
Investigating the Role of Product Information in End-of-Life Decision Making

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OVERVIEW

- Introduction to EOL Management
- The problem
- Possible solution
- Research question
- Product recovery modelling
- Concluding remarks

INTRODUCTION

What is End-of-Life (EOL) Management?

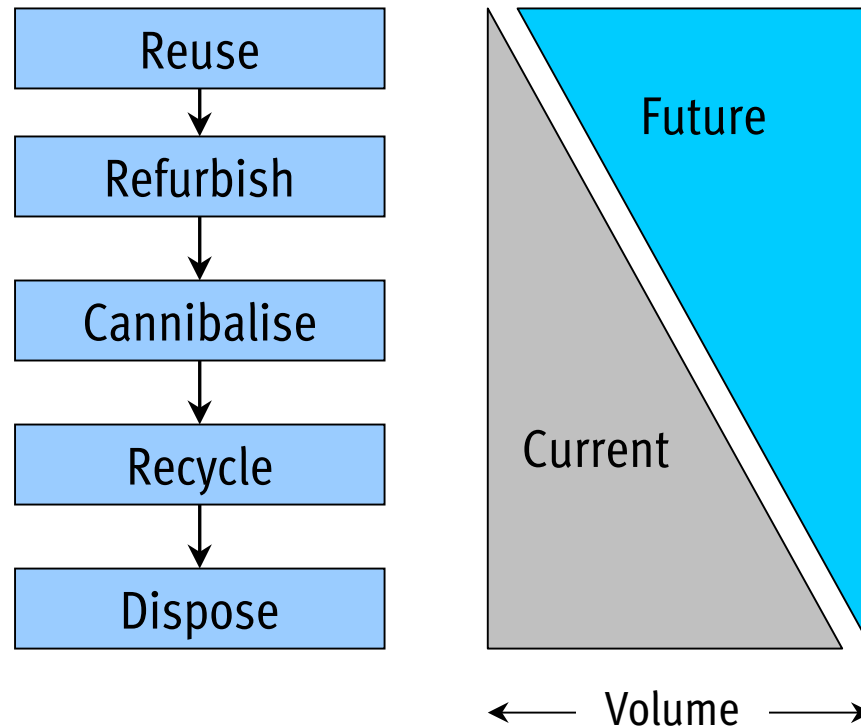


Why End-of-Life Management?

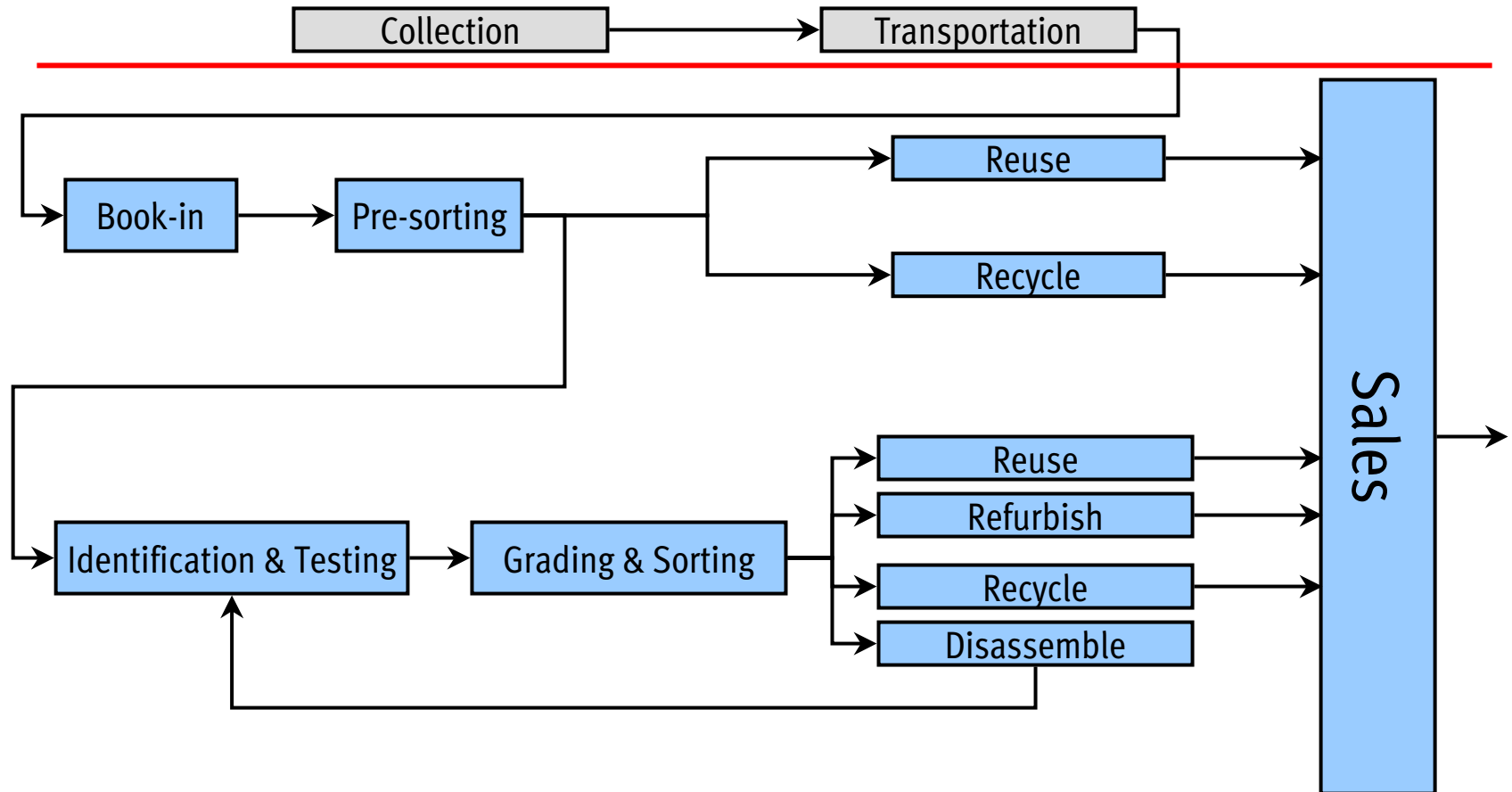
- Government Regulations
- Financial Motives
- New Marketing Opportunities

PRODUCT RECOVERY OPTIONS

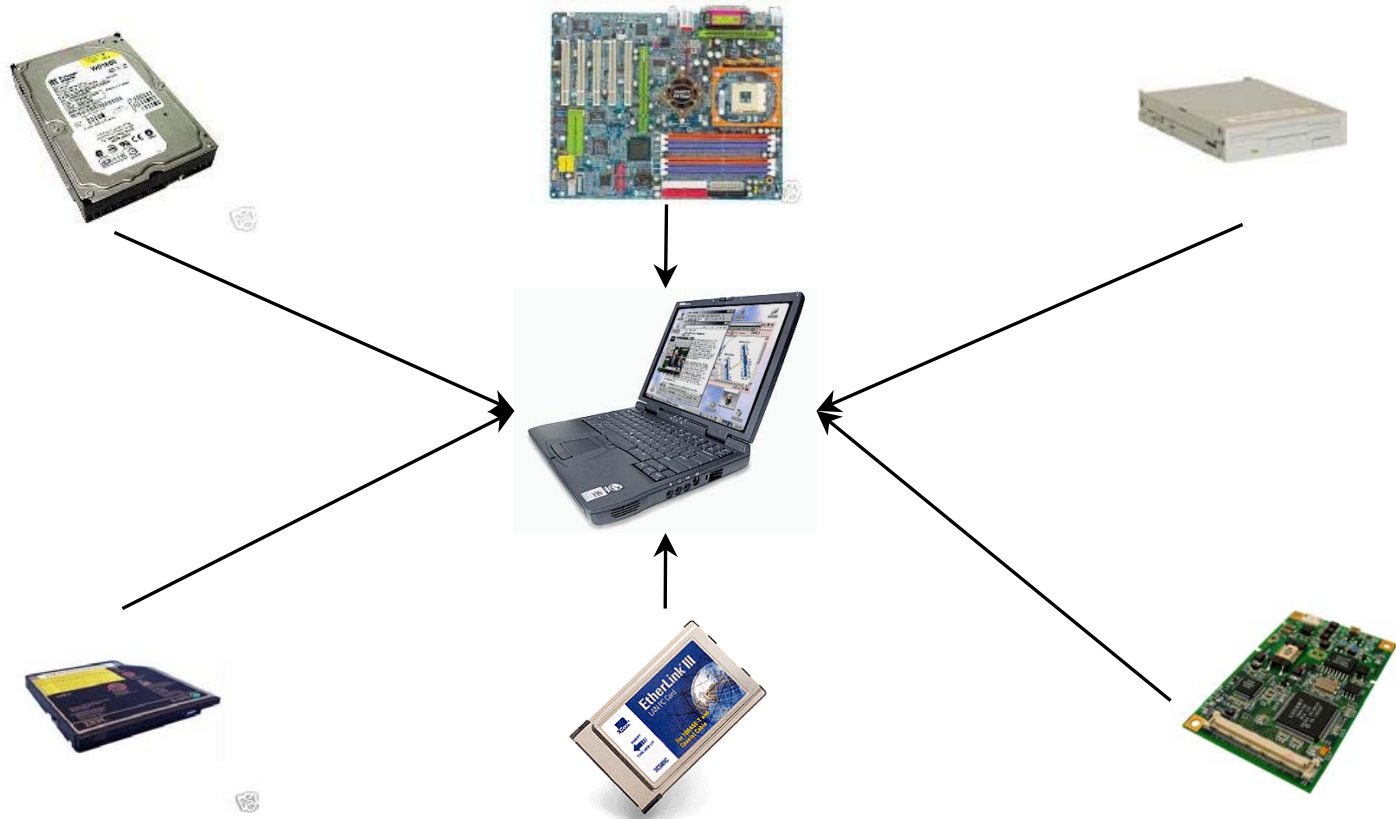
Objective: Maximise of product recovery



PRODUCT RECOVERY OPERATIONS



EXAMPLE: LAPTOP



INFORMATION AVAILABILITY

Laptop

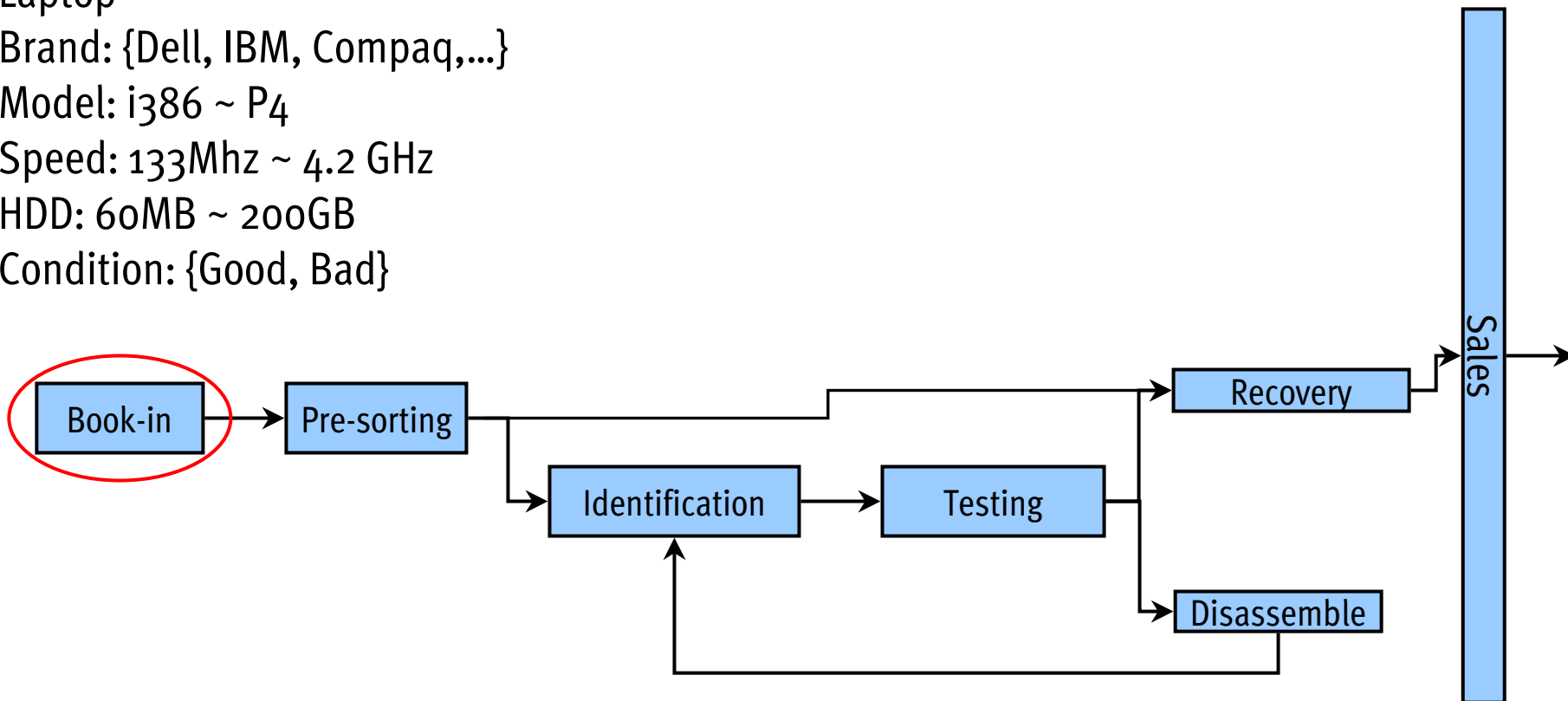
Brand: {Dell, IBM, Compaq,...}

Model: i386 ~ P4

Speed: 133Mhz ~ 4.2 GHz

HDD: 60MB ~ 200GB

Condition: {Good, Bad}



INFORMATION AVAILABILITY

Laptop

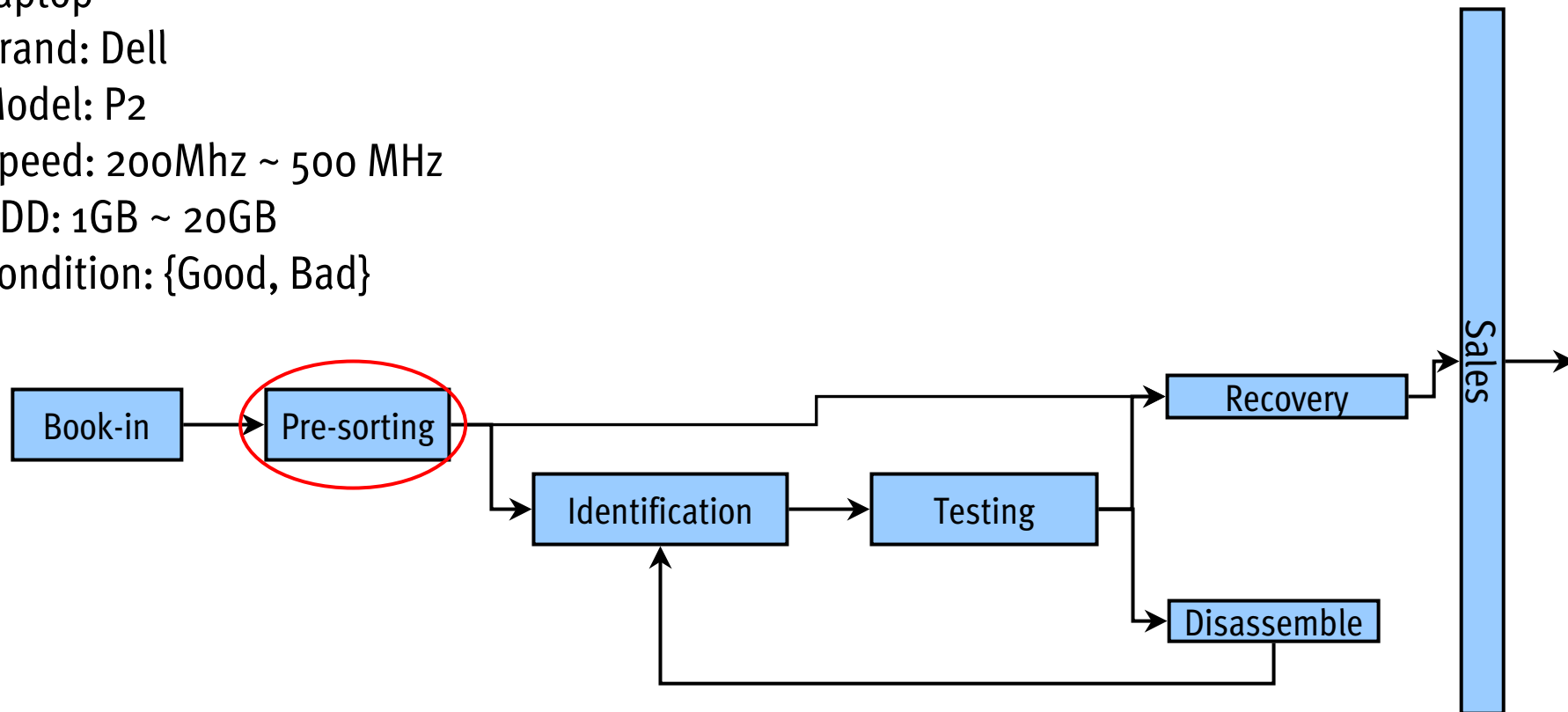
Brand: Dell

Model: P2

Speed: 200Mhz ~ 500 MHz

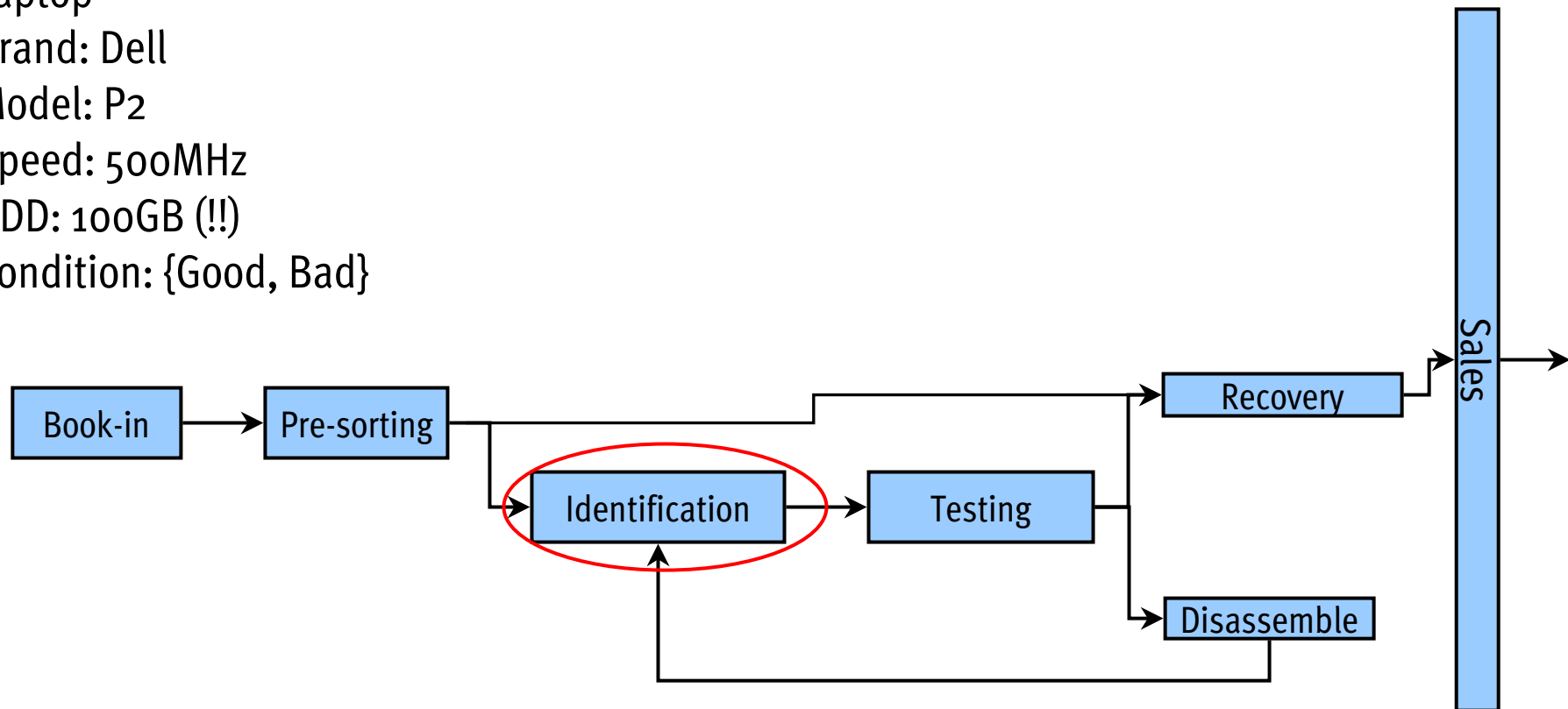
HDD: 1GB ~ 20GB

Condition: {Good, Bad}



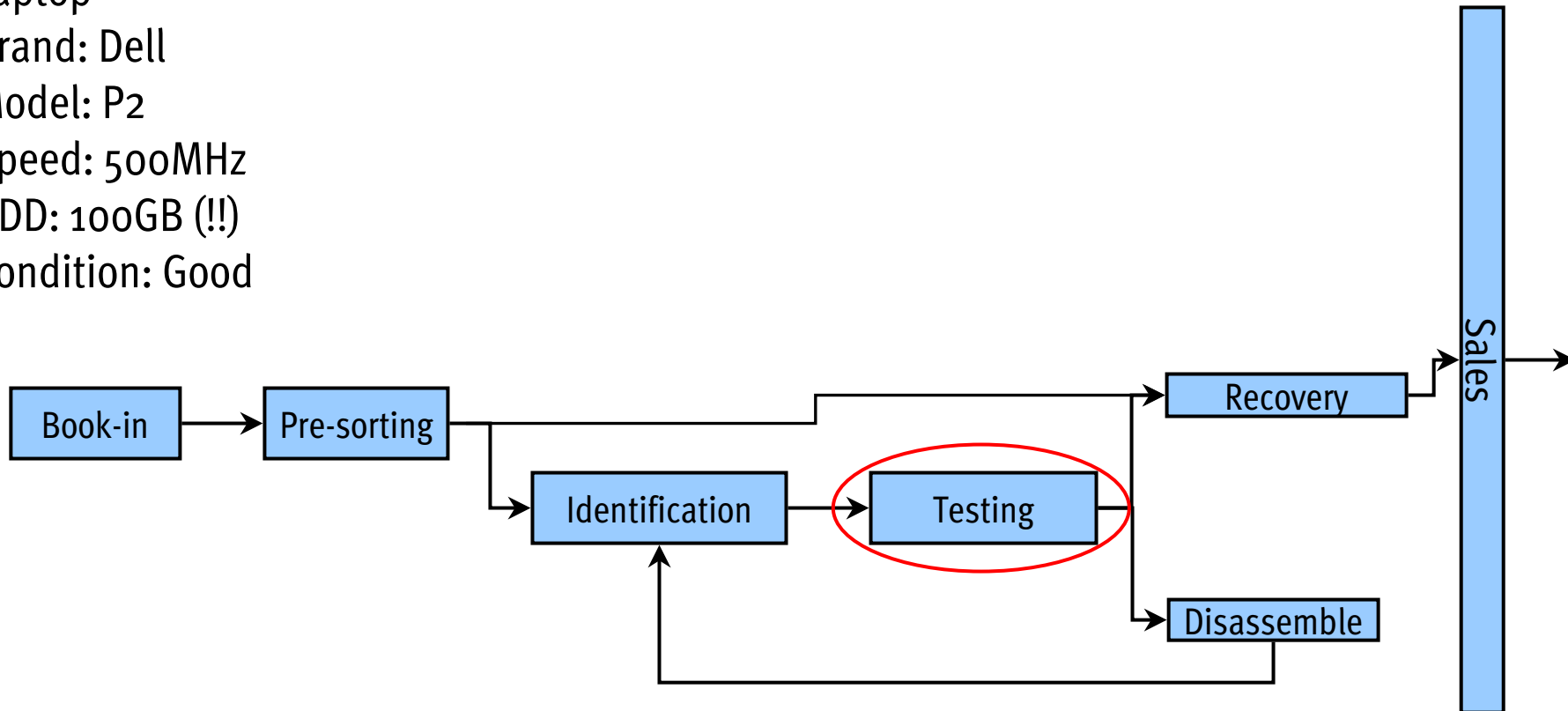
INFORMATION AVAILABILITY

Laptop
Brand: Dell
Model: P2
Speed: 500MHz
HDD: 100GB (!!)
Condition: {Good, Bad}



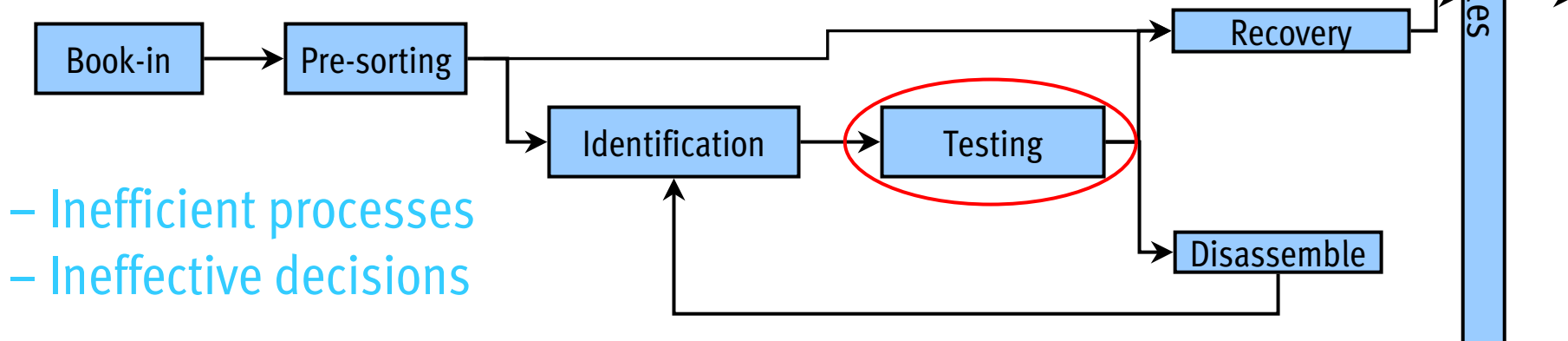
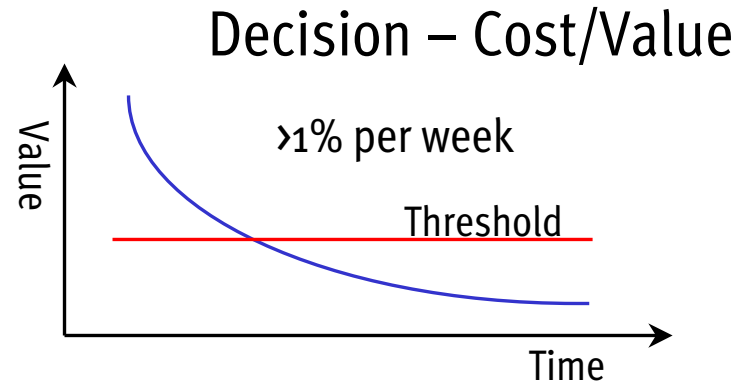
INFORMATION AVAILABILITY

Laptop
Brand: Dell
Model: P2
Speed: 500MHz
HDD: 100GB (!!)
Condition: Good



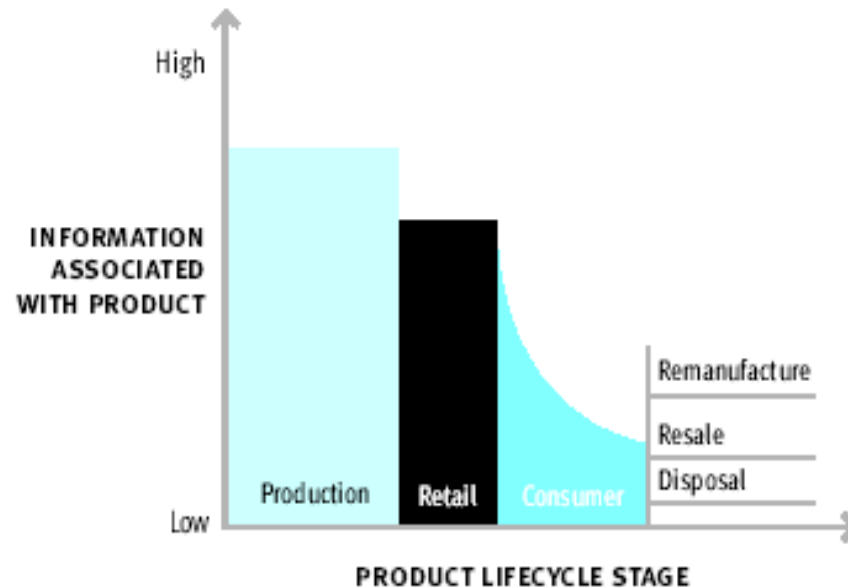
INFORMATION AVAILABILITY

Laptop
Brand: Dell
Model: P2
Speed: 500MHz
HDD: 100GB (!!)
Condition: Good



- Inefficient processes
- Ineffective decisions

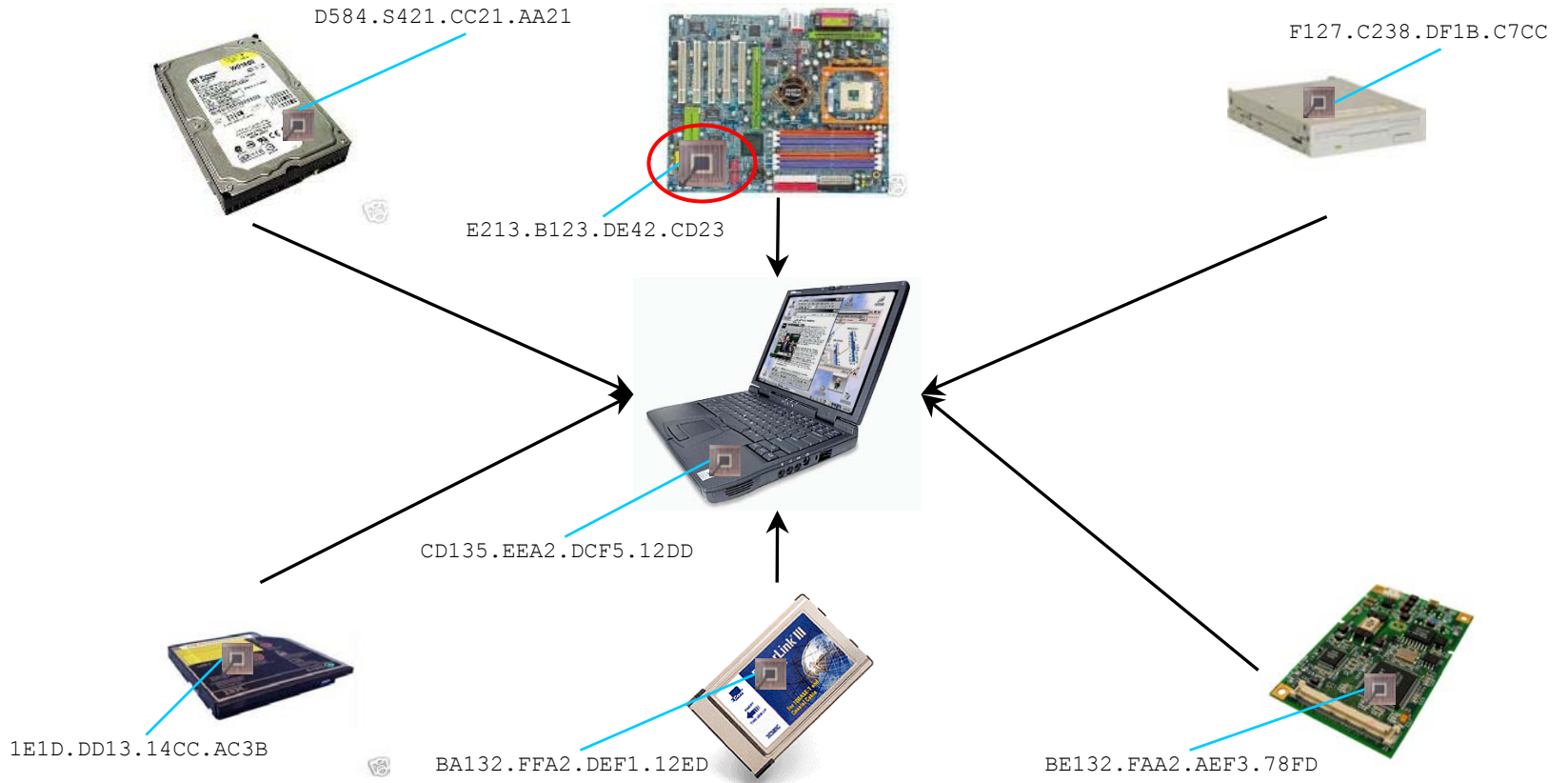
THE PROBLEM



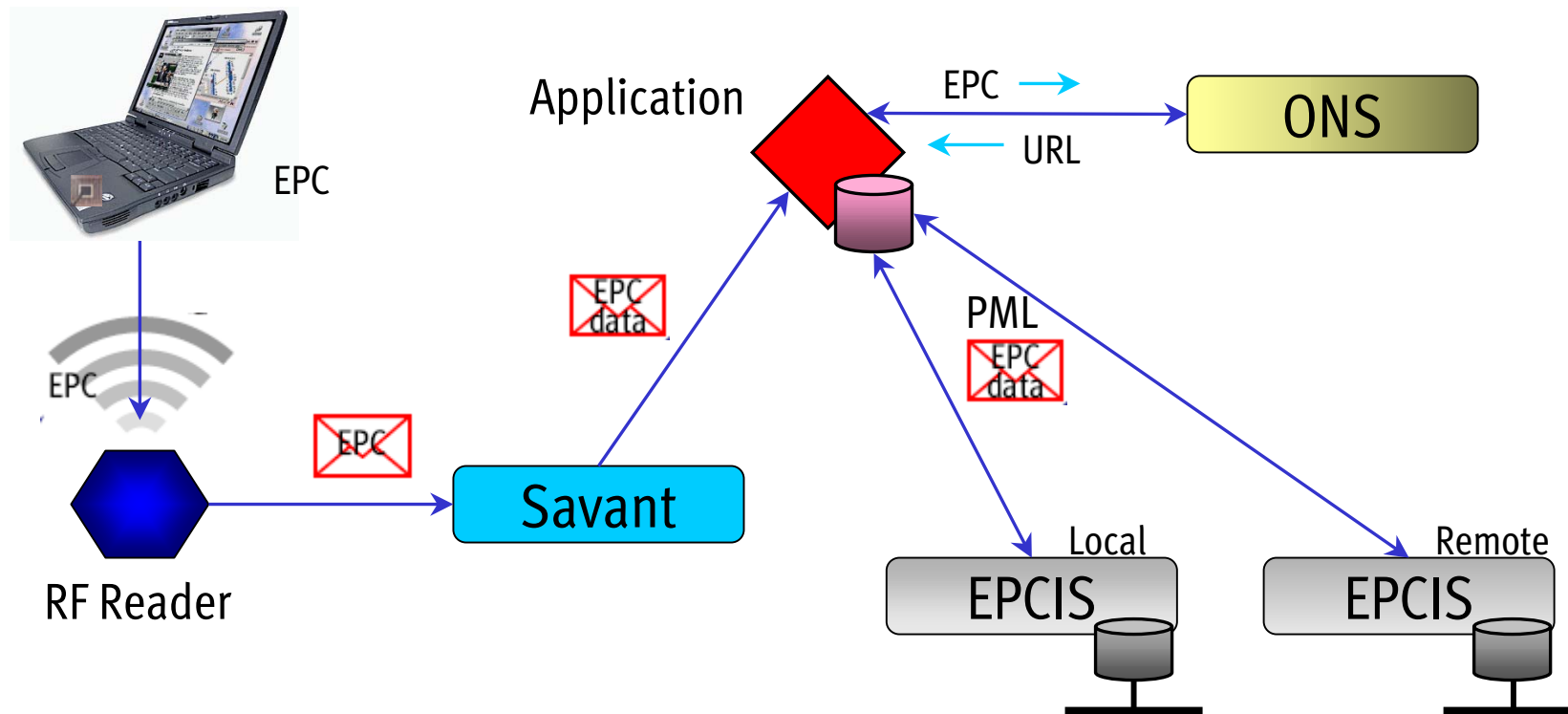
Ready availability of product information

- Completeness
- Timeliness

ELECTRONIC PRODUCT CODE (EPC™)



EPC™ NETWORK TECHNOLOGY BUILDING BLOCKS

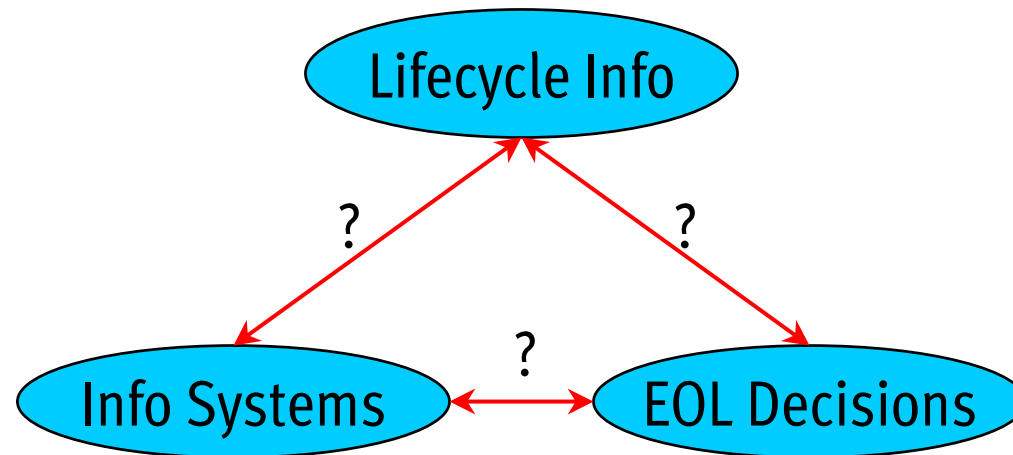


RESEARCH GAP

Ready availability of product information results in:

- Process improvements
- Decision improvements

But...



AIM OF RESEARCH

Measure the “impact” of readily available product information on effectiveness of EOL Decisions.

- How does availability of product information influence recovery processes?
- Will enhanced product information change recovery decisions?
- Will it result in higher product recovery/reuse?
- Will it result in higher profits?

“Benefit” part of the cost/benefit analysis

MODELLING REQUIREMENTS

- Represent product structure
 - Structural uncertainty
- Represent product quality
 - Quality uncertainty
- Represent product recovery process
 - New information gathered at each step
- Represent product recovery decisions
 - Decisions depend on information availability
 - Value depends on product quality
 - Value depends on recovery option chosen
 - Value decreases with time

MODELLING TECHNIQUES

- Graphical techniques (representation of product structure & process)
 - AND/OR Graphs
 - Petri Nets
 - Bayesian networks
- Mathematical modelling (decision modelling)
 - Linear programming
 - Dynamic programming

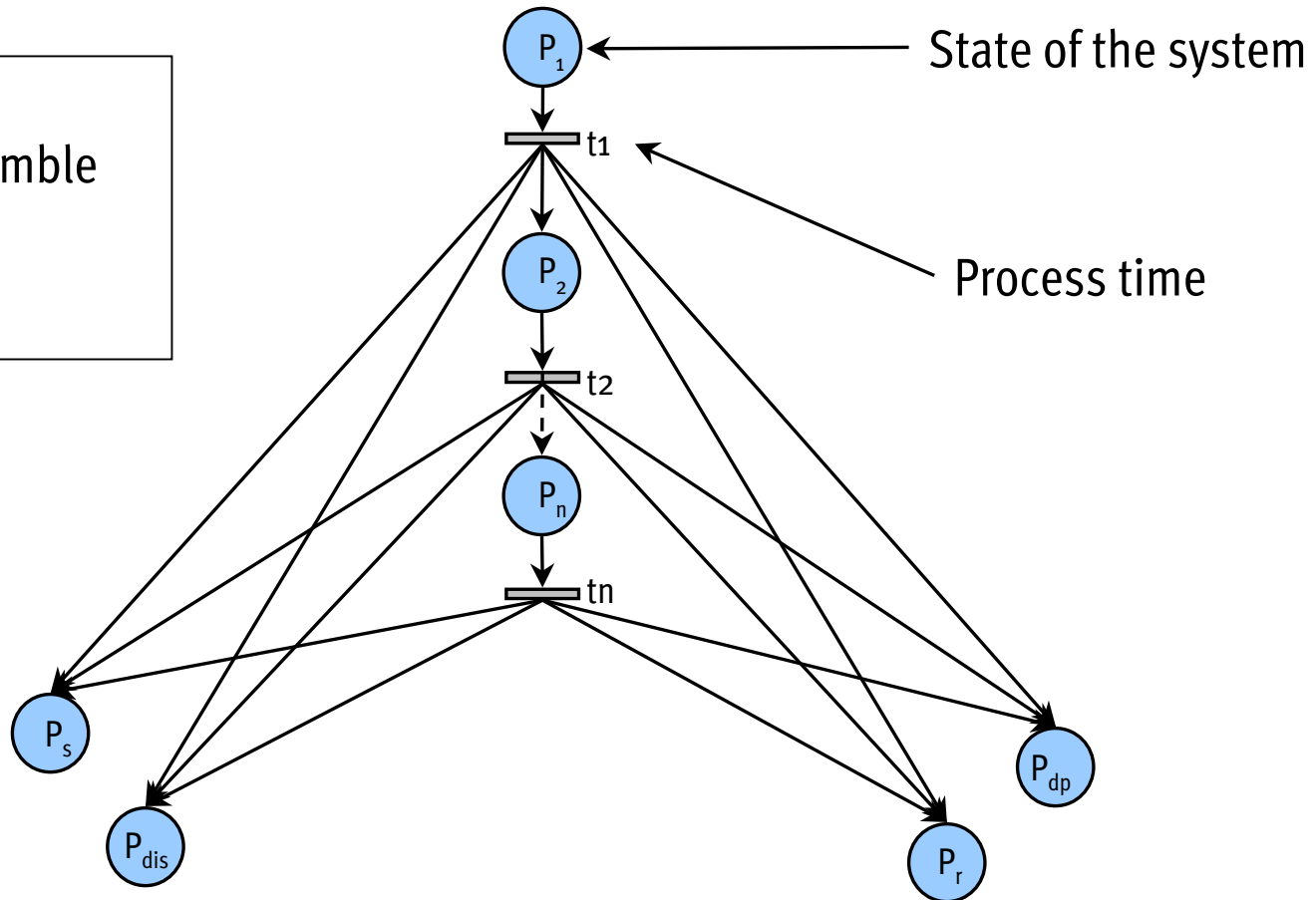
Partially Observable Markov Decision Processes (POMDP)

PROPOSED MODELLING TECHNIQUE

- Process representation
 - Petri Nets
- Product representation (structure & quality)
 - Bayesian Network (belief spaces)
- Decision model
 - Partially Observable Markov Decision Processes (POMDP) & Dynamic programming

PROCESS REPRESENTATION

P_s = Service
 P_{dis} = Disassemble
 P_r = Recycle
 P_{dp} = Dispose



PRODUCT REPRESENTATION

Laptop

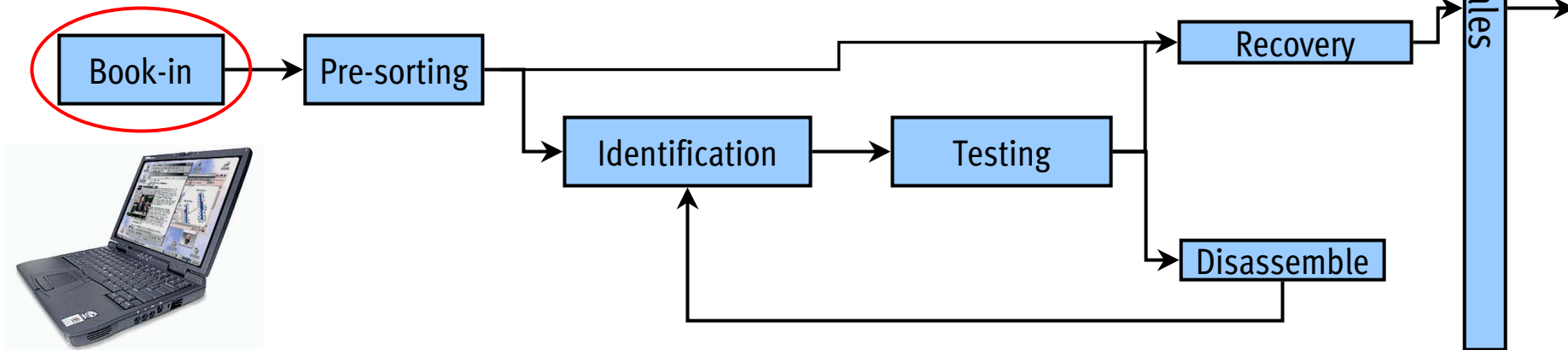
Brand: {Dell, IBM, Compaq,...}

Model: i386 ~ P4

Speed: 133Mhz ~ 4.2 GHz

HDD: 60MB ~ 200GB

Condition: {Good - 50%, Bad - 50%}



PRODUCT REPRESENTATION

Laptop

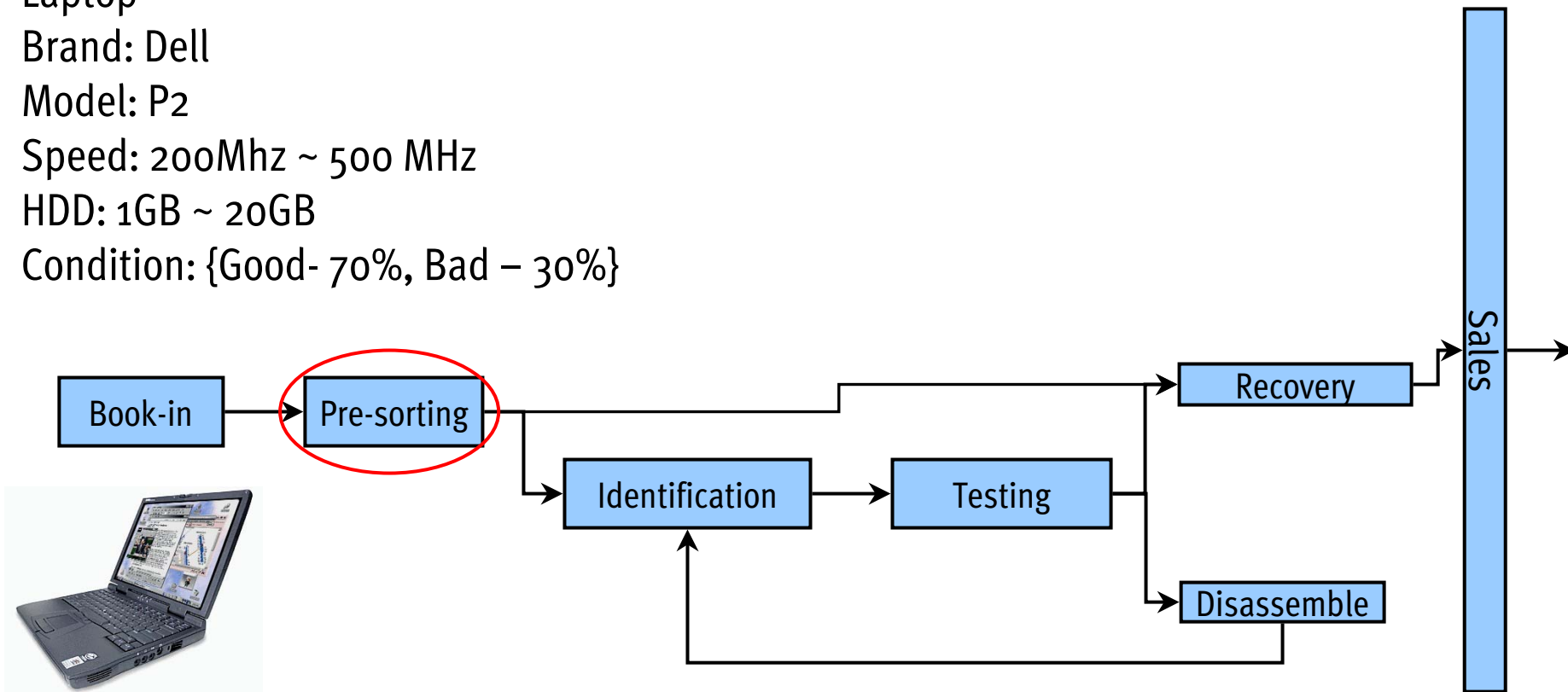
Brand: Dell

Model: P2

Speed: 200Mhz ~ 500 MHz

HDD: 1GB ~ 20GB

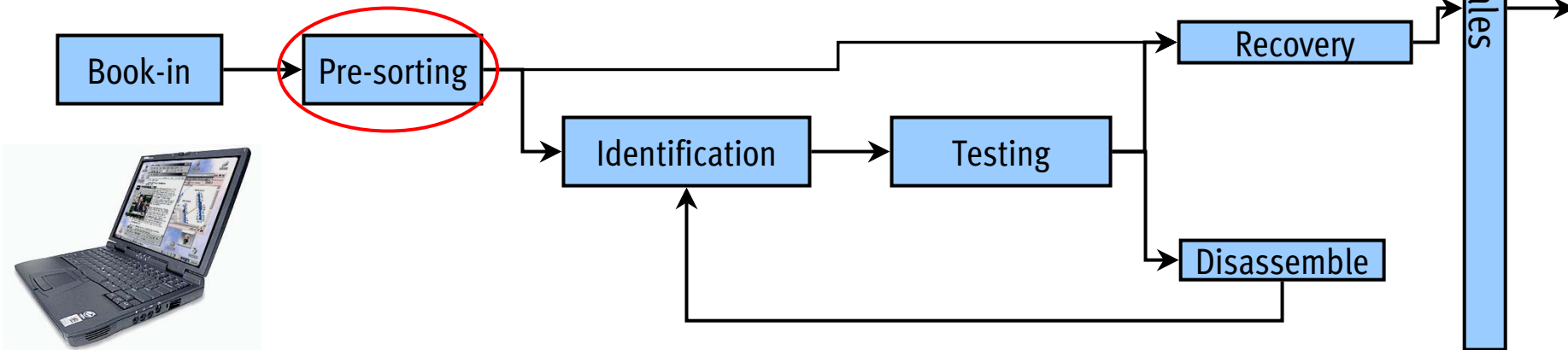
Condition: {Good- 70%, Bad – 30%}



PRODUCT REPRESENTATION

Laptop
Brand: Dell
Model: P2
Speed: 200Mhz ~ 500 MHz
HDD: 1GB ~ 20GB
Condition: {Good- 70%, Bad - 30%}

Information Signal



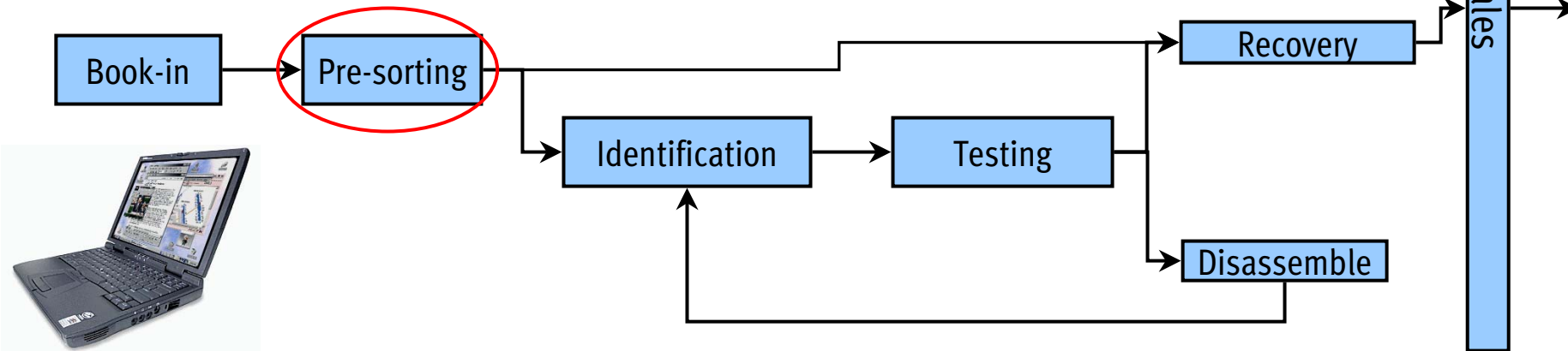
PRODUCT REPRESENTATION

Laptop
 Brand: Dell
 Model: P2
 Speed: 200Mhz ~ 500 MHz
 HDD: 1GB ~ 20GB
 Condition: {Good- 70%, Bad - 30%}

Information structure
 Speed: {133Mhz ~ 4.2GHz} ^{p2} → {200MHz ~ 500 MHz}

Partitioning the belief space

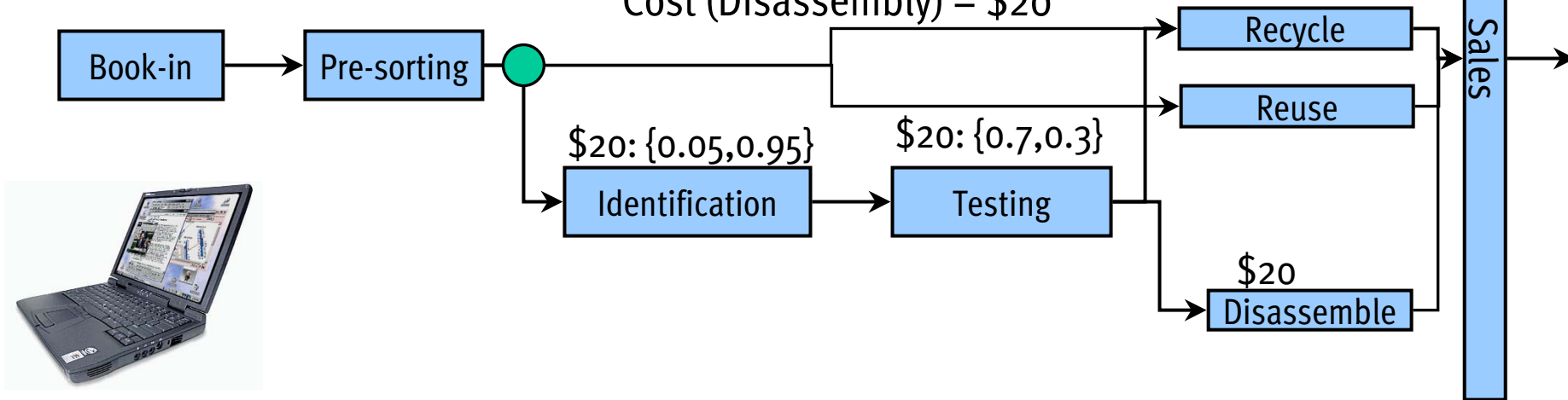
Information Signal



DECISION MODEL

Laptop
 Brand: Dell
 Model: P2
 Speed: 200Mhz ~ 500 MHz
 HDD: 1GB ~ 20GB
 Condition: {Good- 70%, Bad – 30%}

Prob(capacity > 20GB) = 0.05
 Resale Value (>20GB HDD) = \$150
 Resale value (P2 Laptop) = \$0
 Recycle value (P2 Laptop) = \$5
 Cost (Inspection) = \$20
 Cost (Testing) = \$20
 Cost (Disassembly) = \$20



DECISION MODEL

Utility (HD>20GB) = $-20+150+5 = \$135$

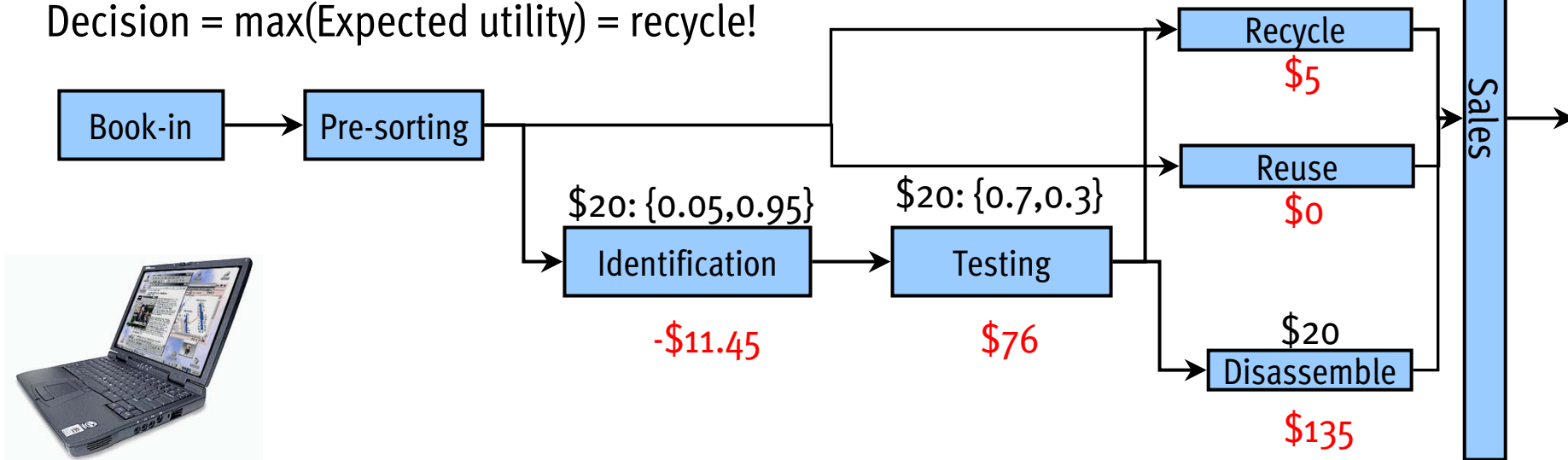
Expected utility_{testing} = $-20+(0.7*135+0.3*5) = \$76$

Expected utility_{identification} = $-20 + (0.05*76+0.95*5) = -\11.45

Expected utility_{recycle} = $\$5$

Expected utility_{reuse} = $\$0$

Decision = max(Expected utility) = recycle!



IMPACT OF INFORMATION

Impact of information =

Expected payoff with information – Expected
payoff with no information = $\$76 - \$5 = \underline{\$71}$

Effect of timeliness

Expected value_{timeliness} = Expected value * $f(\nu, t)$

where ν = volatility of the product

t = time elapsed

CONCLUSIONS

- Ready availability of complete lifecycle information associated with a product is essential for making effective EOL product recovery decisions.
- Product recovery operations are hampered by uncertainties in product structure and quality, resulting in
 - Inefficient processes
 - Ineffective decisions
- Automated product identification systems (e.g., Auto-ID) could provide the required information in a timely and effective manner
- POMDP/Bayesian Networks provide a feasible approach for modelling product recovery operations.

NEXT STEPS

- Investigate other modelling techniques (e.g. real options)
- Develop and refine decision model
- Develop simulation model (POMDP)
- Sensitivity analysis

Thank You

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<http://www.ifm.eng.cam.ac.uk/cdac>