Risk Management

Risks

- Possibility of suffering loss
  - what can go wrong
  - likelihood
  - potential damage
- Integral part of all projects
  - not poor management

Risk Management Process

Risk Considerations

- Risk Exposure
  - $RE = P \times C$
    - P – probability of occurrence
    - C – Cost to project
- Risk Reduction Leverage
  - $RRL = \frac{(RE_{before} - RE_{after})}{cost\ of\ intervention}$
- Provides data to adjust cost estimates

Risk Exposure Example

- Risk
  - 75% of planned third-party components will be integrated into software, remaining functionality must be developed
- Probability: 80%
- Risk Impact
  - 65 components were planned
  - 16 will need to be developed
    - average cost of $9200
  - $147,200
- $RE = 80\% \times \$147{,}200 = \$117{,}760$

RRL Example

- Risk Reduction
  - More research into suitability of components
  - Cost: $400 per component
- Impact
  - 90% of planned third-party components will be integrated into software
  - 7 will need to be developed
- $RE_{after} = 80\% \times \$64{,}400 = \$51{,}520$
- $RRL = \frac{117{,}760 - 51{,}520}{65 \times 400} \cong 2.55$

RRL Example

- Risk Reduction
  - Ask colleagues about suitability of components
  - Cost: $50 per component
- Impact
  - 80% of planned third-party components will be integrated into software
  - 13 will need to be developed
- $RE_{after} = 80\% \times \$119{,}600 = \$95{,}680$
- $RRL = \frac{117{,}760 - 95{,}680}{65 \times 50} \cong 6.8$

RRL Example

- 2.55 RRL – Research
- 6.8 RRL – Ask Colleagues
- Higher RRL is better
  - less risk reduction cost outweighs
  - greater risk exposure cost
- Generally RRL > 1 is worth doing
  - but really depends on risk
    - high risk with RRL of 0.1 may be worth it

Which One is Worth Considering?

Risk Types

- Project Risks
  - threaten project plan
    - e.g. not able to deliver all Must Haves
- Technical Risks
  - threaten quality or timeliness of product
    - e.g. searches across tables too slow
    - e.g. defective module returns incorrect result
- Business Risks
  - threaten viability of project
    - e.g. losing budget

Risk Sources

- External
- Organisation
- People
- Technology
- Software Risks
  - requirements
  - estimation

Risk Examples

Source	Possible Risks
Estimation	Time required to develop the software is underestimated. Rate of defect repair is underestimated. Size of the software is underestimated.
Organisation	Organisation is restructured so that different management are responsible for the project. Organisational financial problems force reductions in the project budget.
People	It is impossible to recruit staff with the skills required. Key staff are unavailable at critical times. Required training for staff is not available.
Requirements	Changes to requirements that require major design rework are proposed. Customers fail to understand the impact of requirements changes.
Technology	Database used cannot process as many transactions per second as expected. Reusable software components contain defects that mean they cannot be reused as planned.
External	Legislation changes require changes to software functionality.

High-level Risk Identification

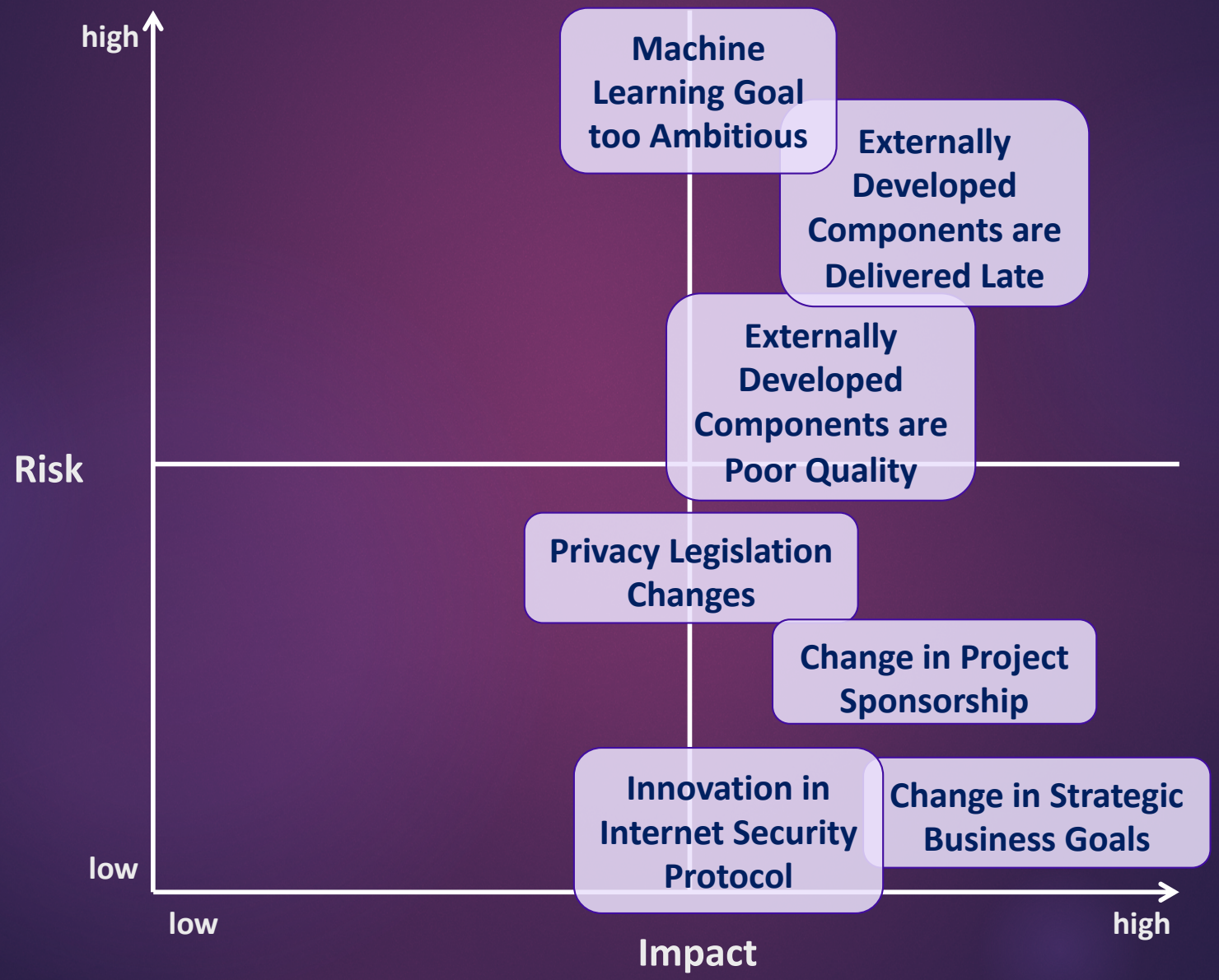
- May impact strategic delivery of product
  - not tactical execution of the project
- Entire team involved
  - post-it notes to identify initial risks
- Examples
  - dependence on another application under development
  - legislative changes requiring alternative solutions if project is late
    - EU GDPR

Post-It Notes?

- Avoid

  Facilitator Risk

Risk Chart


high
Risk
low
low
Impact
high
Machine Learning Goal too Ambitious
Externally Developed Components are Delivered Late
Externally Developed Components are Poor Quality
Privacy Legislation Changes
Change in Project Sponsorship
Innovation in Internet Security Protocol
Change in Strategic Business Goals

Risk Analysis

- Risks have <u>severity</u> and <u>probability</u>
- There is a risk that our lecture will be disrupted by aliens and we will be sold to Klingons for scientific experiments
  - severity is extreme
  - probability isn't very high
- There is a risk that the lecture will take place in the presence of air conditioning that is either too hot or too cold but never somewhere happily in the middle
  - …

Risk Analysis

- Prioritise
- Estimate impact
  - budget cost and schedule impact
  - cost of mitigation
  - lost revenue
- Serious risks require mitigation strategies
  - we could protect our lecture against Klingon attack by spending $10T on a star wars style defence initiative
    - but maybe there should be some balance here …

Risk Probability

Level	Value	Criteria
5	Near Certainty	Everything points to this becoming a problem
4	Very Likely	High chance of this becoming a problem
3	Likely (50/50)	Even chance this may turn into a problem
2	Unlikely	Risks like this may turn into a problem once in a while
1	Improbable	Not much chance this will become a problem

from NASA risk sector plot

Risk Impact

Level	Value	Technical Criteria	Cost Criteria	Schedule Criteria
5	Catastrophic	Product unusable	> $10M or loss of life	Multiple milestone slippage
4	Critical	Product unusable but some work recoverable	> $5M or serious harm	Single milestone slippage
3	Moderate	Functionality degraded but partly usable	> $1M or minor harm	Loss of 1 month in schedule
2	Marginal	Minor loss of functionality or noticeable performance issue	> $100K	Loss of 1 week in schedule
1	Negligible	Trivial loss of functionality or performance	minimal cost	Loss of few days in contingency

Risk Matrix

Probability					
5	**5**	**10**	**15**	**20**	**25**
4	**4**	**8**	**12**	**16**	**20**
3	**3**	**6**	**9**	**12**	**15**
2	**2**	**4**	**6**	**8**	**10**
1	**1**	**2**	**3**	**4**	**5**
	1	2	3	4	5

Impact

Risk Register

Risk Id	Risk	Probability (1-5)	Impact (1-5)	Severity (1-25)	Owner	Mitigation Plan	Contingent Action	Progress
1	Privacy Legislation Change	2	3	6	Legal Team	Scalable levels of security to cope with changes	Review security levels & estimate cost to accom-modate changes	Security levels approved by software architect
2	Change in Project Sponsorship	2	4	8	Project Sponsor	Ensure project visibility at C-level	Escalate to project board	Regular reports to C-suite
3	Major Innovation in Internet Security Protocol Replaces Existing Technology	1	4	4	Software Architect	Modularise system architecture to handle changing technology	Research new technology and estimate cost to replace existing	Architecture is modular
4	Strategic Business Goals of the Organisation Change	1	5	5	Project Sponsor	Monitor business environment	Redo BMC and project charter	–
5	External Development Team does not Complete Components on Time	3	4	12	Project Manager	Late penalty in contract. Staged delivery schedule. Check regularly.	Escalate to project board. Implement late penalty. …	Penalty clause agreed upon
6	Externally Developed Components are Poor Quality	2	4	8	Project Manager	Well-designed test plans. Staged delivery schedule.	Request rework. Escalate to project board. …	Initial outline of test plan done
7	Machine Learning Goal too Ambitious	3	5	15	ML Expert	Schedule ML work early. Incremental improvements.	Revise project goals & rescope project.	ML in schedule

Mitigation Plan

- Risk Exposure vs. Risk Reduction Leverage
- Will mitigation be cost effective?
  - need to estimate
    - impact cost
    - mitigation cost
- How severe is impact?
- Is mitigation possible?

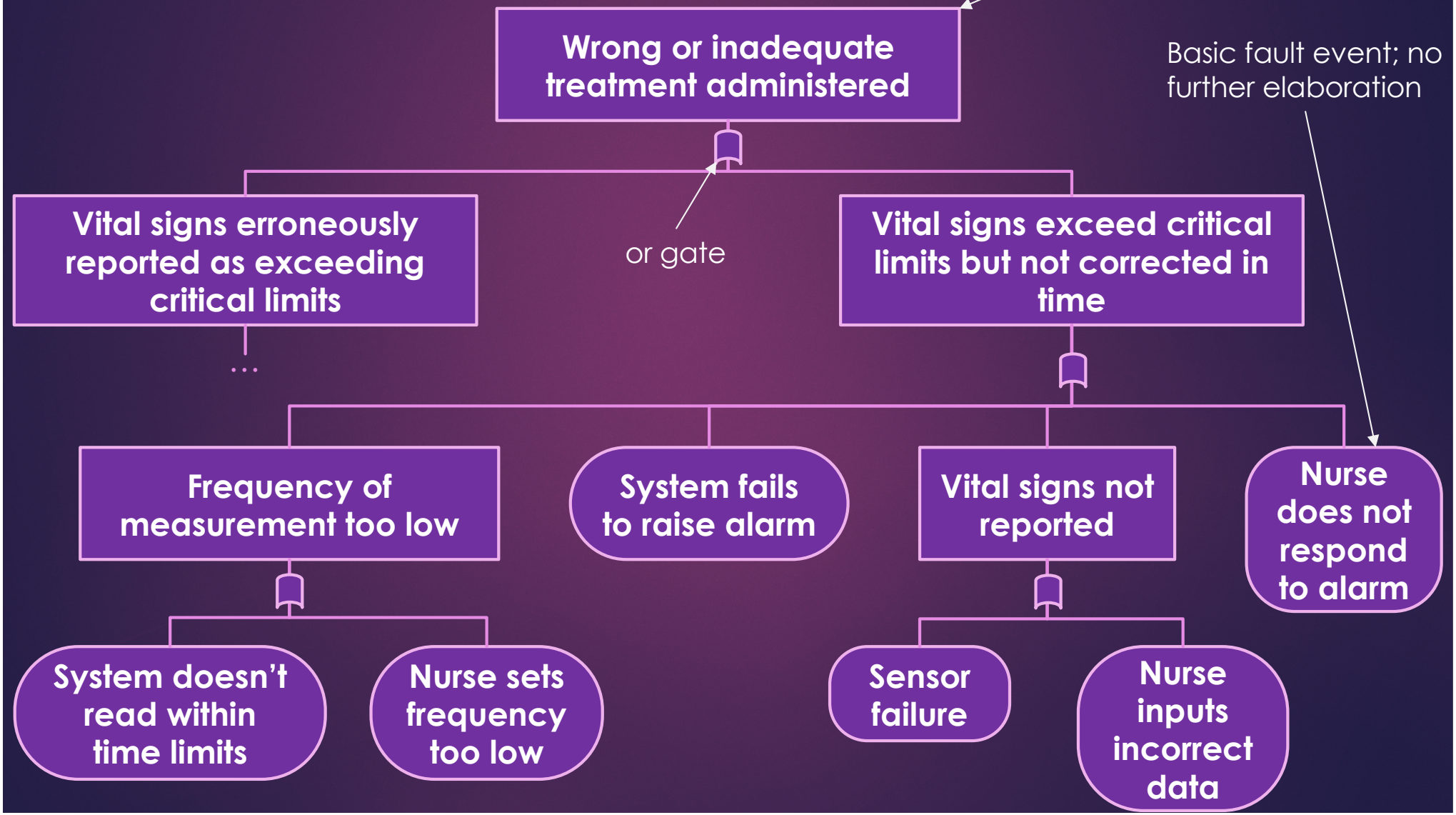
Risk Indicators

Source	Potential Indicators
Estimation	Failure to meet agreed schedule; failure to clear reported defects.
Organisation	Organisational gossip; lack of action by senior management.
People	Poor staff morale; poor relationships amongst team members; high staff turnover.
Requirements	Many requirements change requests; customer complaints.
Technology	Late delivery of hardware or support software; many reported technology problems.
External	News reports; organisation or government leaks.

Complete Incrementally

- Turn assumptions into risks
- Not practical to complete in one try
- Add new risks as soon as identified
  - fill in other details later if necessary
- Risk table should be visible
  - easy for anyone to add new risks
  - keeps risks in everyone's mind
- Update throughout project
  - existing risks are reduced or eliminated
  - new risks are identified

Identifying Technical Risks
Fault Tree Analysis



Investigating Technical Risk

- Spike
  - shortest / cheapest action to investigate technical risk
  - focus solely on a specific issue
  - may raise more questions to be answered
  - needs to be time-boxed
    - few hours
    - day or two
  - several spikes can look at different aspects of problem

Reading

- Sommerville
  - section 22.1
- Wiegers
  - chapter 32
- Larman
  - section 2.5

Next Steps

- Thursday: Software Quality
- Tutorial
  - Use Case Modelling
- Next Week
  - Lecture: Verification and Validation
  - Guest lecture: From PR to Production
    - Charles O'farrell, Amazon