- Because attackers think differently
  - Creator blindness/new perspective

The Approach In a Nutshell



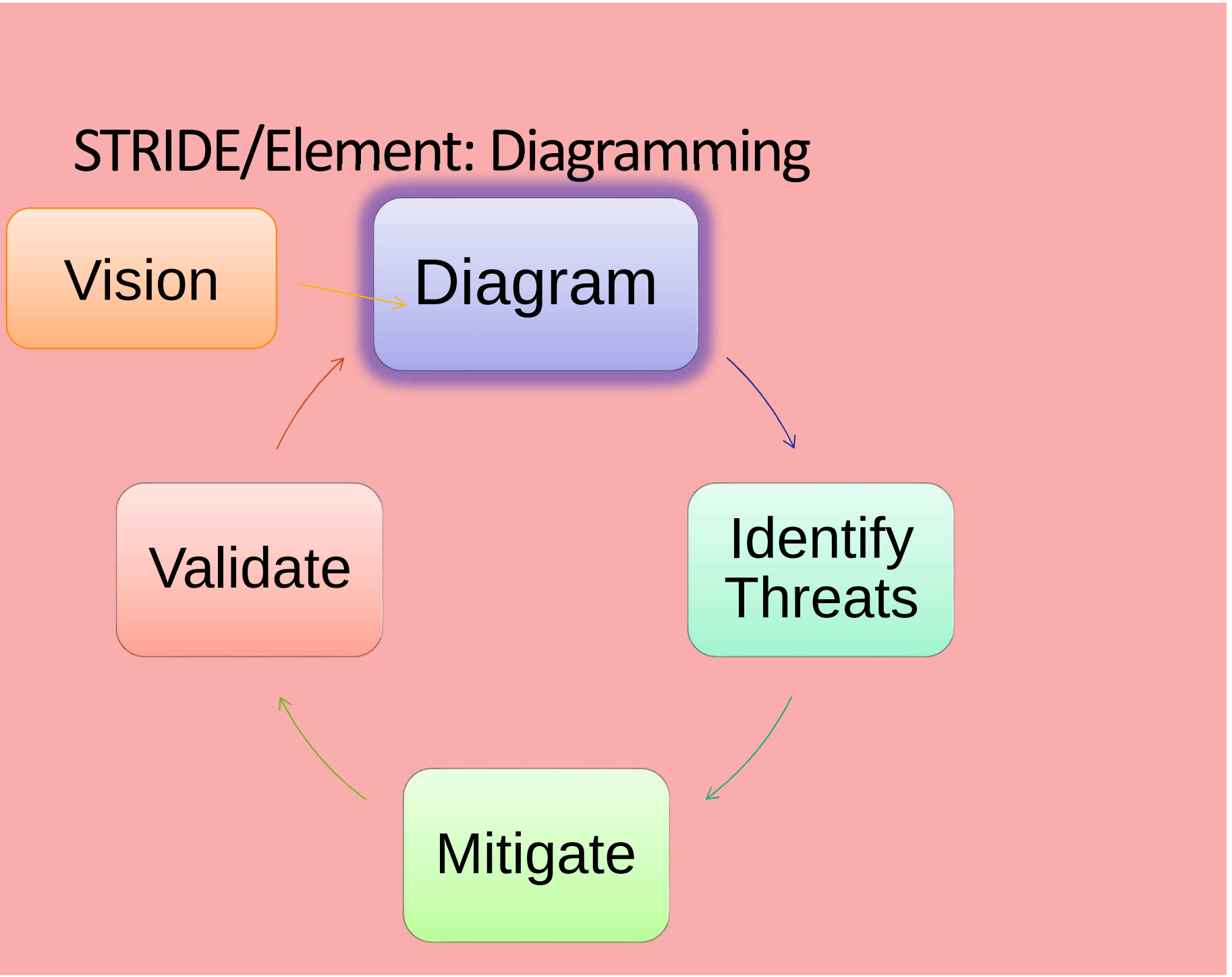
STRIDE/Element: Vision



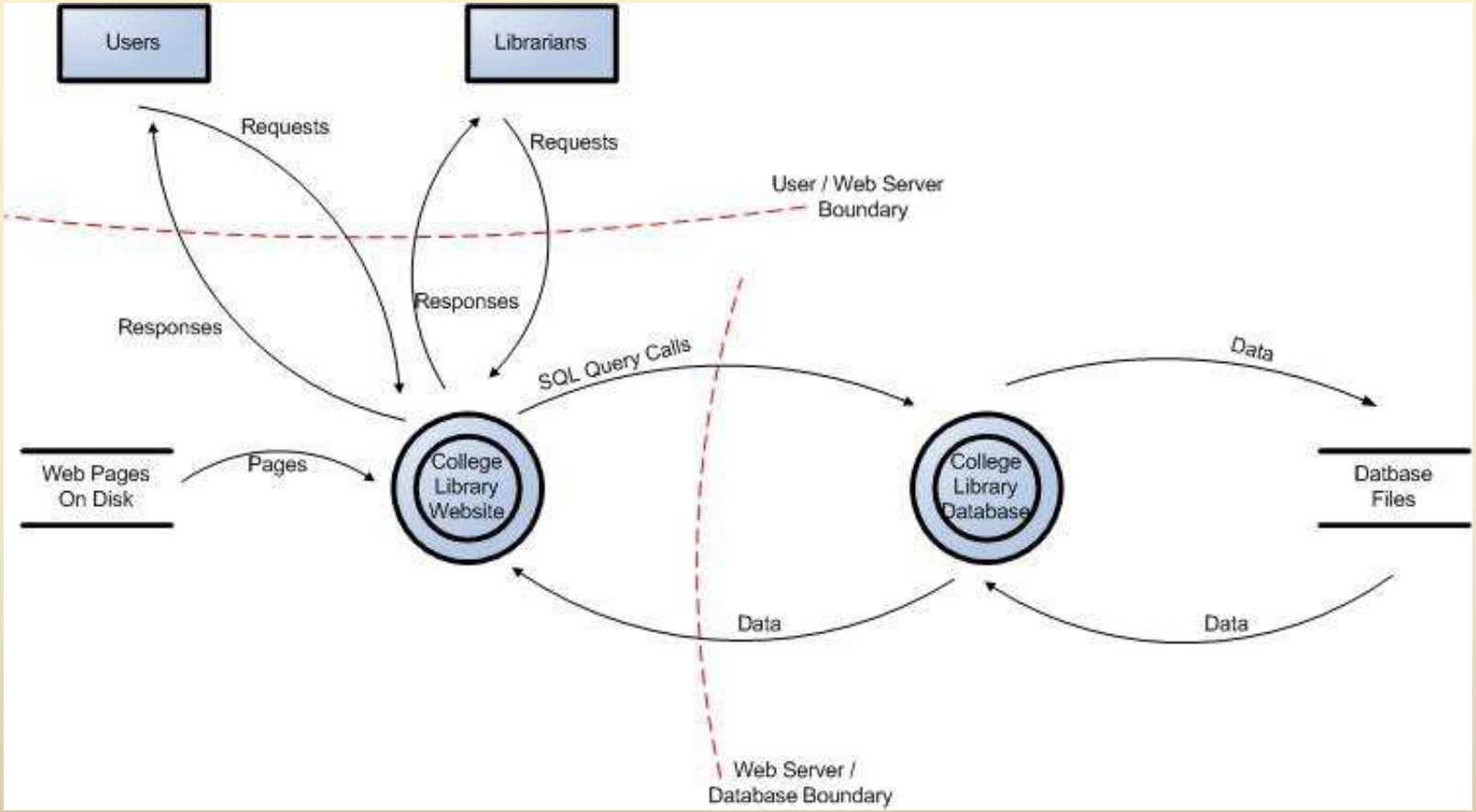
Vision

- Scenarios
  - Where do you expect the product to be used?
  - XBOX is different from Windows 7
  - xbox.com is different from XBOX
- Use cases/Use Stories
- Add security to scenarios, use cases
- Assurances/Guarantees
  - Structured way to think about “what are you telling customers about the product’s security?”

STRIDE/Element: Diagramming



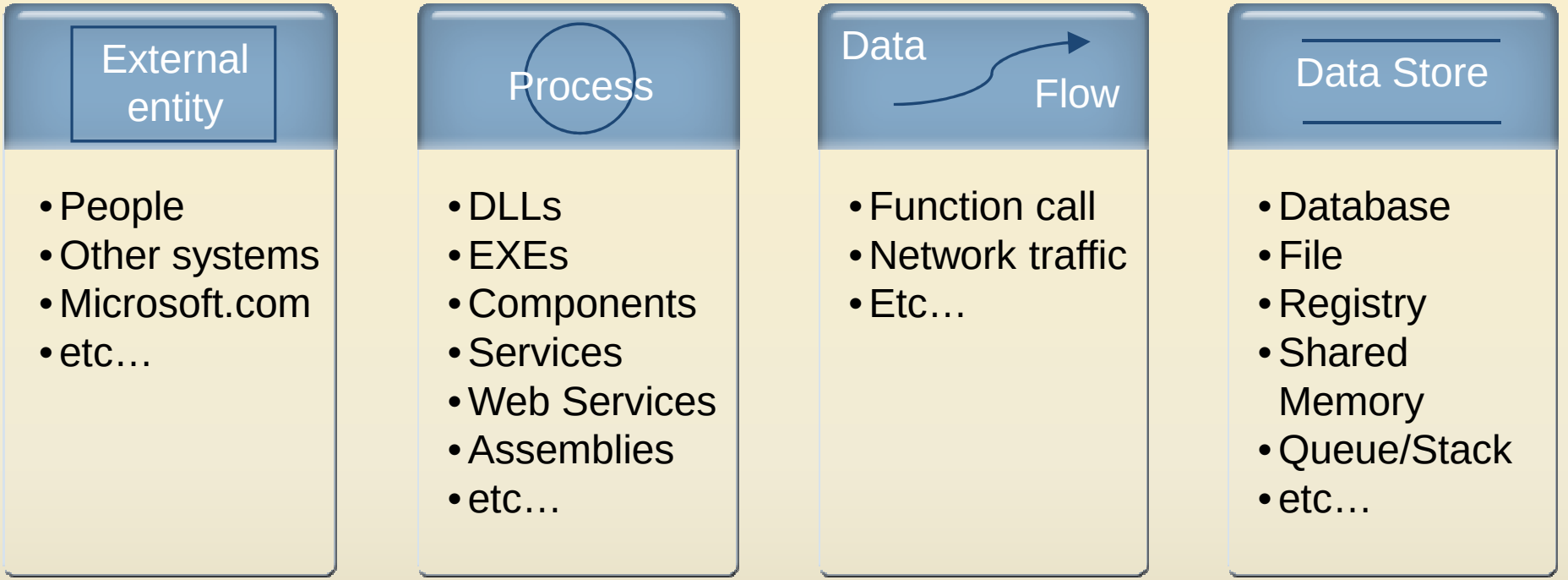
Example: Library Website



How to Create Diagrams

- Go to the whiteboard
- Start with an overview which has:
  - A few external interactors (some use ‘actors’)
  - One or two processes
  - One or two data stores (maybe)
  - Data flows to connect them
- Check your work
  - Can you tell a story without edits?
  - Does it match reality?

Diagram Elements - Examples



- People
- Other systems
- Microsoft.com
- etc…

- DLLs
- EXEs
- Components
- Services
- Web Services
- Assemblies
- etc…

- Function call
- Network traffic
- Etc…

- Database
- File
- Registry
- Shared Memory
- Queue/Stack
- etc…

- Process boundary
- File system

Diagramming

- Use DFDs (Data Flow Diagrams)
  - Include processes, data stores, data flows
  - Include trust boundaries
  - Diagrams per scenario may be helpful
- Update diagrams as product changes
- Enumerate assumptions, dependencies
- Number everything (if manual)

Diagrams: Trust Boundaries

- Add trust boundaries that intersect data flows
- Points/surfaces where an attacker can interject
  - Machine boundaries, privilege boundaries, integrity boundaries are examples of trust boundaries
  - Threads in a native process are often inside a trust boundary, because they share the same privs, rights, identifiers and access
- Processes talking across a network always have a trust boundary

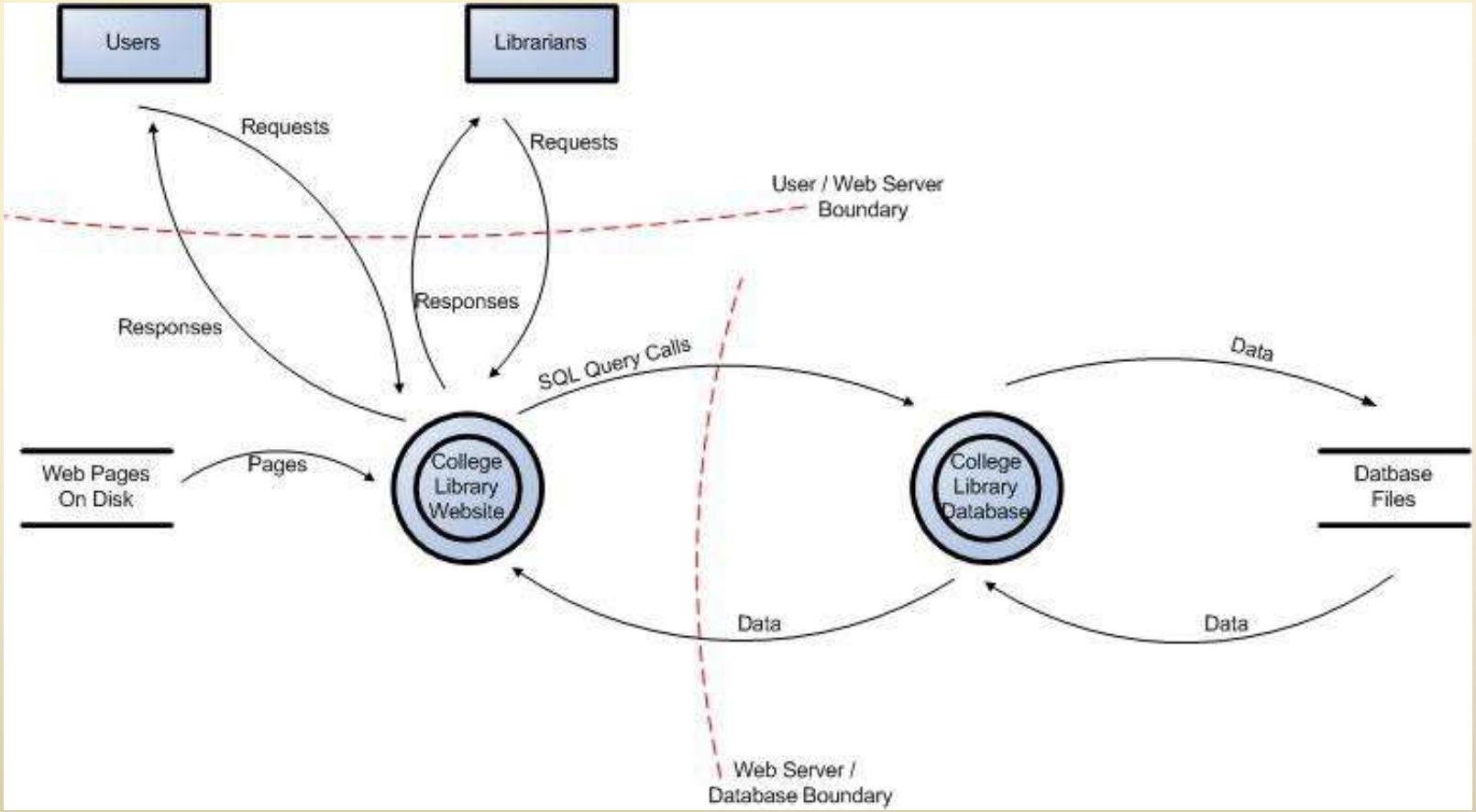
Diagram Iteration

- Iterate over processes, data stores, and see where they need to be broken down
- How to know it “needs to be broken down?”
  - More detail is needed to explain security impact of the design
  - Object crosses a trust boundary
  - Words like “sometimes” and “also” indicate you have a combination of things that can be broken out
    - “Sometimes this datastore is used for X”…probably add a second datastore to the diagram

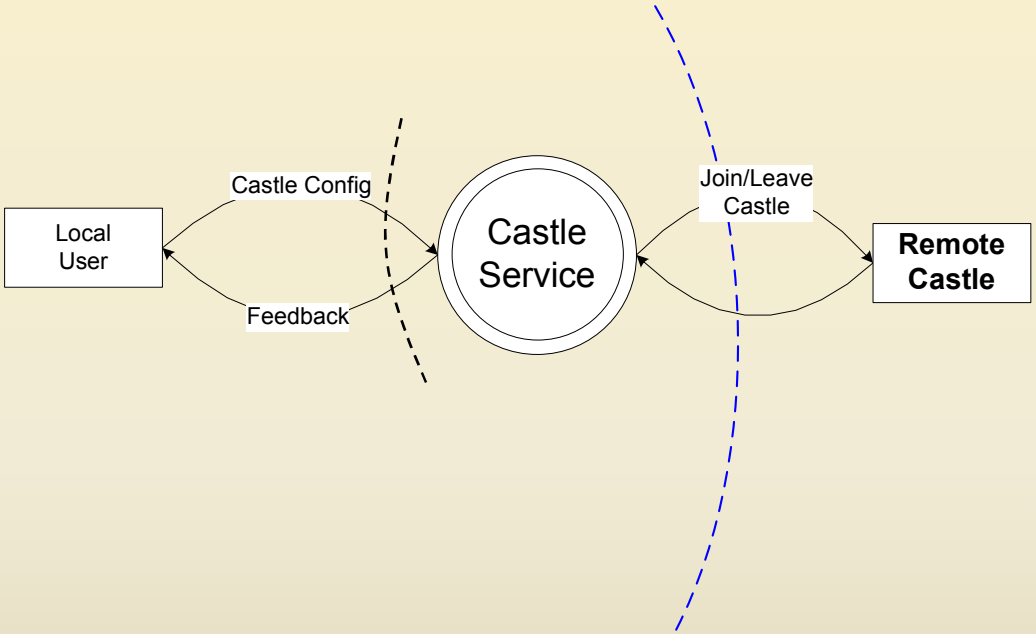
Diagram layers

- Context Diagram
  - Very high-level; entire component / product / system
- Level 1 Diagram
  - High level; single feature / scenario
- Level 2 Diagram
  - Low level; detailed sub-components of features
- Level 3 Diagram
  - More detailed
  - Rare to need more layers, except in huge projects or when you're drawing more trust boundaries

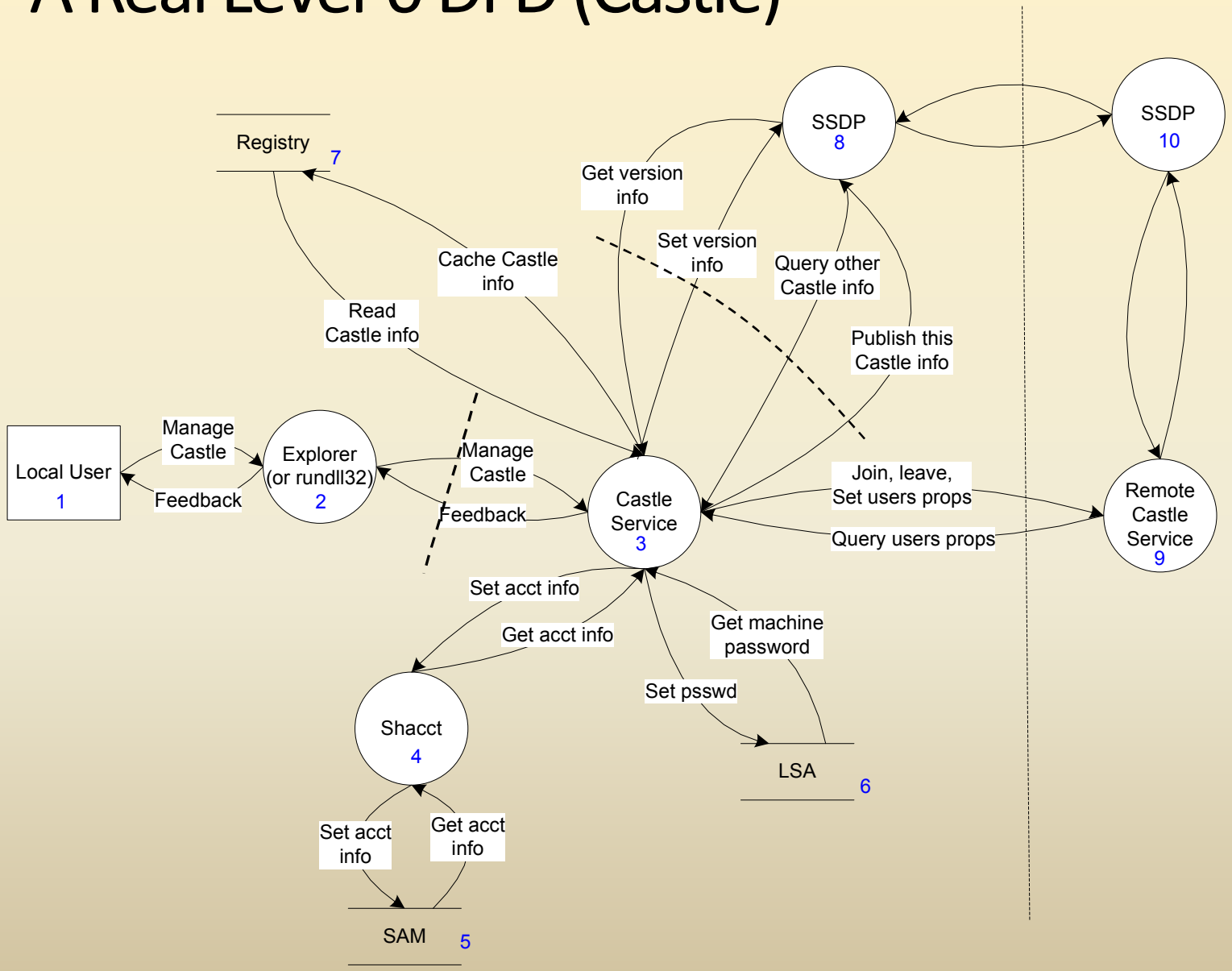
Example: Library Website



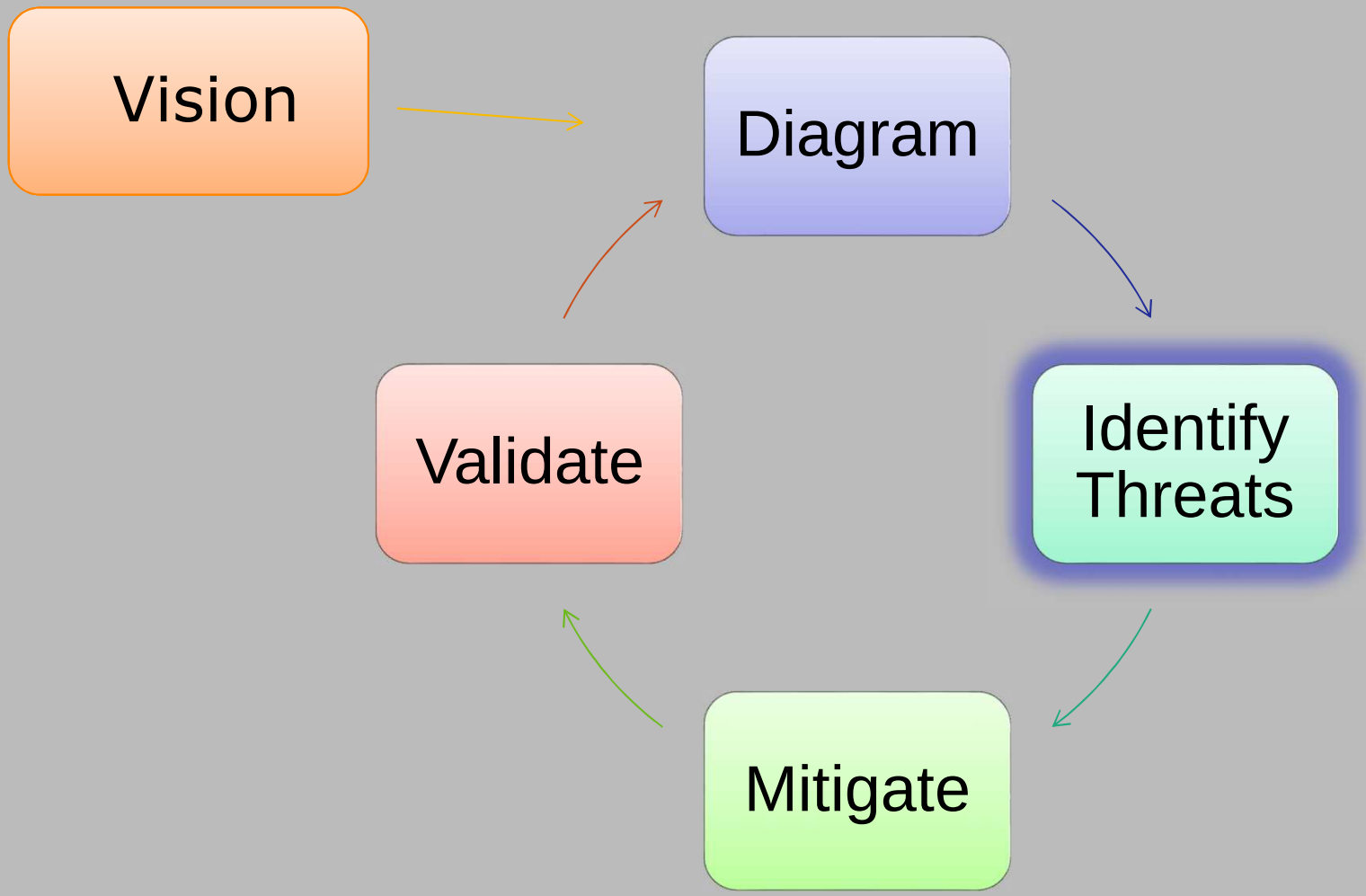
Example: A Real Context Diagram (Castle)



A Real Level-0 DFD (Castle)



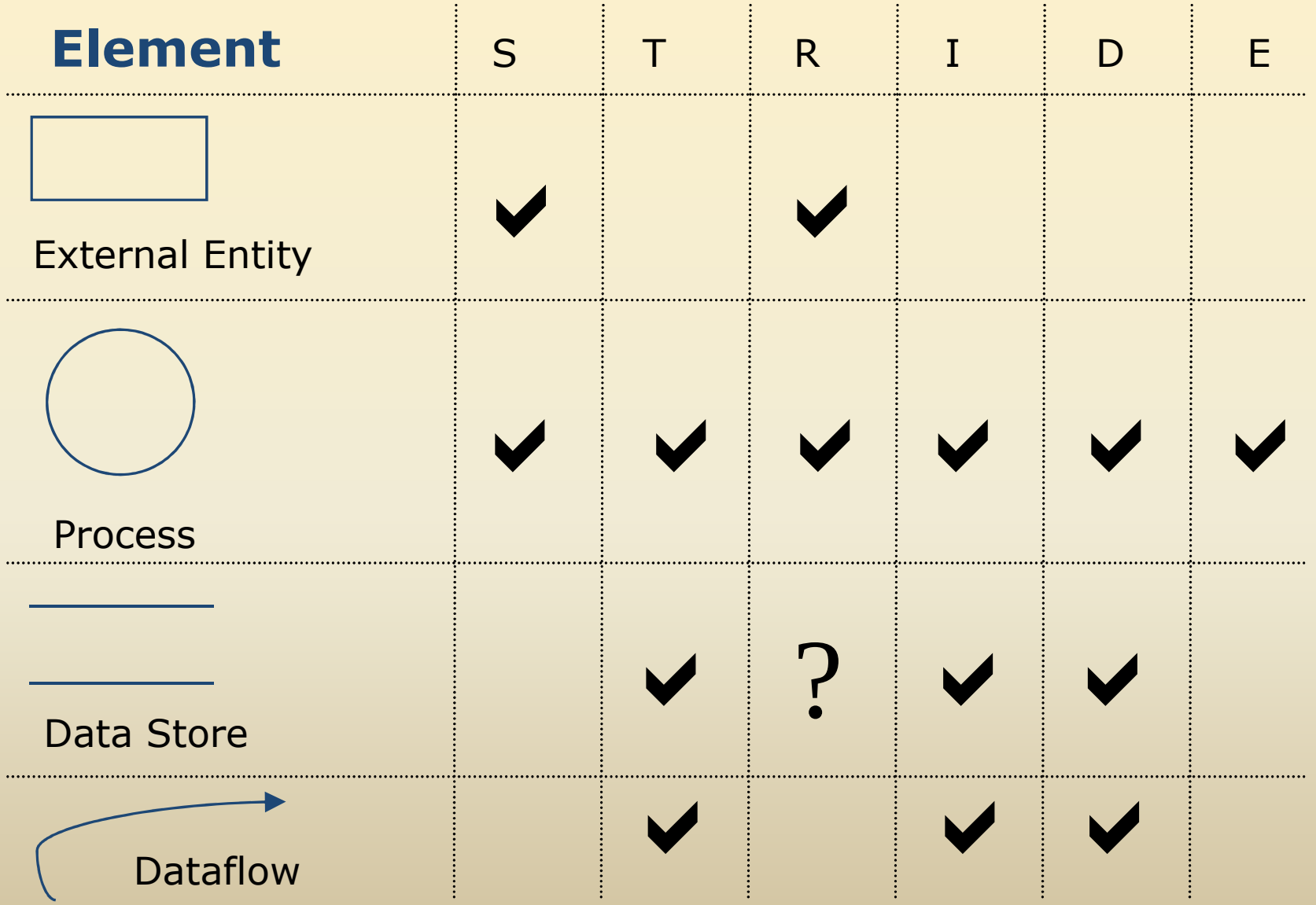
STRIDE/Element: Identifying Threats



Understanding the threats

Threat	Property	Definition	Example
Spoofing	Authentication	Impersonating something or someone else.	Pretending to be any of billg, xbox.com or a system update
Tampering	Integrity	Modifying data or code	Modifying a game config file on disk, or a packet as it traverses the network
Repudiation	Non-repudiation	Claiming to have not performed an action	"I didn't cheat!"
Information Disclosure	Confidentiality	Exposing information to someone not authorized to see it	Reading key material from an app
Denial of Service	Availability	Deny or degrade service to users	Crashing the web site, sending a packet and absorbing seconds of CPU time, or routing packets into a black hole
Elevation of Privilege	Authorization	Gain capabilities without proper authorization	Allowing a remote internet user to run commands is the classic example, but running kernel code from lower trust levels is also EoP

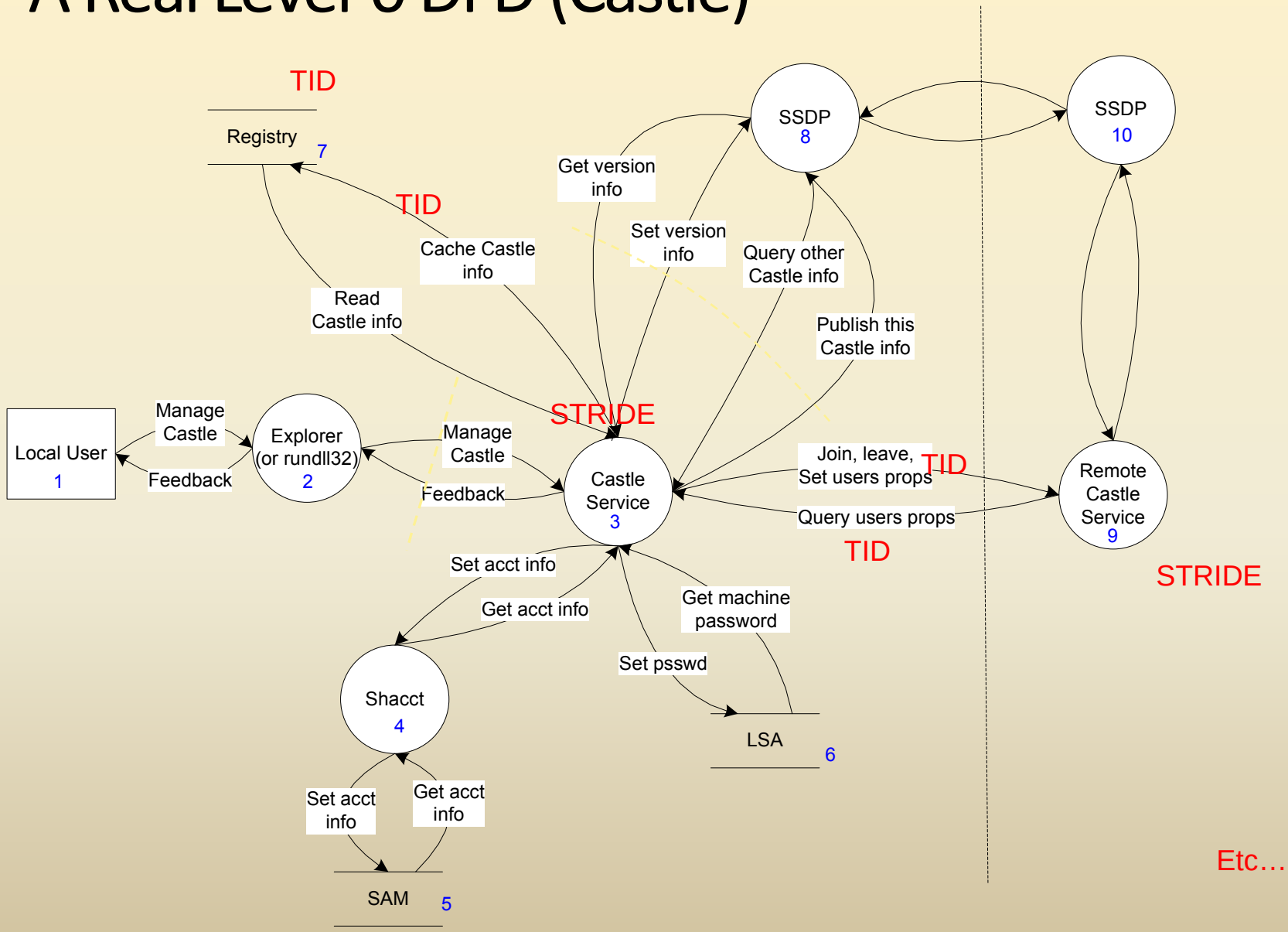
Different threats affect each type of element



Apply STRIDE Threats To Each Element

- For each thing on the diagram:
  - Apply relevant parts of STRIDE
  - External Entity: SR
  - Process: STRIDE
  - Data Store, Data Flow: TID
    - Data stores which are logs: TID+R
  - Data flow inside a process:
    - Don’t worry about T,I or D
- Number things so you don’t miss them

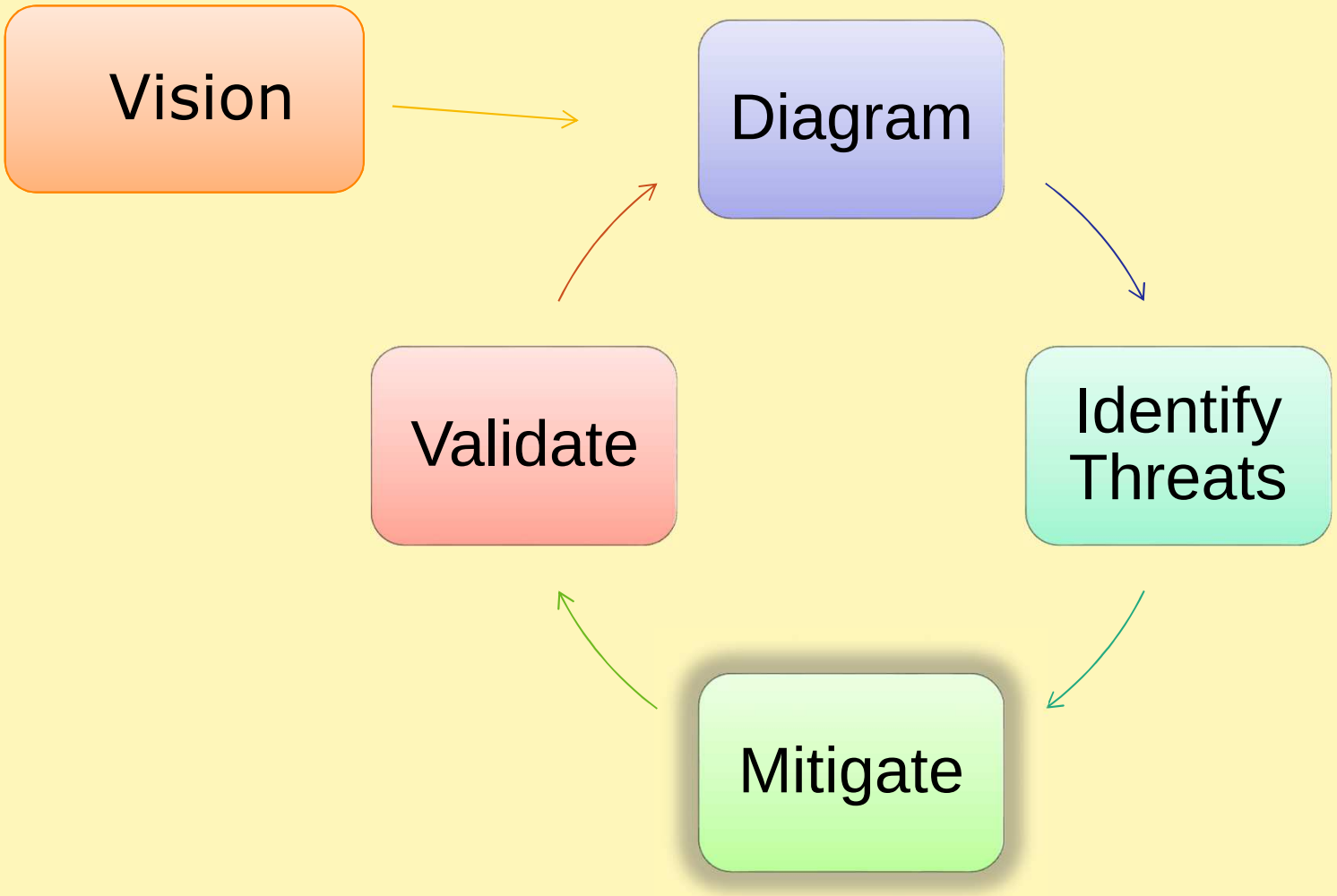
A Real Level-0 DFD (Castle)



Use the trust boundaries

- Trusted/high code reading from untrusted/low
  - Validate everything for specific uses
- High code writing to low
  - Make sure your errors don’t give away too much

STRIDE/Element: Mitigating



Mitigation is the point of threat modeling

- Mitigation:
  - To address or alleviate a problem
- Protect customers
- Design secure software
- Why bother if you:
  - Create a great model
  - Identify lots of threats
  - Stop
- So find problems and fix them
  - File bugs to track them

Mitigate

- Address each threat
- Four ways to address threats:
  - Redesign to eliminate
  - Apply standard mitigations
  - Invent new mitigations
    - Riskier
  - Accept vulnerability in design
- Address each threat!

Standard Mitigations

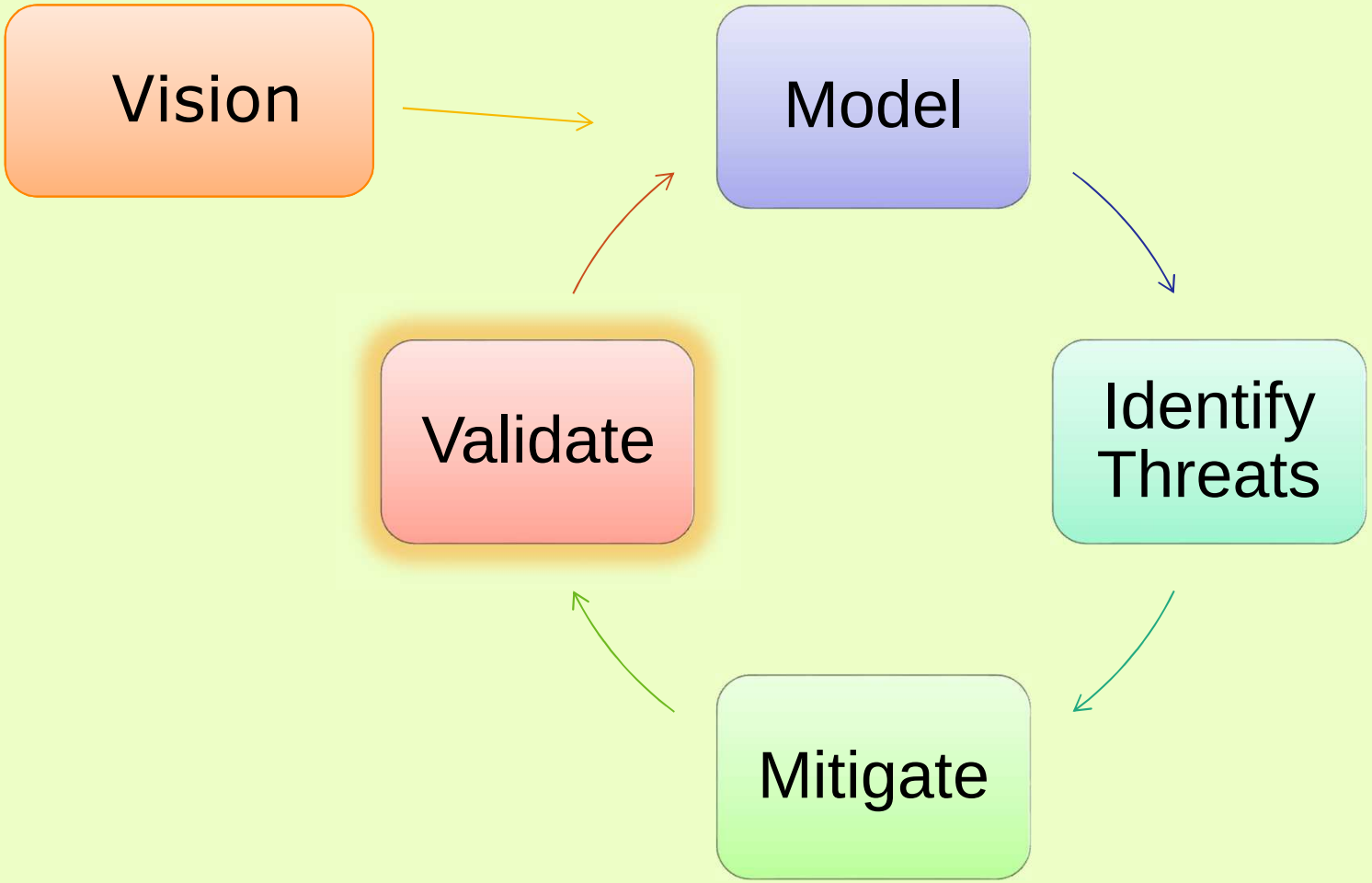
Spoofing	Authentication	To authenticate principals: • Basic & Digest authentication • LiveID authentication • Cookie authentication • Windows authentication (NTLM) • Kerberos authentication • PKI systems such as SSL/TLS and certificates • IPSec • Digitally signed packets To authenticate code or data: • Digital signatures • Message authentication codes • Hashes
Tampering	Integrity	• Windows Mandatory Integrity Controls • ACLs • Digital signatures • Message Authentication Codes
Repudiation	Non Repudiation	• Strong Authentication • Secure logging and auditing • Digital Signatures • Secure time stamps • Trusted third parties
Information Disclosure	Confidentiality	• Encryption • ACLS
Denial of Service	Availability	• ACLs • Filtering • Quotas • Authorization • High availability designs
Elevation of Privilege	Authorization	• ACLs • Group or role membership • Privilege ownership • Permissions • Input validation

Inventing Mitigations is Hard

- Mitigations are an area of expertise like networking, databases, or cryptography
- Amateurs make mistakes, so do pros
- Mitigation failures will appear to work
  - Until an expert looks at them
  - We hope that expert will work for us

- When you need to invent mitigations, get expert help
  - We will try to talk you off the ledge ☺

STRIDE/Element: Validating



Validating Threat Models

- Validate the whole TM
  - Does diagram match final code?
  - Are threats enumerated?
  - Minimum: STRIDE per element that touches a trust boundary
  - Has Test reviewed the model?
    - Created appropriate test plans
    - Tester approach often finds issues with TM, or details
- Is each threat mitigated?
  - Are mitigations done right
- Did you check these before FSR?
  - Shipping will be more predictable

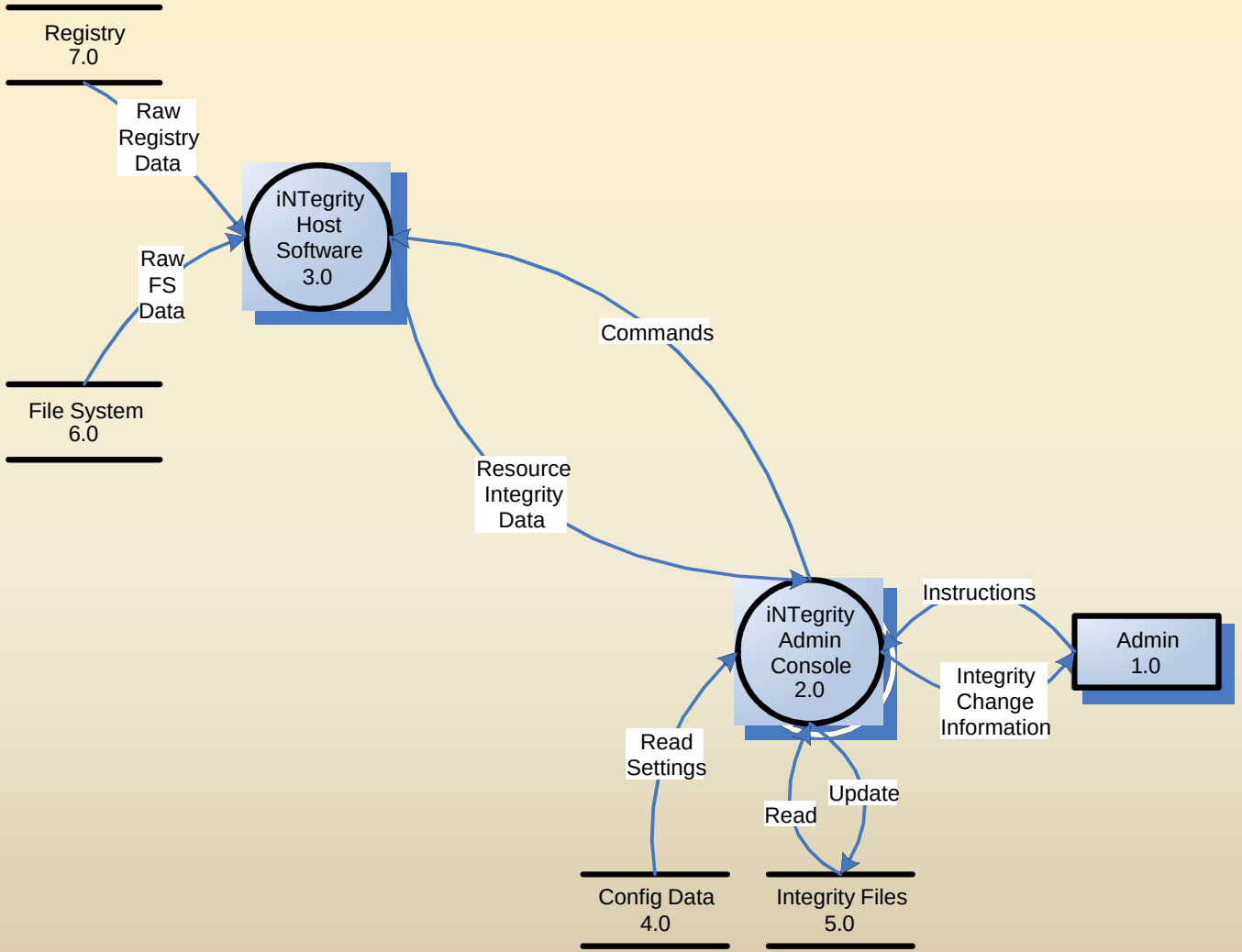
PAUSE FOR QUESTIONS BEFORE EXERCISE

Exercise

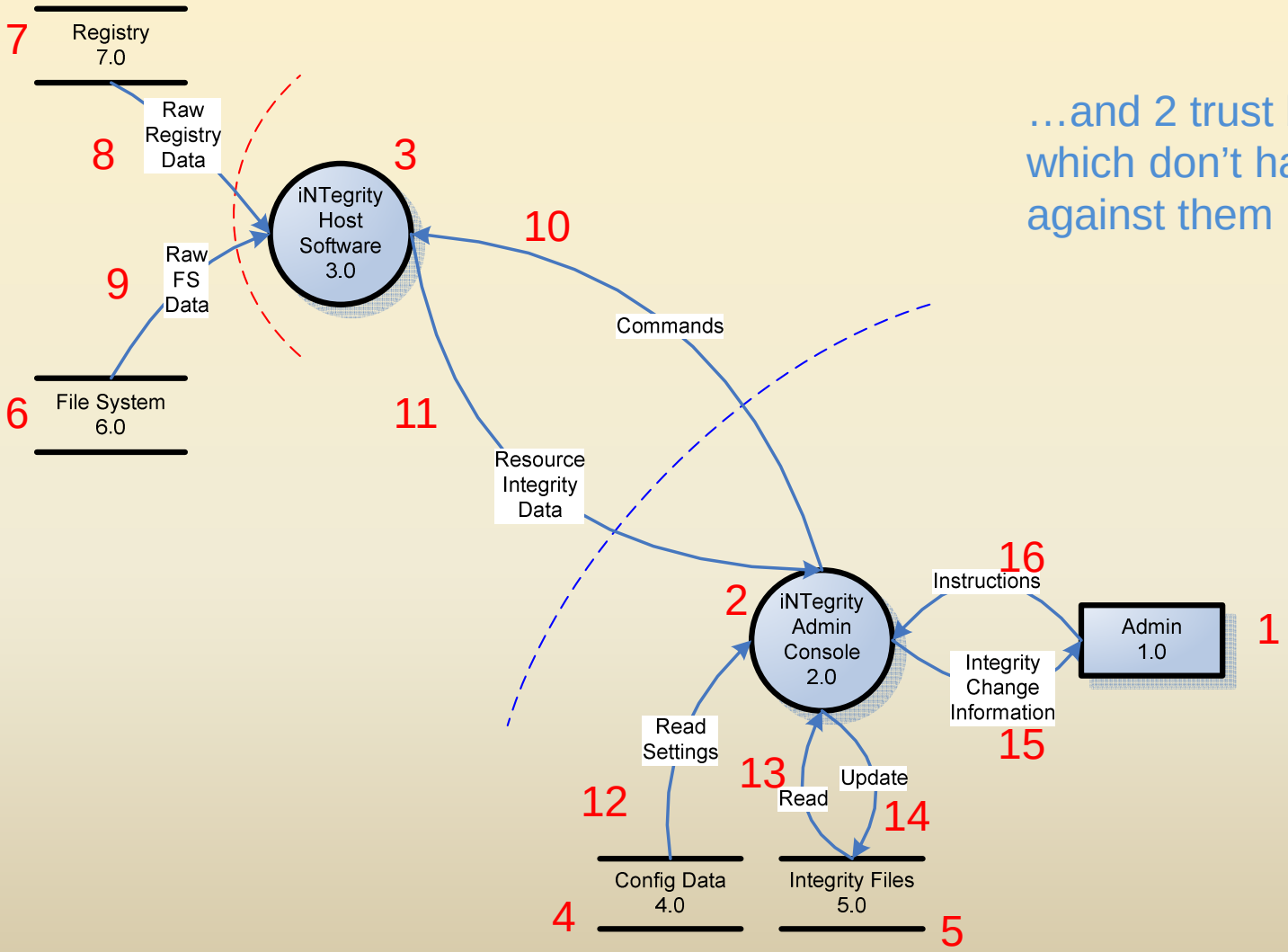
- Handout
- Work in teams to:
  - Identify all diagram elements
  - Identify threat types to each element
  - Identify at least 3 threats
  - Identify first order mitigations

  - Extra credit: improve the diagram

Identify all Elements



Identify all Elements: 16 Elements…



…and 2 trust boundaries, which don't have threats against them

Identify threat types to each element

Threats

Elements

Administrator

Admin console (2) , Host SW (3)

Config data (4), Integrity data (5), Filesystem data (6), registry (7)

8. raw reg data
9. raw filesystem data
10. commands
11. resource integrity data
12. read settings
13. read

.... 16

Identify Threats!

- Specific
- Understand threat and impact
- Identify 1st order mitigations

END EXERCISE

Call to Action

- Threat model your work!
  - Start early
  - Track changes
- Work with your Security Advisors!
- Talk to your “dependencies” about security assumptions
- Learn more
  - http://blogs.msdn.com/sdl

Learning Resources

- MSDN Magazine
  - Uncover Security Design Flaws Using the STRIDE Approach http://msdn.microsoft.com/msdnmag/issues/06/11/ThreatModeling/default.aspx
  - http://msdn.microsoft.com/en-us/magazine/cc700352.aspx
  - Getting Started with the SDL TM Too
  - http://msdn.microsoft.com/en-us/magazine/2009.01.securitybriefs.aspx
- Lots more SDL: Training and Resources
  - http://msdn.microsoft.com/en-us/security/cc448120.aspx
- Books: lots of info which drove evolution of better processes