

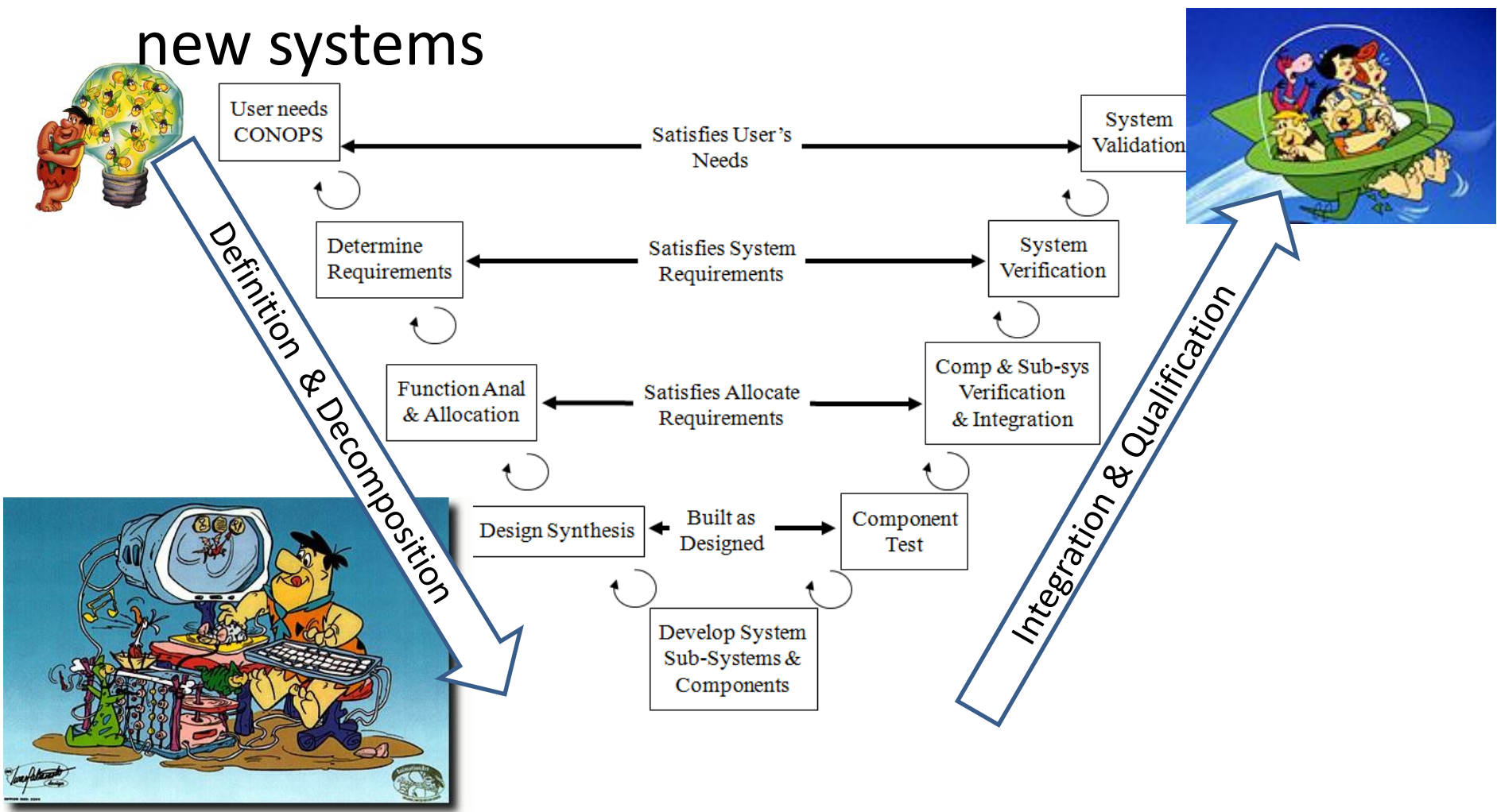
Systems Engineering for Legacy Systems

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Why Legacy Systems?

- All of our academic training is for the design of new systems



Why Legacy Systems?

- Most of us are:
 - Modifying existing systems
 - Integrating new capabilities
- Often we
 - Have no existing requirements baseline
 - Have a fragmented requirements baseline
 - Have no traceability
 - Have sketchy design information

We need an intelligent process to guide us through this quagmire of knowns and unknowns.

Tutorial Project

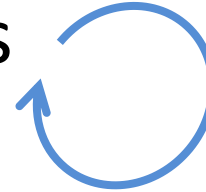
Modifying systems to add new capability

- To proceed we need a project we can all relate with
 - Home computer system upgrade
 - Modify an old tower to control a home security camera system
 - I need a method to make my video (securely) available to me
 - I want notification when my alarm goes off

I will present this project in class in order to illustrate how you might implement a Legacy Systems Engineering Process

What is our process?

1. Determine our requirements
2. Synthesize a design solution
3. Develop or acquire the necessary components
4. Integrate the components
5. Verify compliance
6. Validate the end solution in its intended environment



Expect a highly
iterative process

Looks like the Systems Engineering V-model, doesn't it?

How do we determine our requirements?

- Define the desired functional & performance requirements of the “Future” state
- Determine our “As is” state
 - Create a model of our physical system
 - Document interfaces (physical, electrical, logical)
 - Document functionality of each component
- Trade alternative “Future” state solutions
 - Identify the interfaces relevant to our upgrade
 - Are there any interface issues to be resolved?
 - Is there any functionality needed on the “legacy” side of the interface?
 - What is the cost of the upgrade?
 - What is the technical difficulty?
- Translate the result into a set of requirements
 - Technical requirements
 - Task requirements
- Capture the requirements in a systems specification¹ and use that to guide the development and testing

1. Our specification may be model based or document based as required to fit our environment

How do I know if I'm going to get the reliability I need?

- Once I have an architecture I can analyse the failure modes and effects
 - What are my probable failures?
 - Can I use my physical model to identify failure modes?
 - Can I use my physical model to understand the cascading effects?
 - What are the resultant probabilities?

How do I define my integration process?

- Using the physical model to define the integration process
 - Disassembly of the existing system
 - Reassembly and integration of new components
 - What test should I perform during integration?

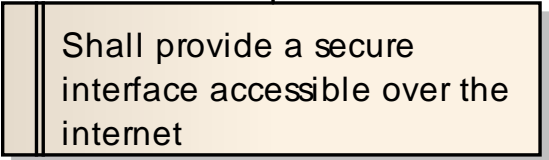
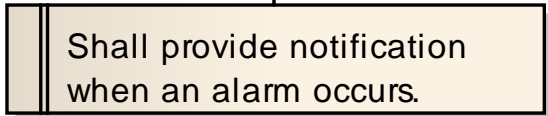
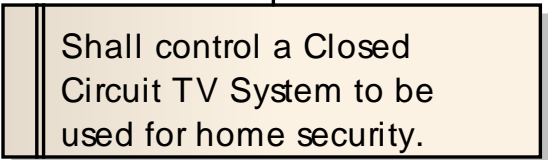
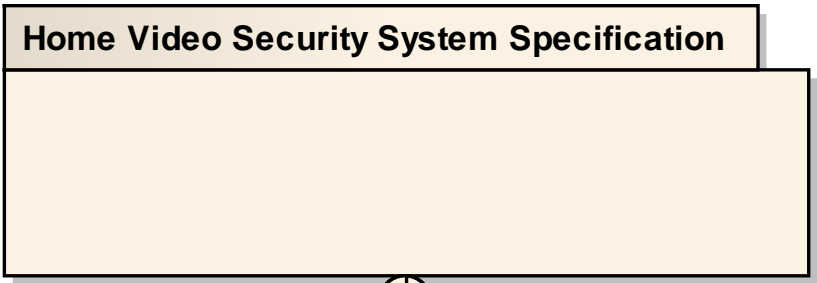
How do I define my final set of tests?

- Verification
 - How do I ensure that the final product satisfies my requirements?
- Validation
 - How do I ensure that the final product will meet my operational needs?

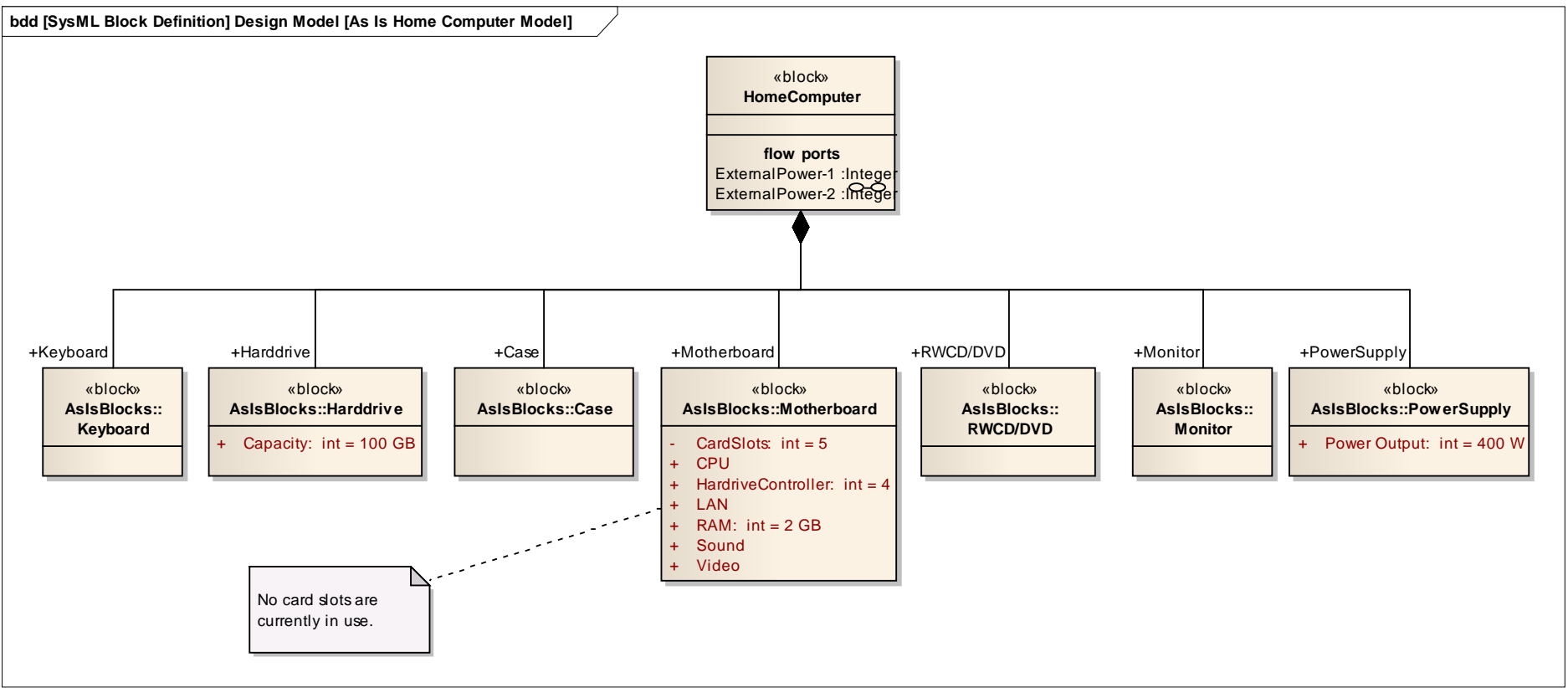
Home Video Security System

Customer Requirements

req [SysML Requirements] Home Video Security System Specification [Specifications]

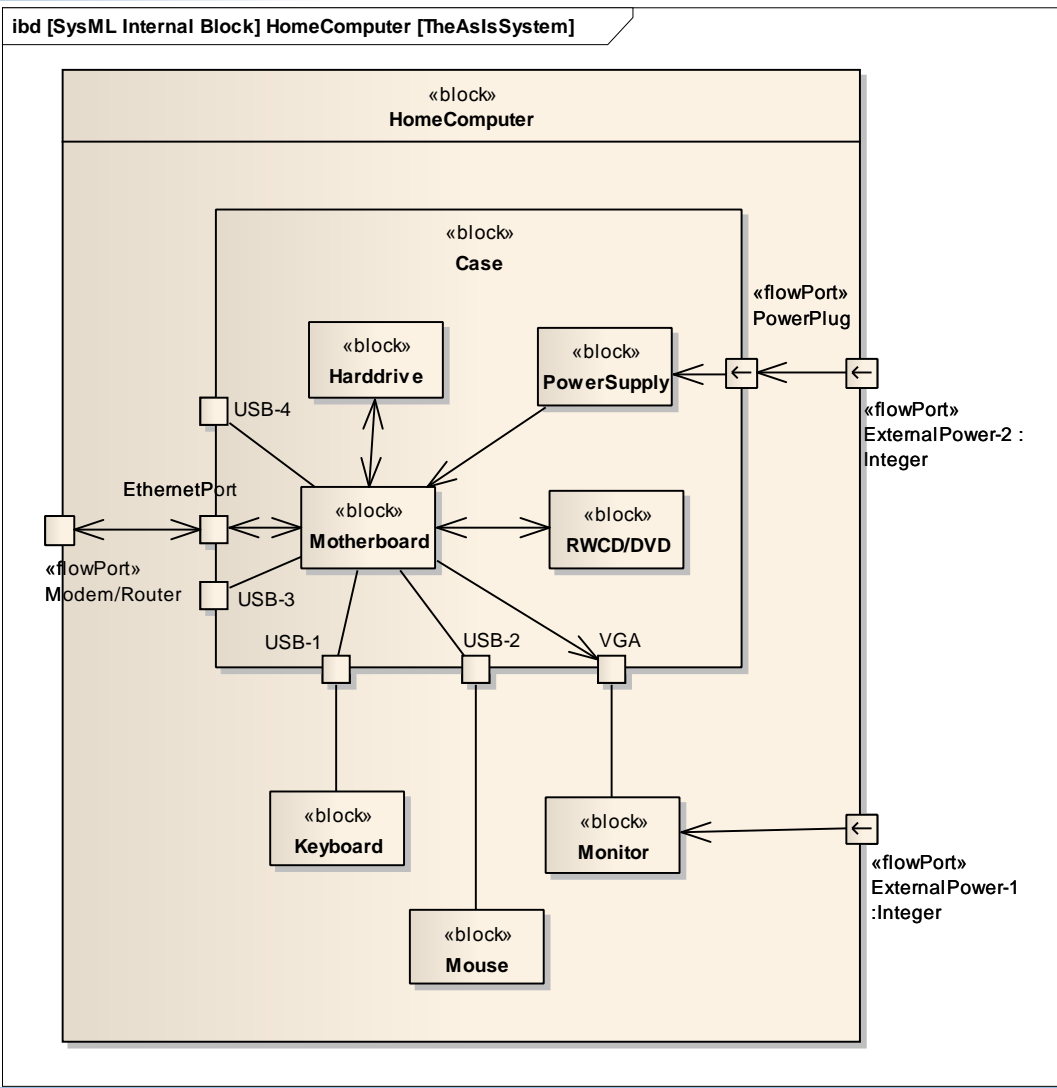


Decomposition of the Home Computer System



Understanding the "As-Is" state of our system.

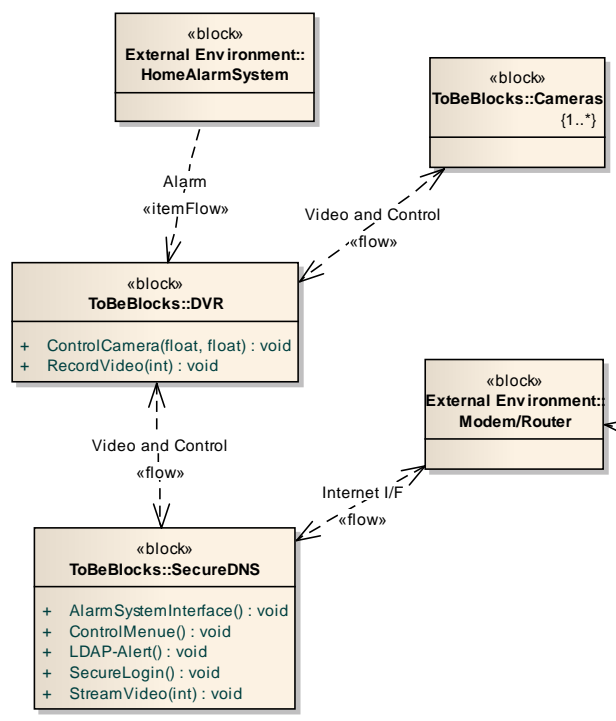
Block Diagram of Home Computer



Understanding the "As-Is" state of our system.

Design Trade Environment

ibd [SysML Internal Block] Design Model [TheToBeSystem (Functional)]



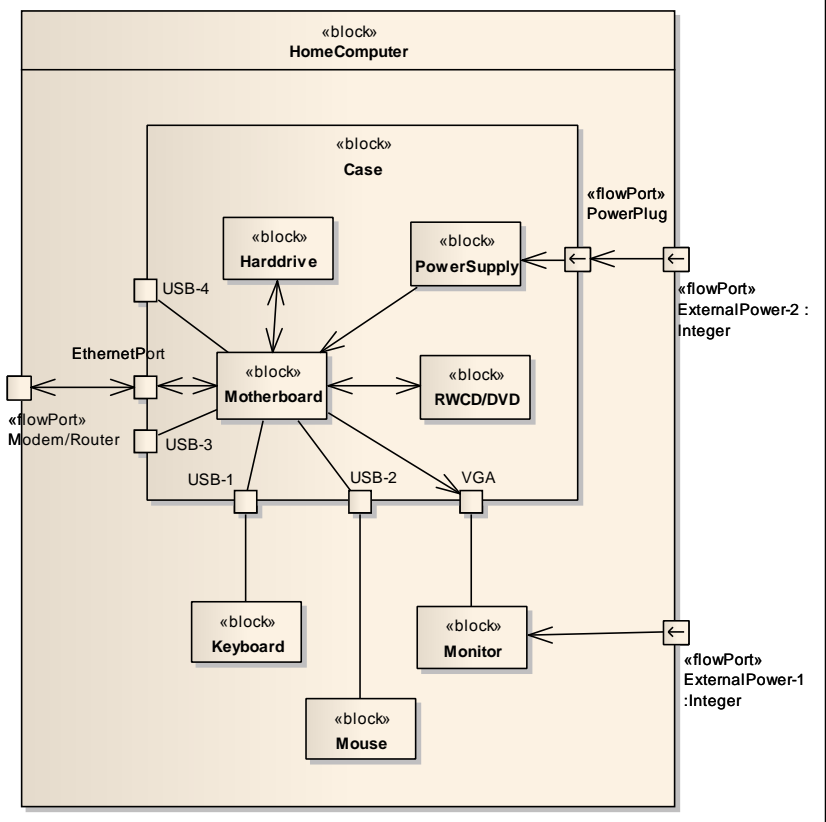
Trades

1. DVR System internal or external to home computer
2. Develop own DNS environment or use an OTS solution

Analysis

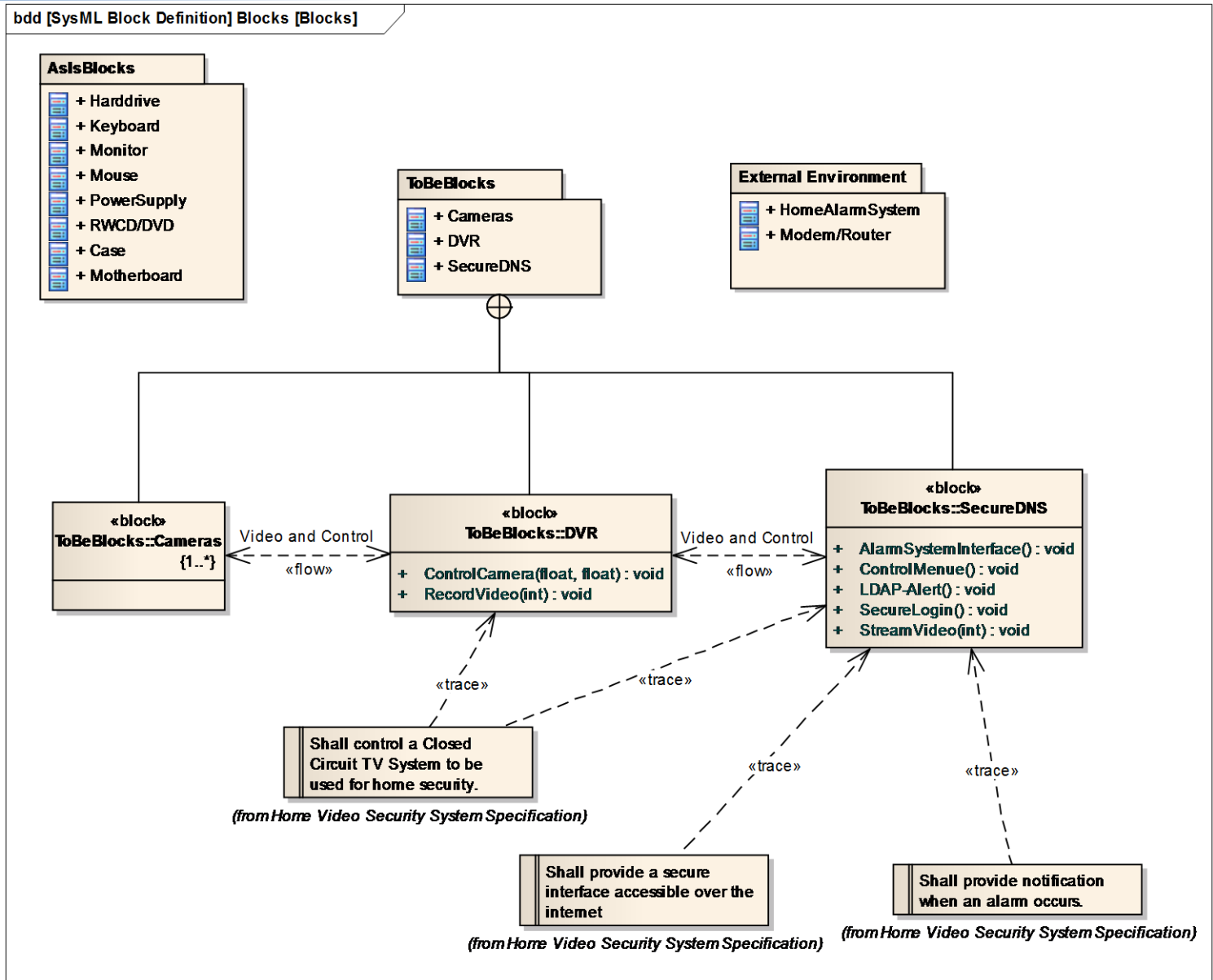
1. Determine the number of cameras needed
 - 4 camera system -- Low Cost
 - 8 camera system -- Medium Cost
 - 16 camera system -- High Cost
 - >16 camera system -- Cost Prohibitive

ibd [SysML Internal Block] HomeComputer [TheAsisSystem]



“To-Be” State (functional)

Mapping of Customer Requirements



Requirements Analysis

- “As Is” System Definition
 - Computer Interfaces
 - 5 available PC card slots
 - Ethernet interface
 - Functionality
 - Interfaces with Internet through Modem/Router
 - Constraints
 - Hard drive memory may limiting depending on information loaded on system
 - RAM of 2 GB
 - Power Supply of 400 W

Requirements Analysis

- “To Be” System Trades
 - DVR Internal or External
 - Impacts definition of LAN I/F
 - Impacts camera type selection
 - Internal will require IP Cameras
 - » May have an impact on the current router if the cameras are not wireless
 - External can use standard analog video and a serial control I/F
 - Impacts on-board Video, greater capacity may be required (> 2 GB VRAM for internal DVR)
 - DNS
 - Use Vendor Supplied with a Security System
 - Develop a DNS

Requirements Analysis

- “To Be” System Trades – Questions to answer
 - Is there any functionality needed on the “legacy” side of the interface?
 - External
 - Internal
 - What is the cost of the upgrade?
 - External
 - Internal
 - What is the technical difficulty? (10-easy, 1-very difficult)
 - External
 - Internal

Architecture Trades

		Candidates					
		Internal			External		
Evaluation Criteria.	Wt.	Performance	Raw Score	Wtd. Score	Performance	Raw Score	Wtd. Score
Card Slots Rq'd	4.23	Req's Video Card	10	42.27	No Video Card	10	42.27
HD impact	3.16	Records on HD	5	15.82	Records at DVR	10	31.64
RAM impact	18	None	10	179.98	None	10	179.98
Power Supply impact	14.5	None	10	144.77	None	10	144.77
LAN I/F impact	3.55	None at Computer	7	24.82	None	10	35.46
Camera functionality	6.99	Requires more expensive camera	1	6.99	Requires less expensive analog camera	1	6.99
Video card impact	8.38	Requires increase in Video RAM to 2 GB	1	8.38	None	10	83.79
DNS	6.76	Can use commercial or own DNS	10	67.58	Requires a commercial DNS	8	54.06
Legacy Functionality	3.86	Significant impact to functionality	1	3.86	No impact	10	38.58
Cost of upgrade	8.8	Roughly equal	1	8.80	Roughly equal	1	8.80
Difficulty	21.8	Slightly more	8	174.45	Slightly less	10	218.07
Total	100			677.72			844.41

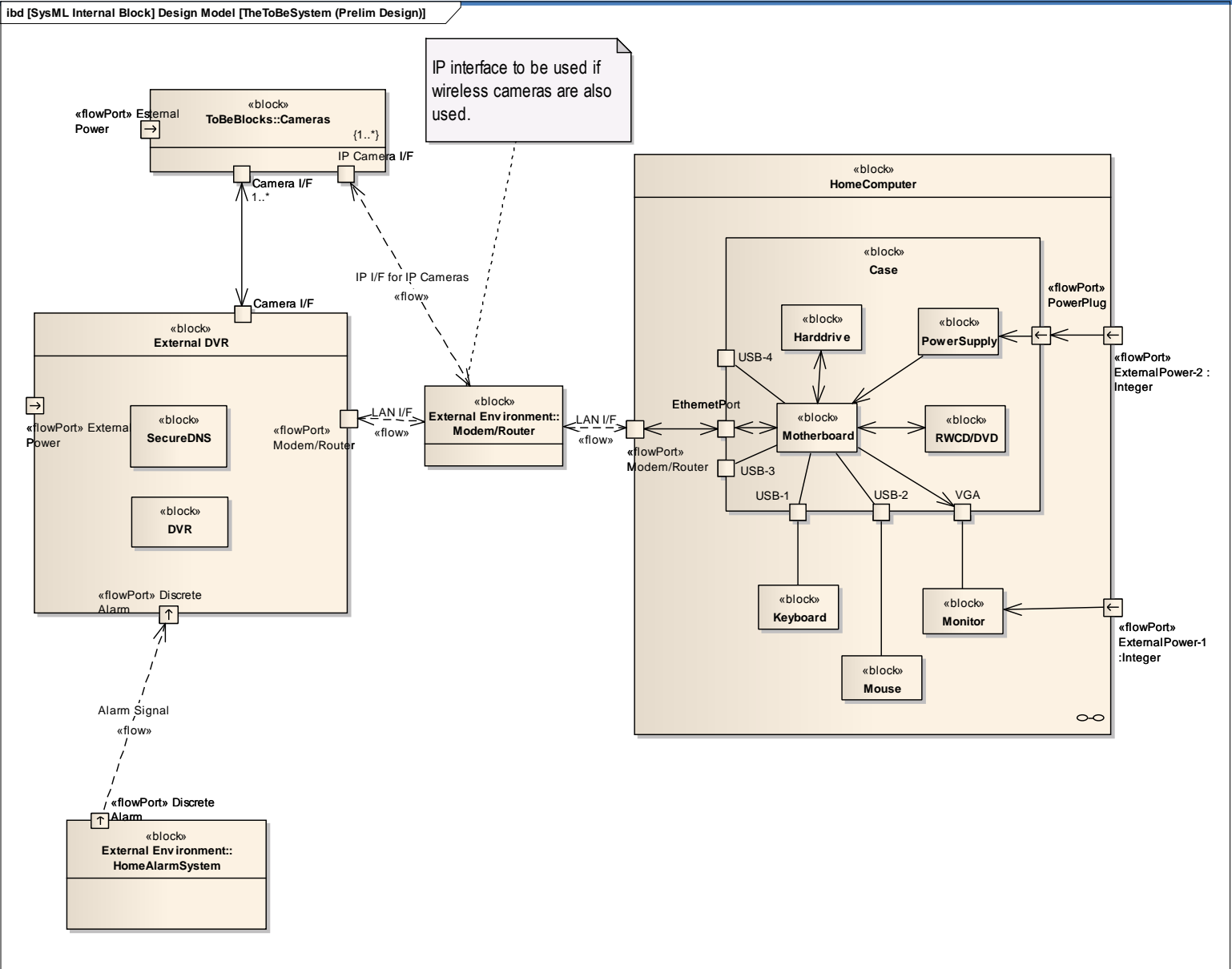
Results of Architecture Trades

- I have not picked a specific solution only an approach
 - I did use knowledge gained from some research of available solutions

I do have an architecture!

Preliminary Design

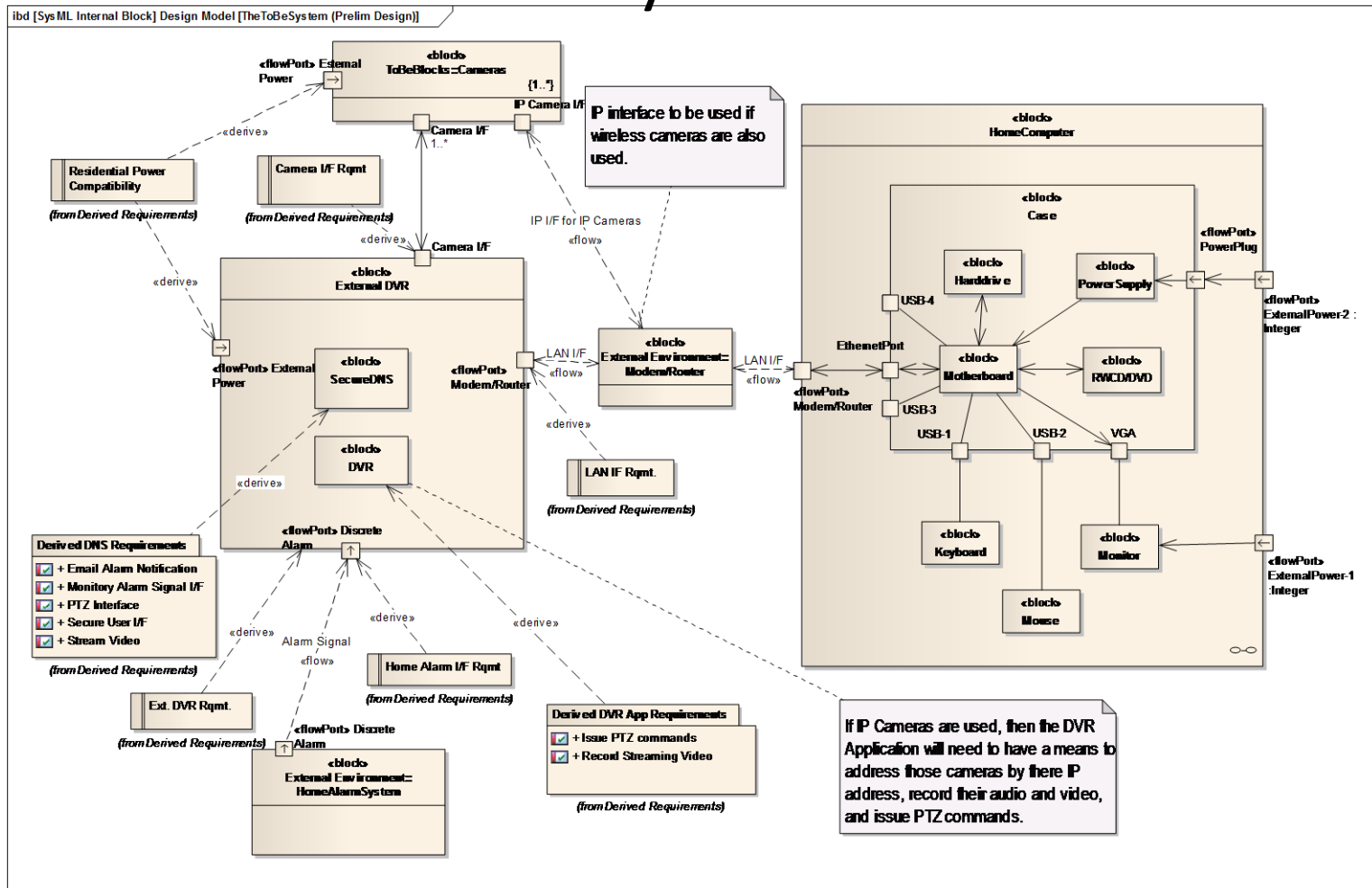
Home Video Security System Architecture





Requirements Derivation

- I'm now ready to capture my requirements that I will use to select my final solution



Failure Modes and Effects



HVSS FMEA

1	2	3	4	5	6	7	9	8	10
FR, DP, or Process Step	Potential Failure Mode	Potential Failure Effects	S E V	Potential Causes	O C C	Current Controls	D E T	R P N	Actions Recommended

1. Define scope, the Functional Requirements (FR), or Design Parameter (DP) and process Steps
2. Identify potential failure modes
3. Potential failure effects(s)
4. Severity (1-Least Severe to 10-Most Severe)
5. Potential causes
6. Occurrence (1-Remote, unlikely to 10-Very High, persistent failures)
7. Current controls
8. Detection (1-Almost certain to 10-Absolute uncertainty)
9. Risk priority number = $SEV * OCC * DET$
10. Actions recommended

Integration Plan

- Table Top (My SIL)
 1. Single Camera integration with DVR
 2. DVR integration with My Computer
 3. Connect DVR to Modem/Router
 4. Power on and follow OEM setup procedures
 5. Test all Camera ports
 6. Login to Secure Internet Site and test functionality

Integration Plan

- Full Integration
 1. Install External DVR in a secure location
 2. Run Power to DVR
 3. Run Ethernet cables to DVR (if not wireless)
 4. Run Cable for first camera
 5. Connect camera before mounting and use video feed to determine final mounting location
 6. Mount Camera
 7. Repeat steps 4, 5, & 6 until all cameras are mounted

Final Test Activities

- Integration verified the basic system
- Login to secure site using “Air Card” and test functionality
- Login to secure site from work and test functionality

In Summary, What did we learn?

- With some minor tailoring our SE process still works
 - We need to understand our customer's requirements apart from what the final system looks like
 - We need to understand the "As Is" system
 - The "To Be" functional model is needed for
 - requirements allocation of customer requirements
 - Identification of design trades
 - Design trades, failure modes analysis, implementation, verification and validation proceed as always