



University of Southern California
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Integrating Software Cost and Quality Modeling for Program Risk Management

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Outline

- **Research Motivation**
- **Value-Based Software Quality Model (VBSQM)**
- **ODC and Domain Specific Extension of VBSQM**
- **Conclusions and Future Work**



Software Assurance Risk Profile

- **Software assurance in a competitive world**
 - Software quality requirements often conflict with schedule/cost requirements
- **How much software quality investment is enough?**
 - When to stop testing and release the product
- **Our Approaches**
 - Combined risk analyses based on VBSQM
 - * Determining a risk-balanced “sweet spot” operating point
 - * Optimal combinations and application order of risk reduction techniques



Competing on Schedule and Software Quality Investment

– A risk analysis approach

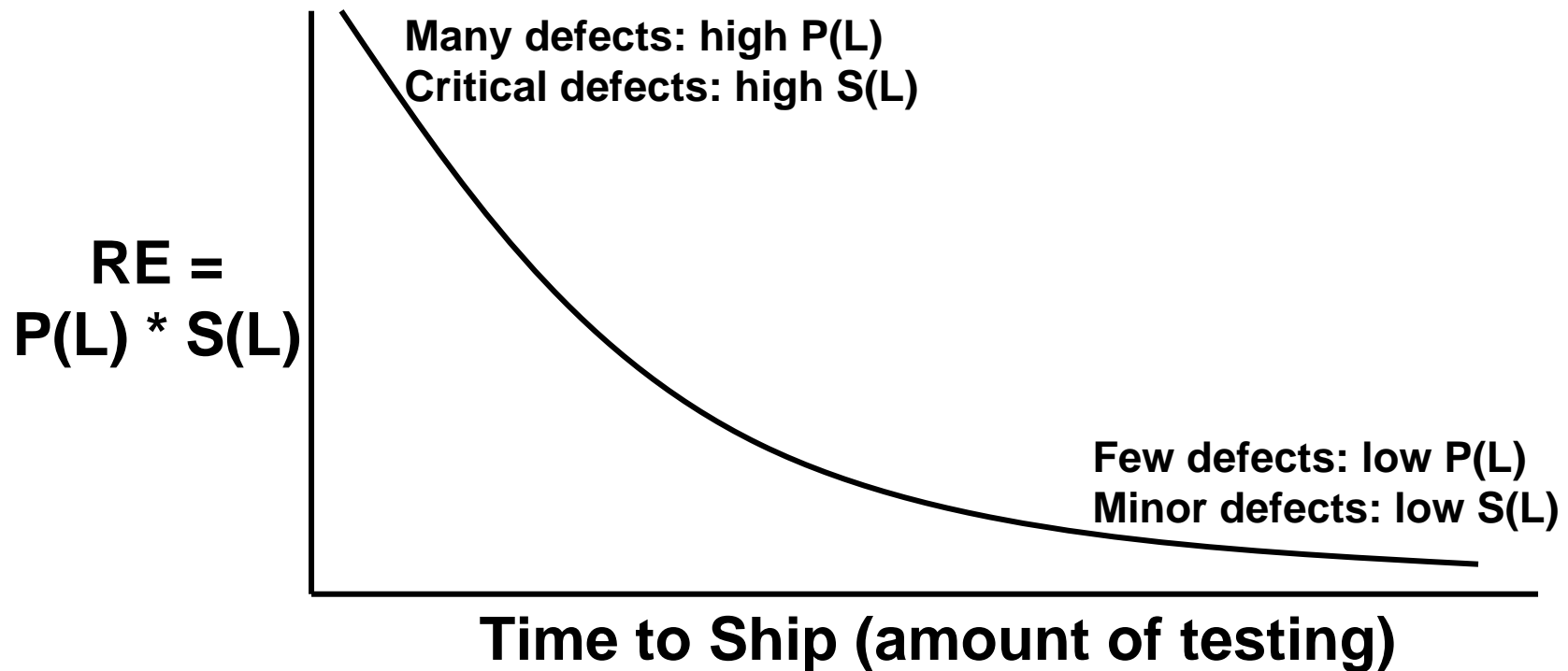
- **Risk Exposure RE = Prob (Loss) * Size (Loss)**
 - “Loss” – financial; reputation; future prospects, ...
- **For multiple sources of loss:**

$$RE = \sum_{\text{sources}} [\text{Prob (Loss)} * \text{Size (Loss)}]_{\text{source}}$$



Example RE Profile: Time to Ship

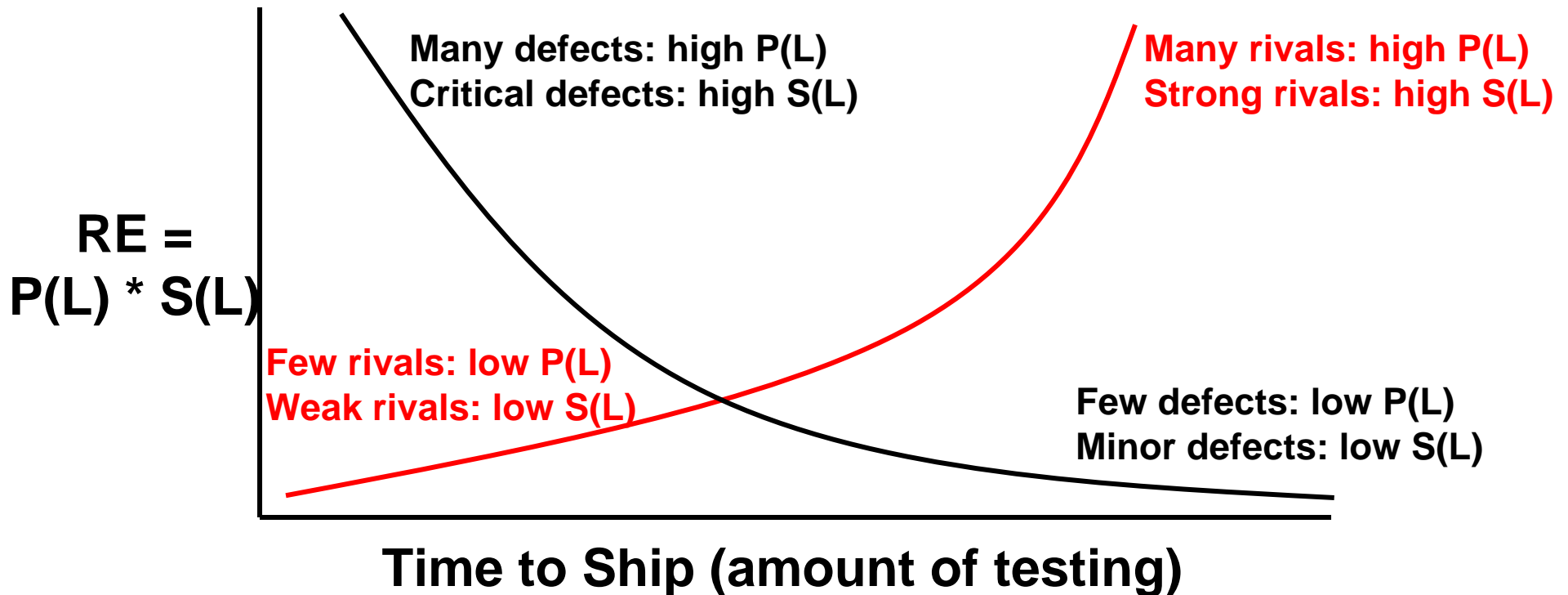
– Loss due to unacceptable software quality





Example RE Profile: Time to Ship

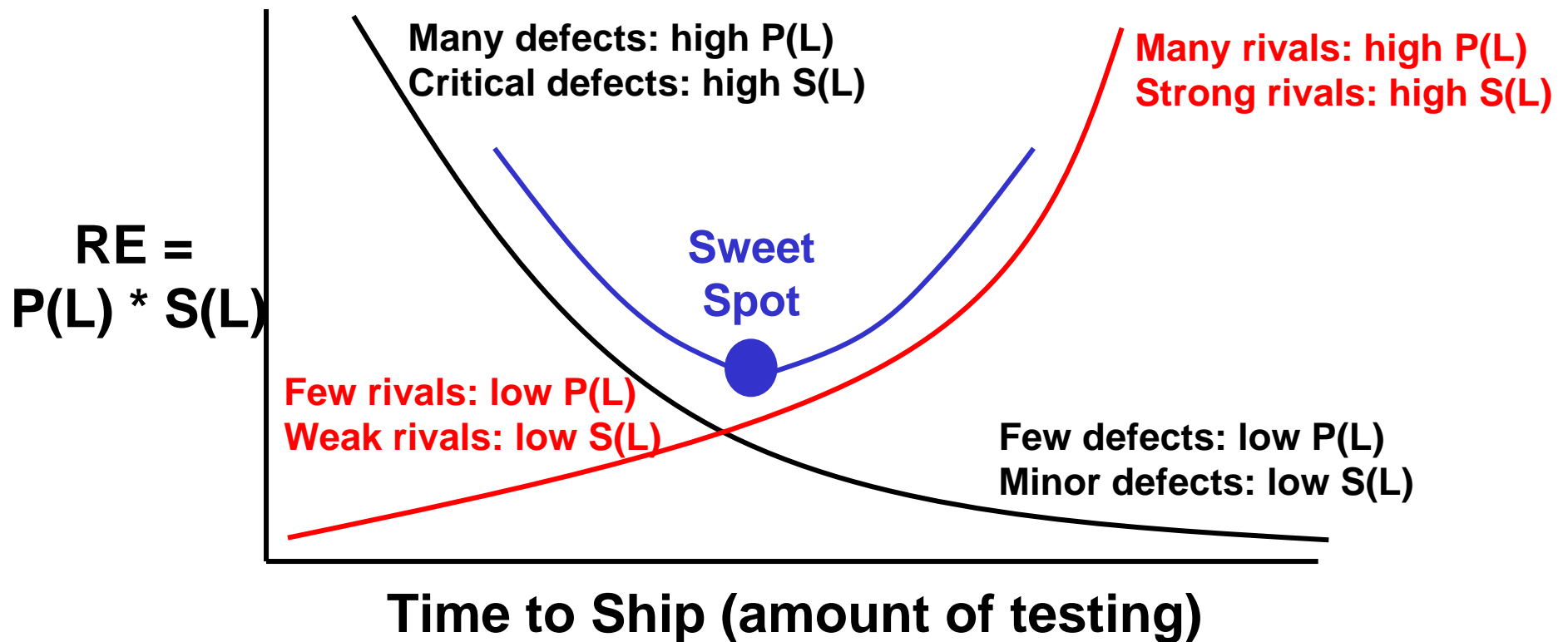
- Loss due to unacceptable software quality
 - **Loss due to market share erosion**



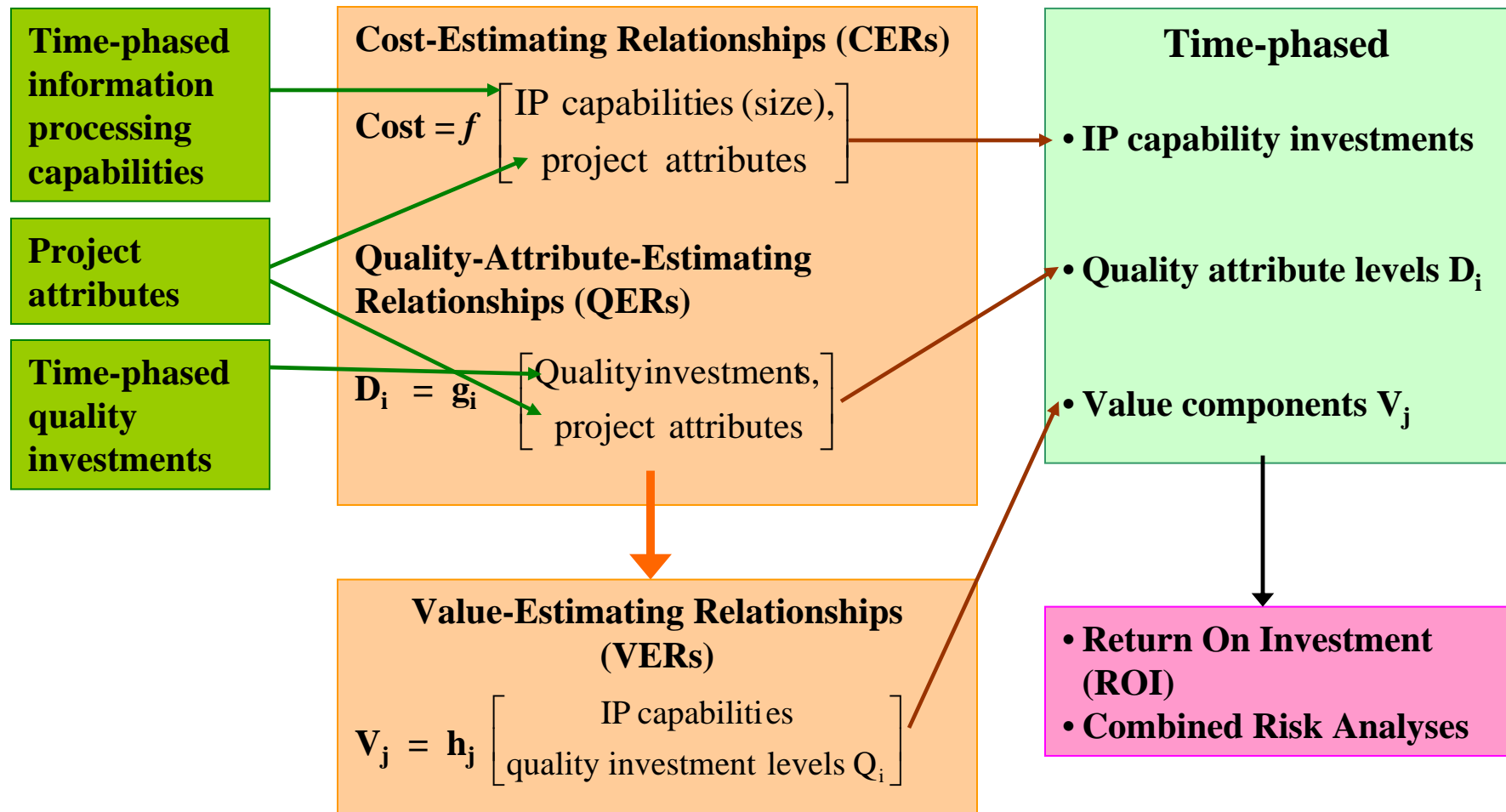


Example RE Profile: Time to Ship

- Sum of Risk Exposures



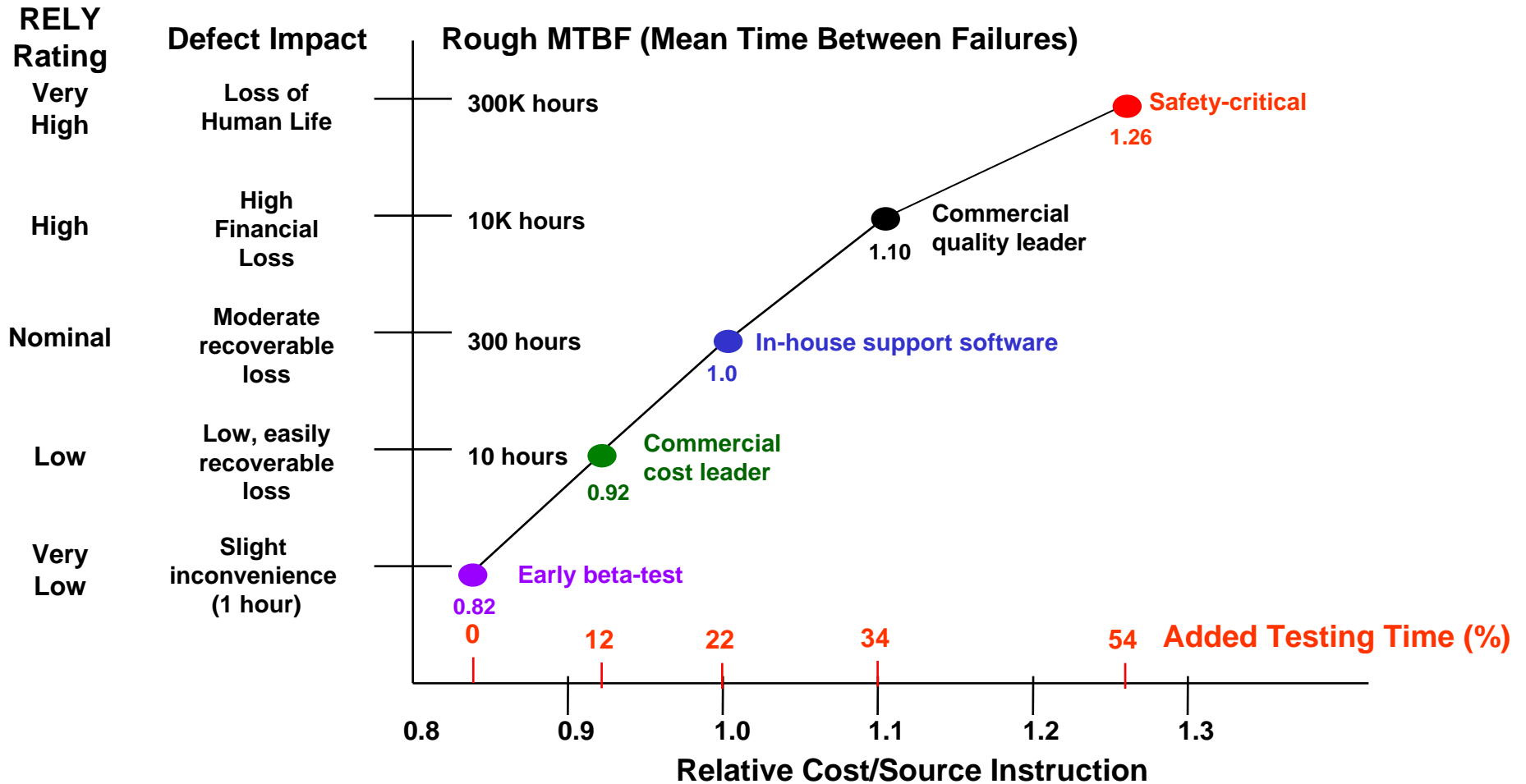
Value-Based Software Quality Model (VBSQM)





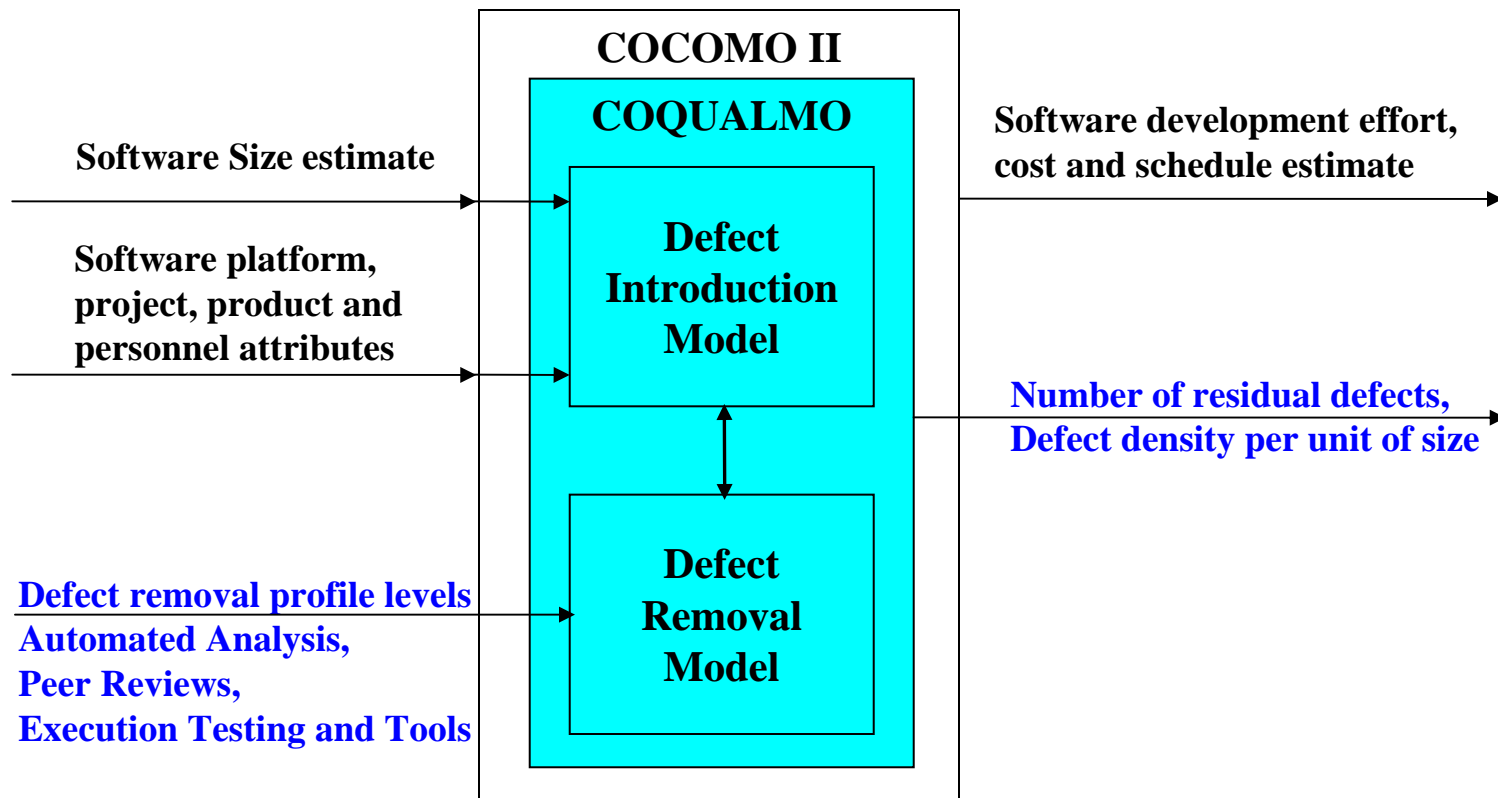
Development Cost of “Required Reliability”: COCOMO II

– calibrated based on 161 industry projects





Cost of “Reduced Delivered Defect Density”: COQUALMO





COQUALMO Defect Removal Rating Scales

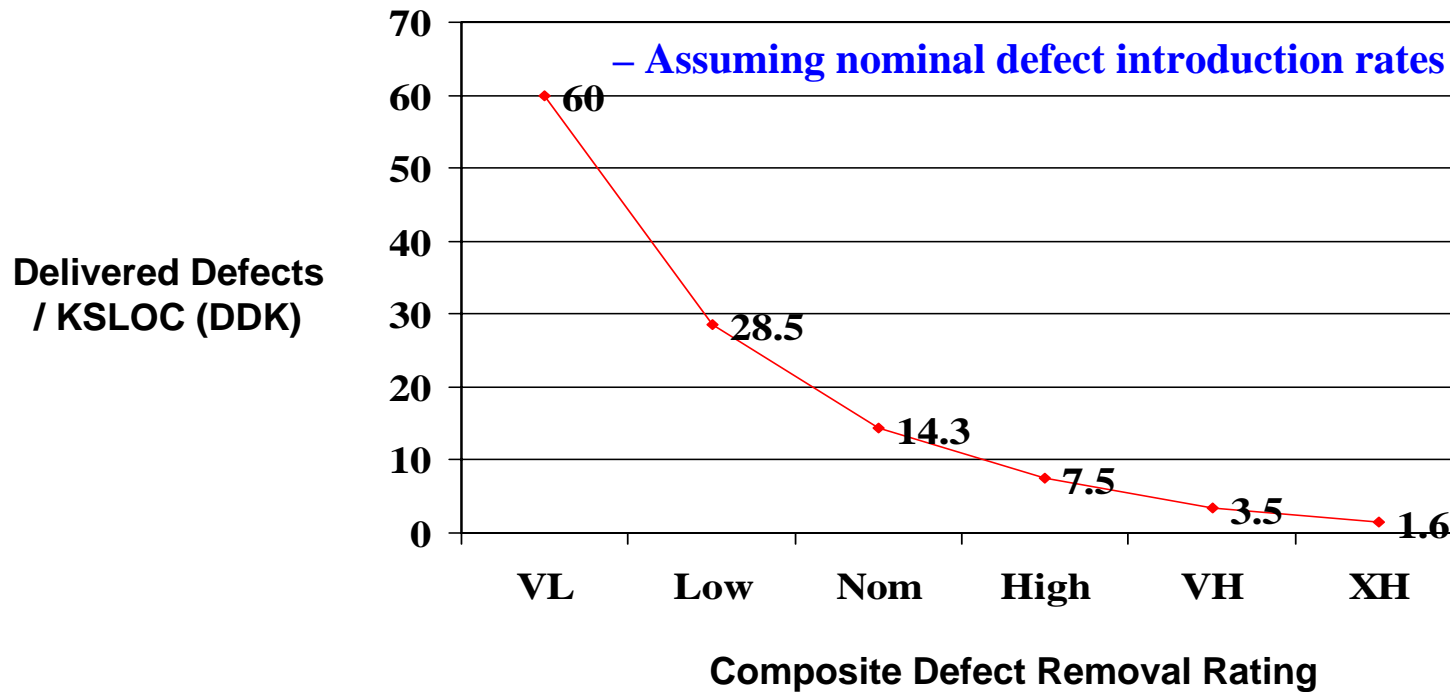
COCOMO II p.263

	Very Low	Low	Nominal	High	Very High	Extra High
Automated Analysis	Simple compiler syntax checking	Basic compiler capabilities	Compiler extension Basic req. and design consistency	Intermediate-level module Simple req./design	More elaborate req./design Basic dist-processing	Formalized specification, verification. Advanced dist-processing
Peer Reviews	No peer review	Ad-hoc informal walk-through	Well-defined preparation, review, minimal follow-up	Formal review roles and Well-trained people and basic checklist	Root cause analysis, formal follow Using historical data	Extensive review checklist Statistical control
Execution Testing and Tools	No testing	Ad-hoc test and debug	Basic test Test criteria based on checklist	Well-defined test seq. and basic test coverage tool system	More advance test tools, preparation. Dist-monitoring	Highly advanced tools, model-based test



COQUALMO Defect Removal Estimates

– Nominal Defect Introduction Rate (60 defects/KSLOC)





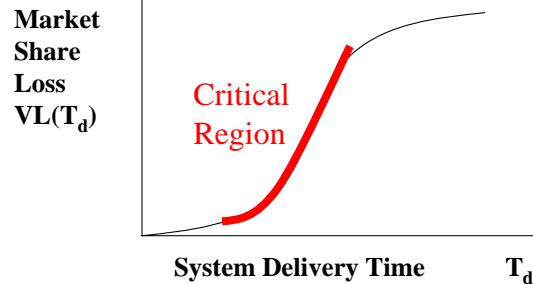
Relations Between COCOMO II and COQUALMO

- **COQUALMO rating scales for levels of investment in defect removal via automated analysis, peer reviews, and execution testing and tools have been aligned with the COCOMO II RELY rating levels.**
- **Bidirectional mapping between COCOMOII RELY and COQUALMO defect removal profile**

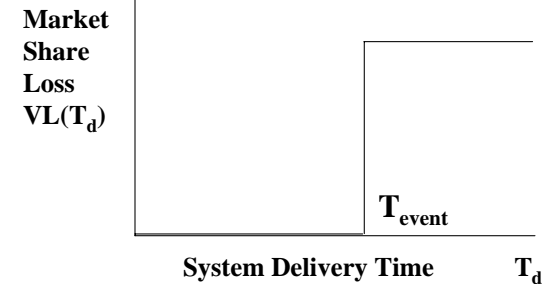


Typical Marketplace Competition Value Estimating Relationships

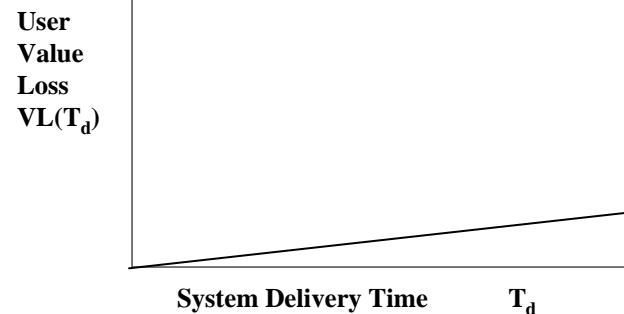
**Internet Services, Wireless Infrastructure:
Value Loss vs. System Delivery Time**



**Fixed-schedule Event Support:
Value of On-time System Delivery**



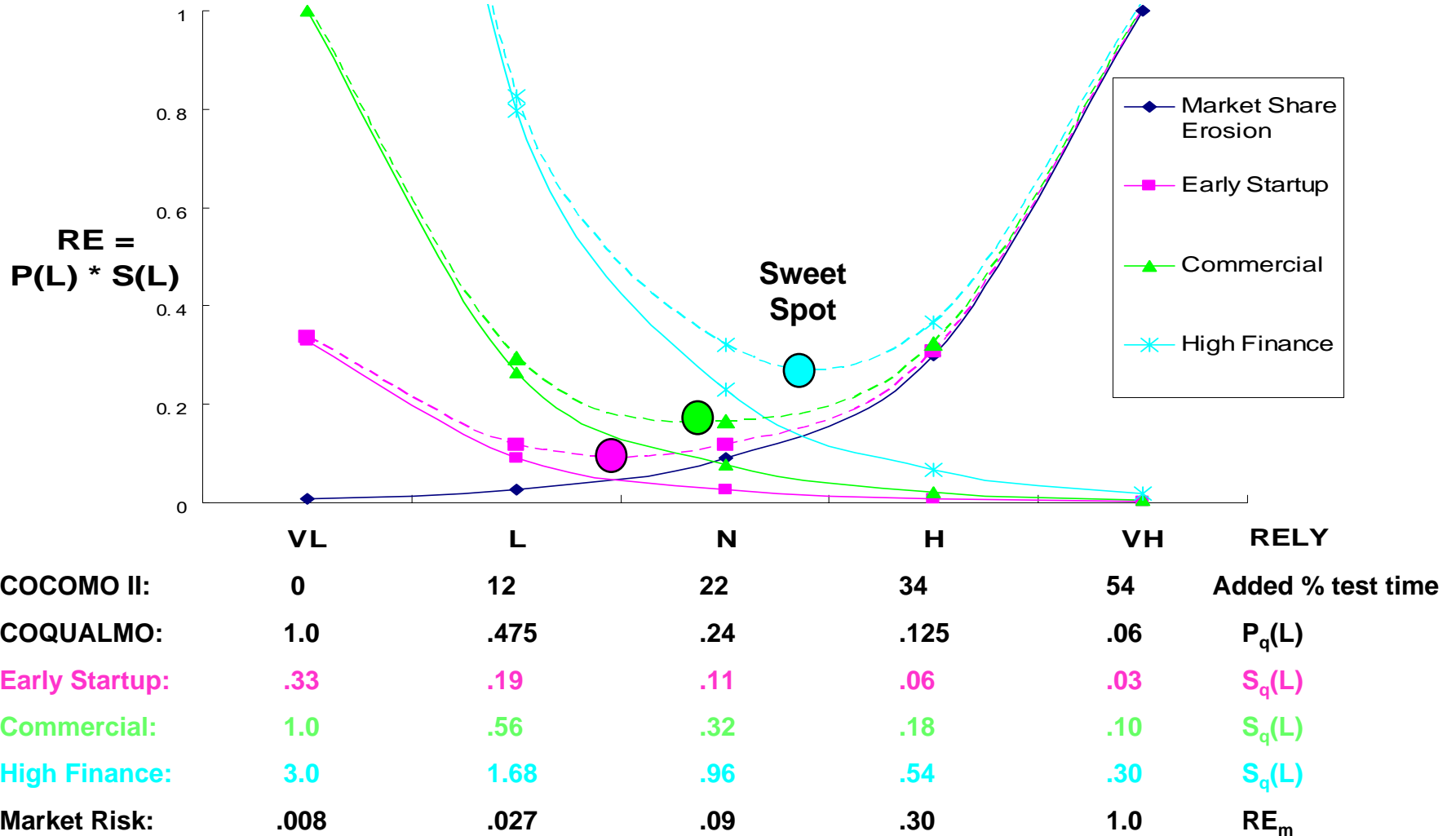
**Off-line Data Processing:
Value Loss vs. System Delivery**





How much Software Quality Investment is Enough?

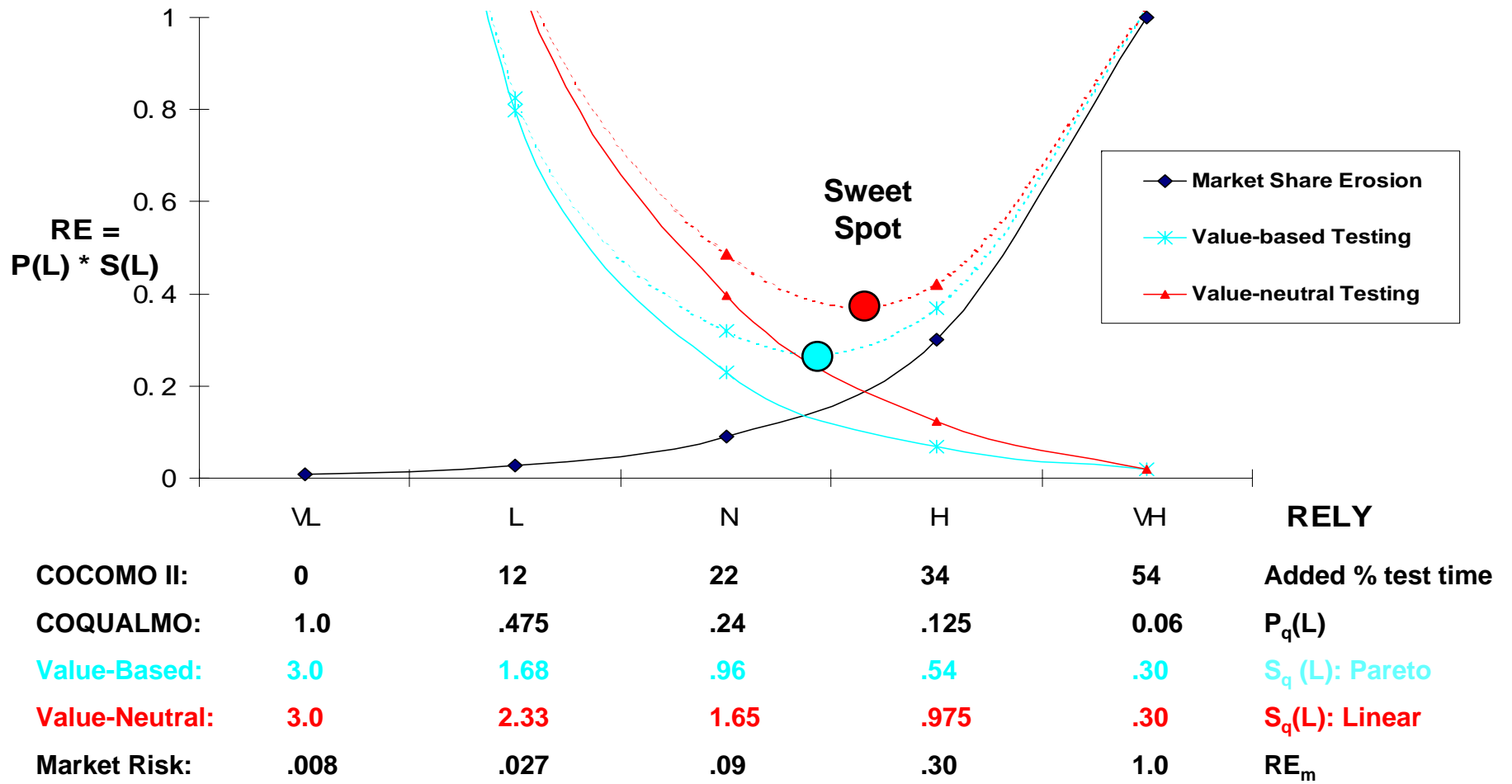
Combined Risk Exposure





Value/Risk-Driven Testing: 40% Gain

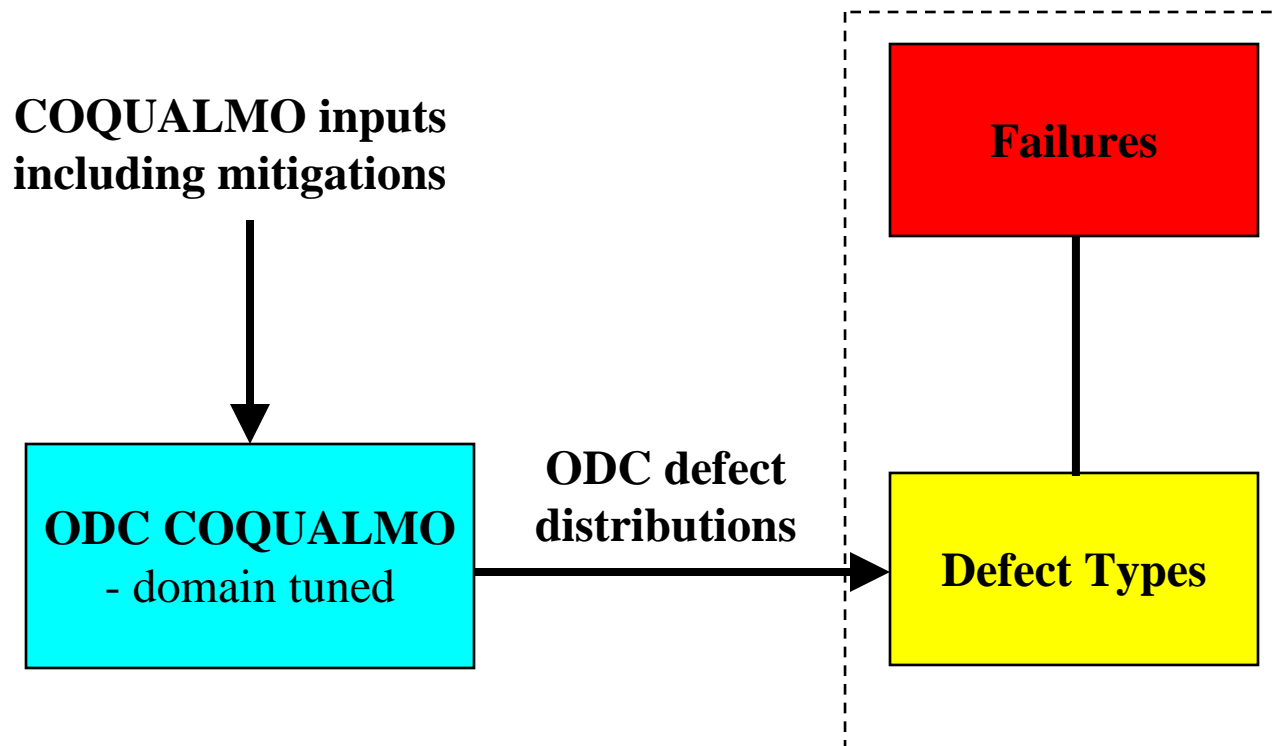
Combined Risk Exposure





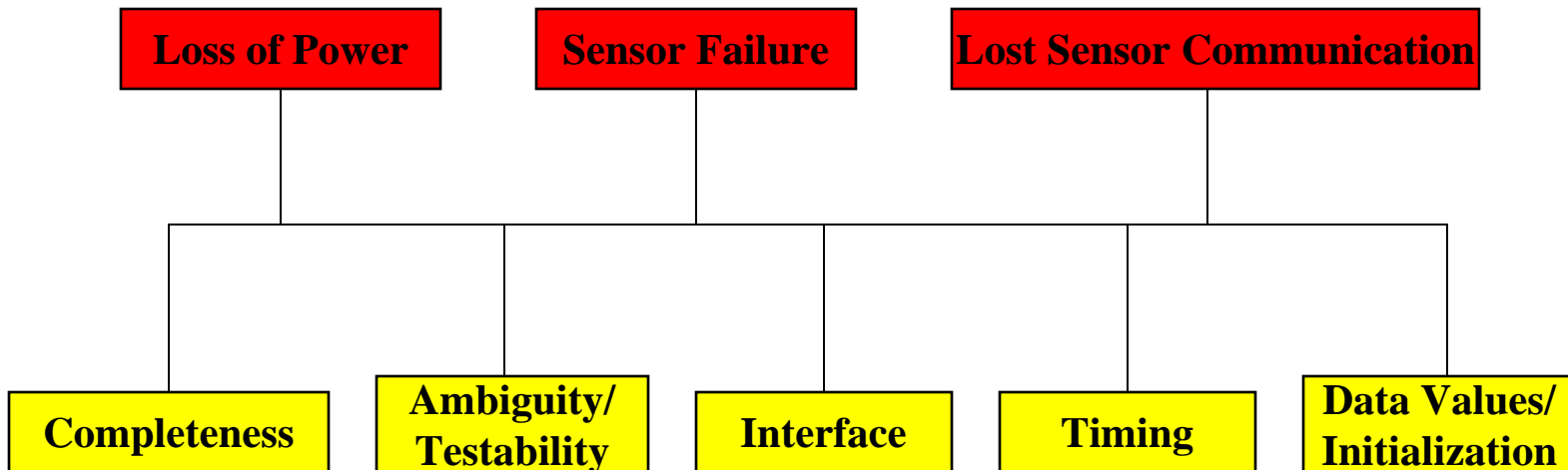
ODC COQUALMO and Failure/Defect Model

Failure/Defect Model



Calculating Probability of Loss

Failures



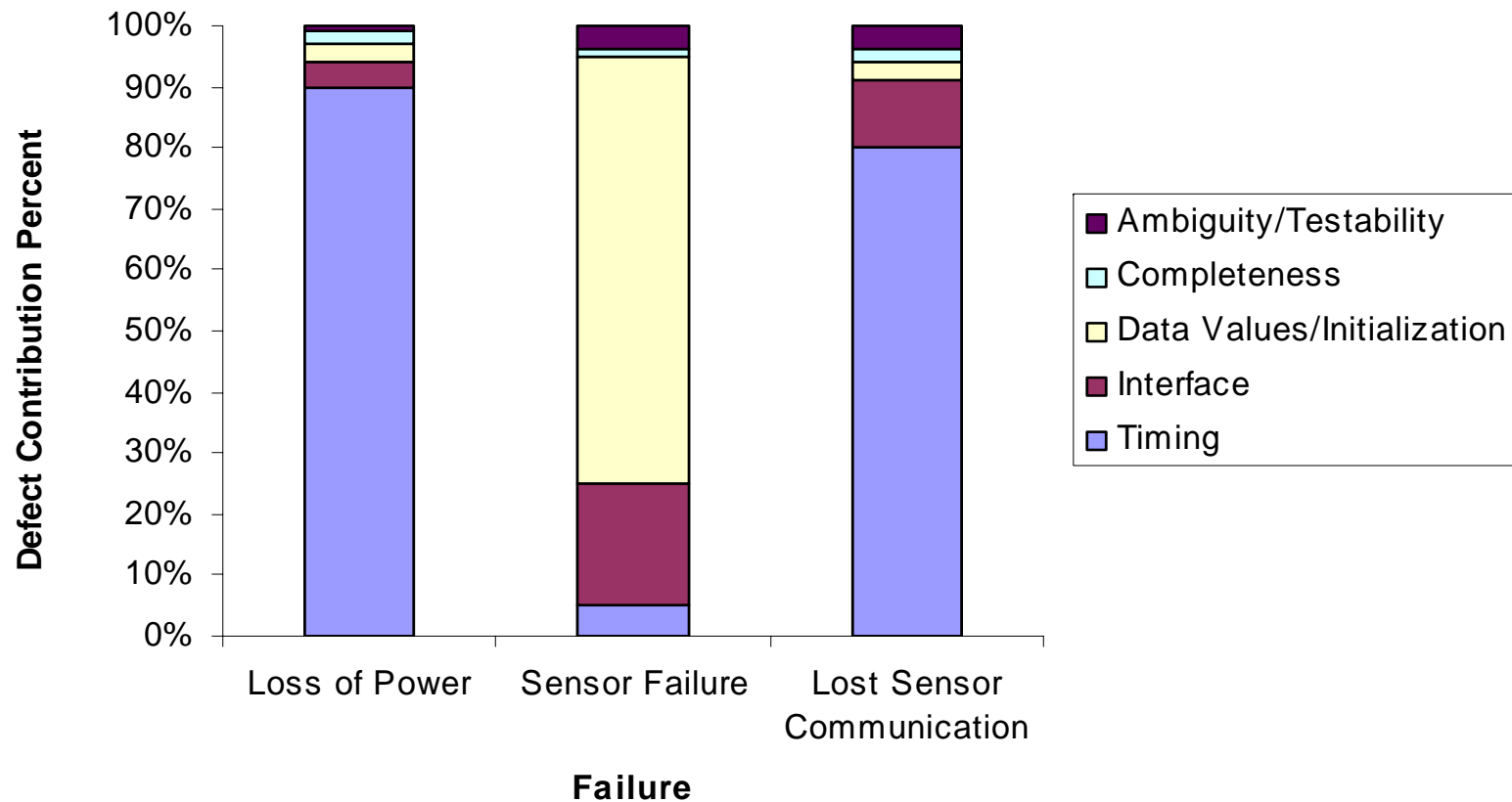
ODC Defect Types

$$Pr obability (Loss) = \sum_{i=1}^{\# \text{ defect categories}} \% \text{ Contribution}_i \times Pr obability_i$$



Example Defect Contributions to Failures

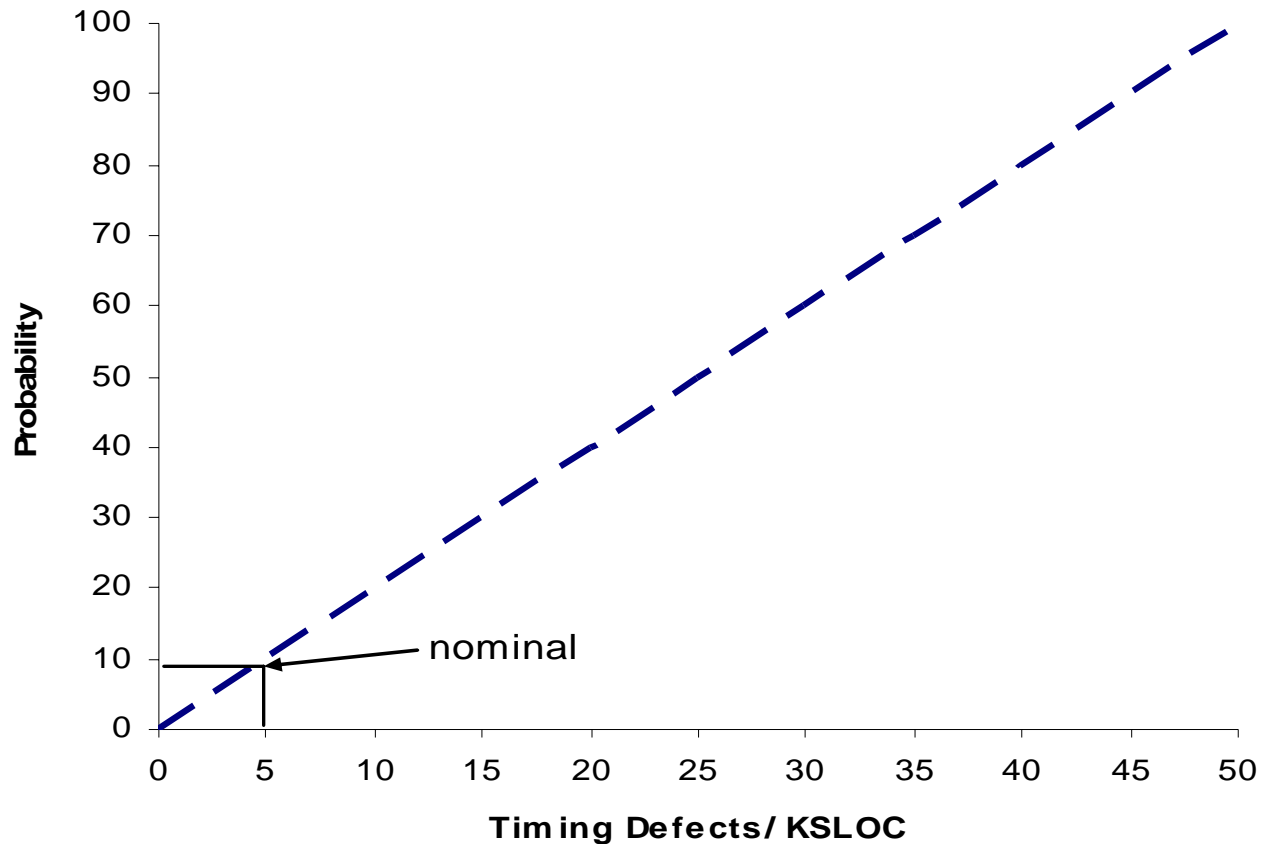
Historical Failure Data





Failure Probability vs. Defect Density (I)

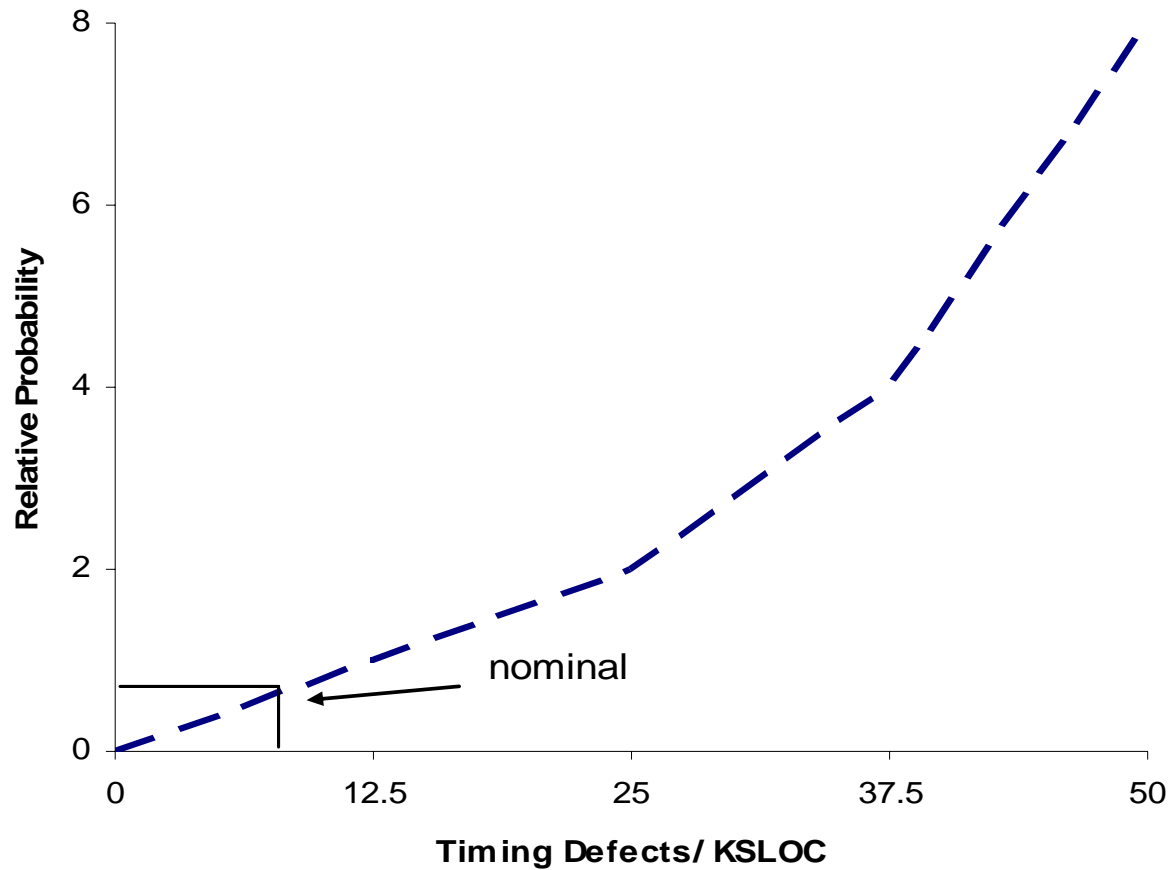
Probability of Lost Sensor Communication
Due to Timing Defect





Failure Probability vs. Defect Density (II)

**Relative Probability of Lost Sensor
Communication Due to Timing Defect**





Conclusion and Future Work

- **Integrating Cost, Quality Model and VERs supports combined risk analyses on software quality assurance**
- **ODC and domain specific extensions of VBSQM help select optimal combinations and application order of risk reduction techniques**
- **Refine COQUALMO and VBSQM models on Autonomy Software**



Thank You



Questions and Comments