Integrating Operational Research and Human Sciences to analyse Network Enabled Capability

14th ICCRTS, June 2009

Duncan Feveyear

Peter Barber

Defence Science and Technology Laboratory

Contents

- Background
- Human Decision Making
- Exploitation
- Conclusions

Background

- Network Enabled Capability (NEC) definition:
  - "*the coherent integration of sensors, effectors and decision makers in order to achieve increased effect*"
- NEC gives potential for new ways of operating:
  - Data (e.g. shared sensor data)
  - Information (e.g. shared tracks)
  - People (e.g. distributed decisions)
  - Teams (e.g. agile command structures)

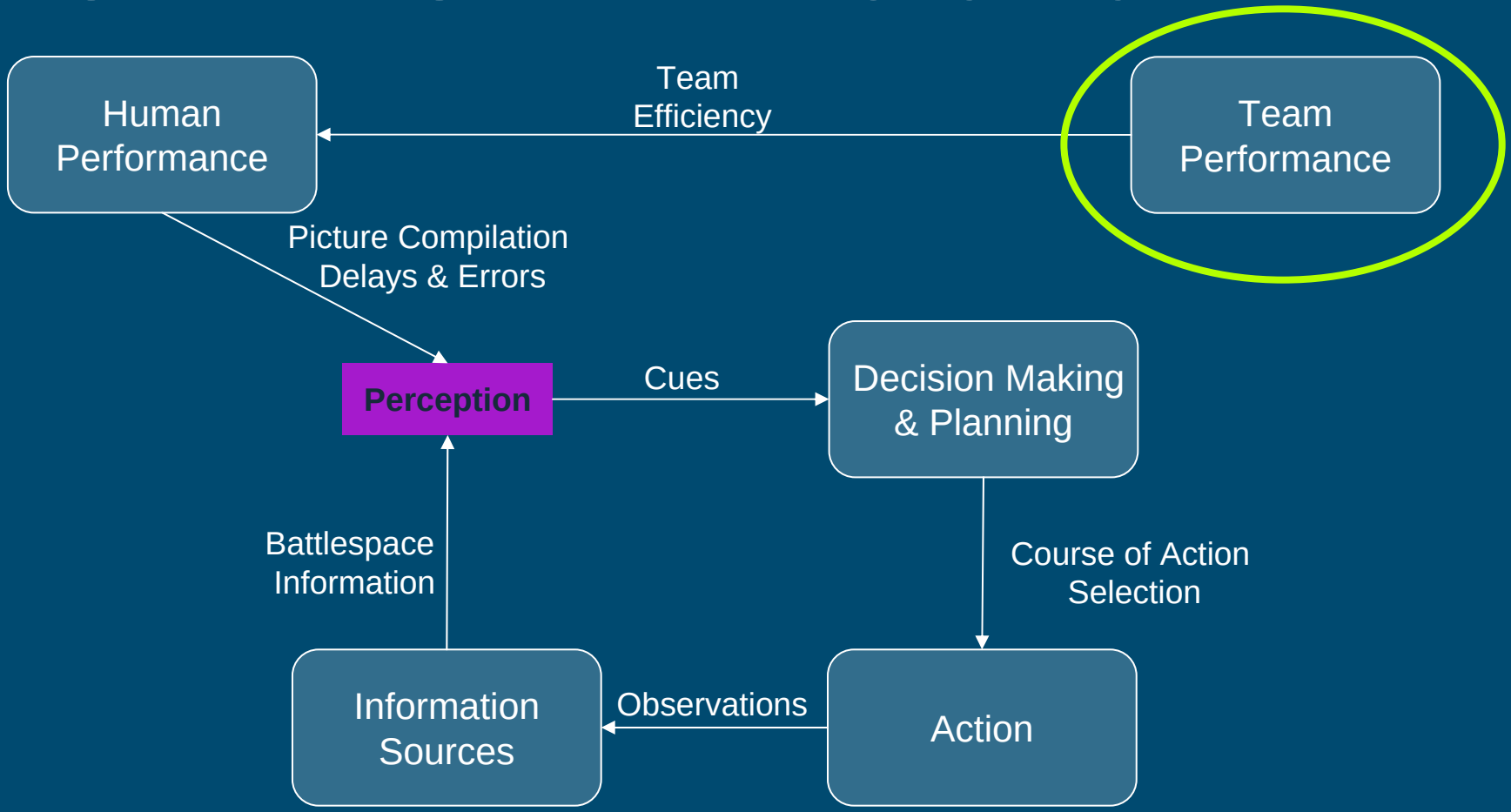
SIMMAIR

- SIMple Maritime and AIR Operational Research model
- C2-centric, sub-campaign level constructive simulation
- Required to examine NEC related issues
  - Measure the improvement (or otherwise) in operational effect expected through improved networking
  - Assess new systems, but also new concepts of use / ways of working
  - Assess the impact of differing C2 structures
    - Force agility, Reachback, HQ location etc
  - Impact of ISTAR on Operational outcome, at appropriate granularity

Contents

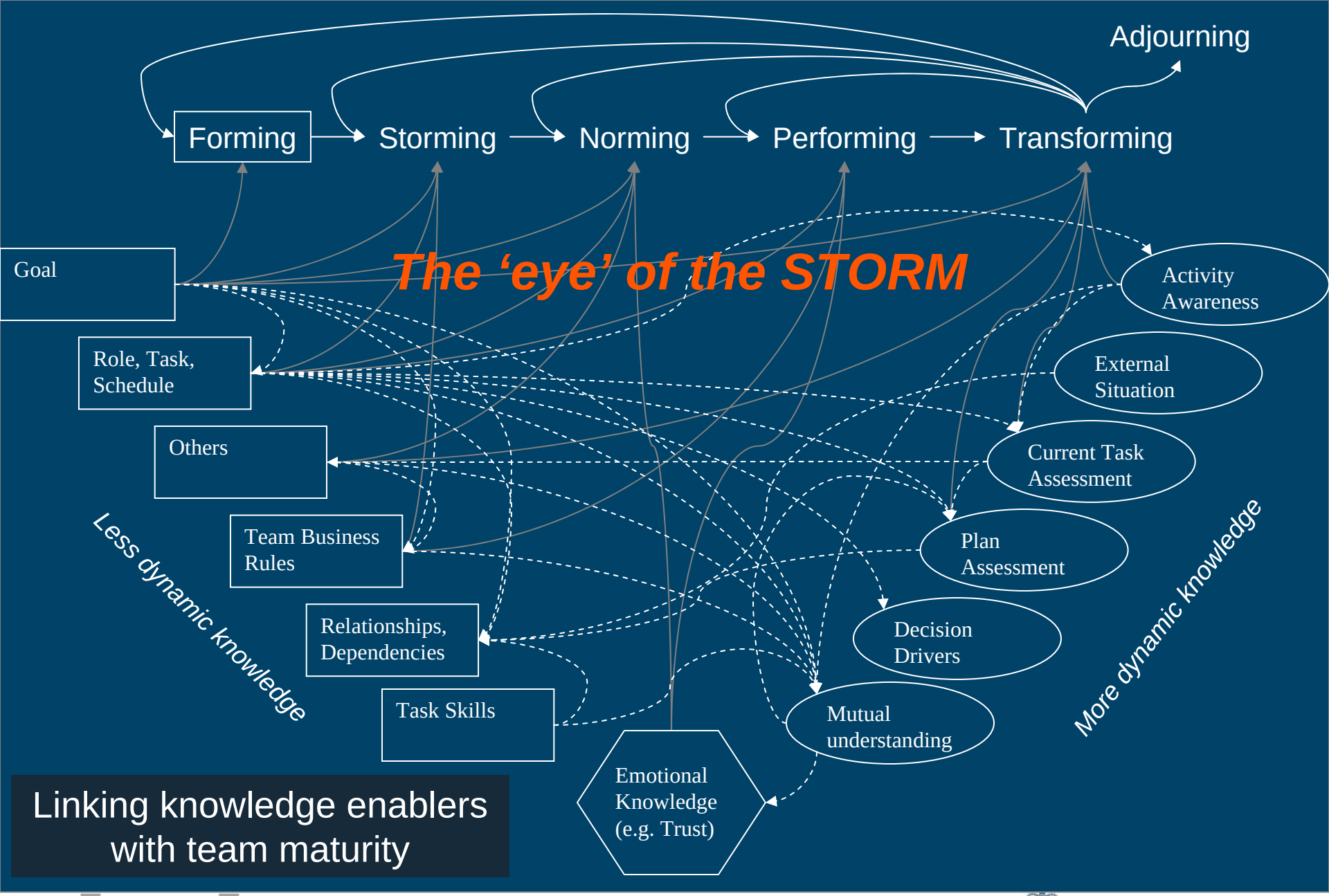
- Background
- Human Decision Making
- Exploitation
- Conclusions

C4ISTAR in SIMMAIR - overview



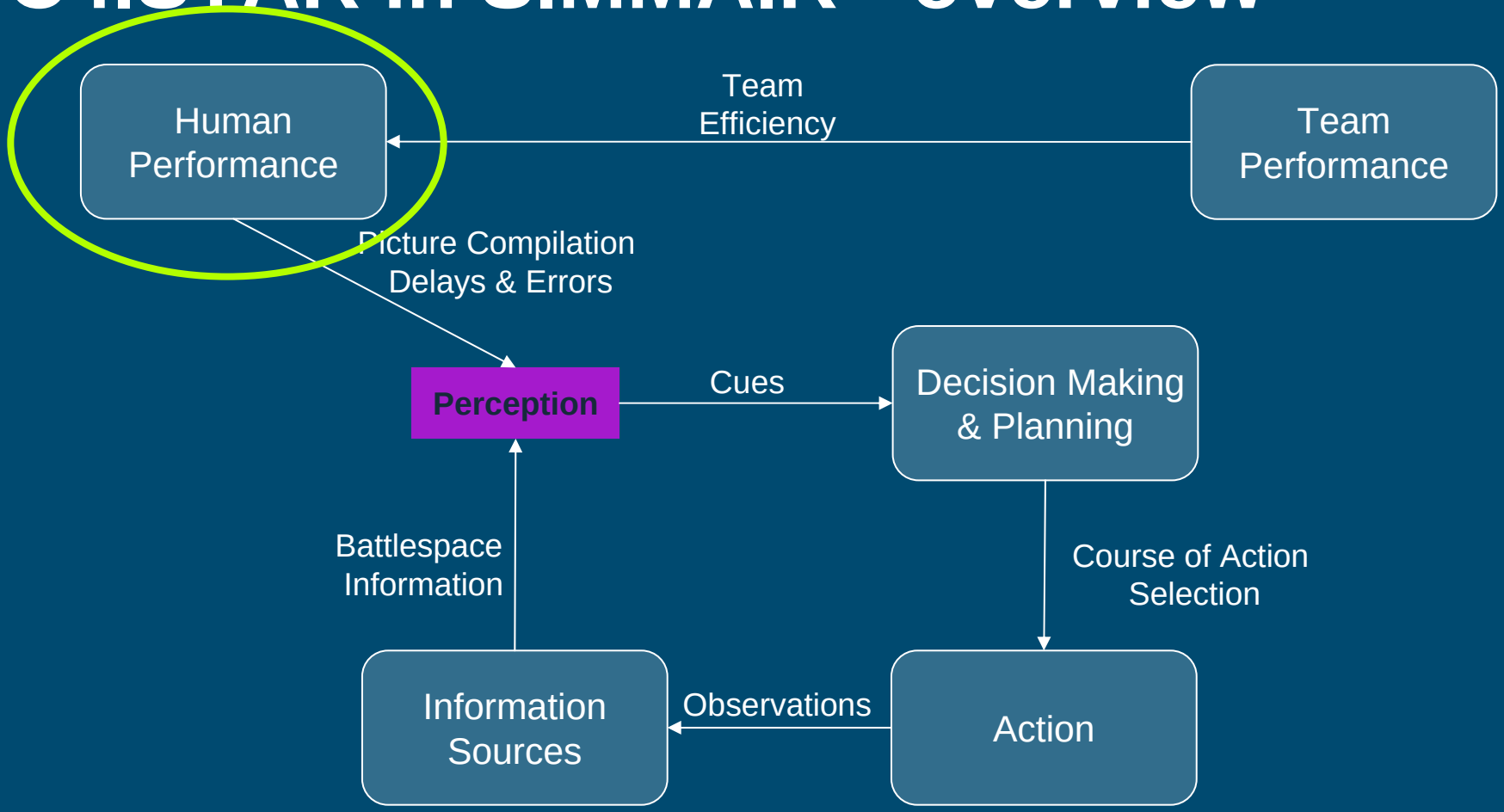
Teamworking

- STORM (Socio-cultural Teamworking for OR Models) will provide a realistic representation of the following:
  - Dynamic Collaborative Interworking
  - Performance of Agile Mission Groups
  - Coalition/ Interagency working
  - The impact of location of team members



Linking knowledge enablers with team maturity

C4ISTAR in SIMMAIR - overview

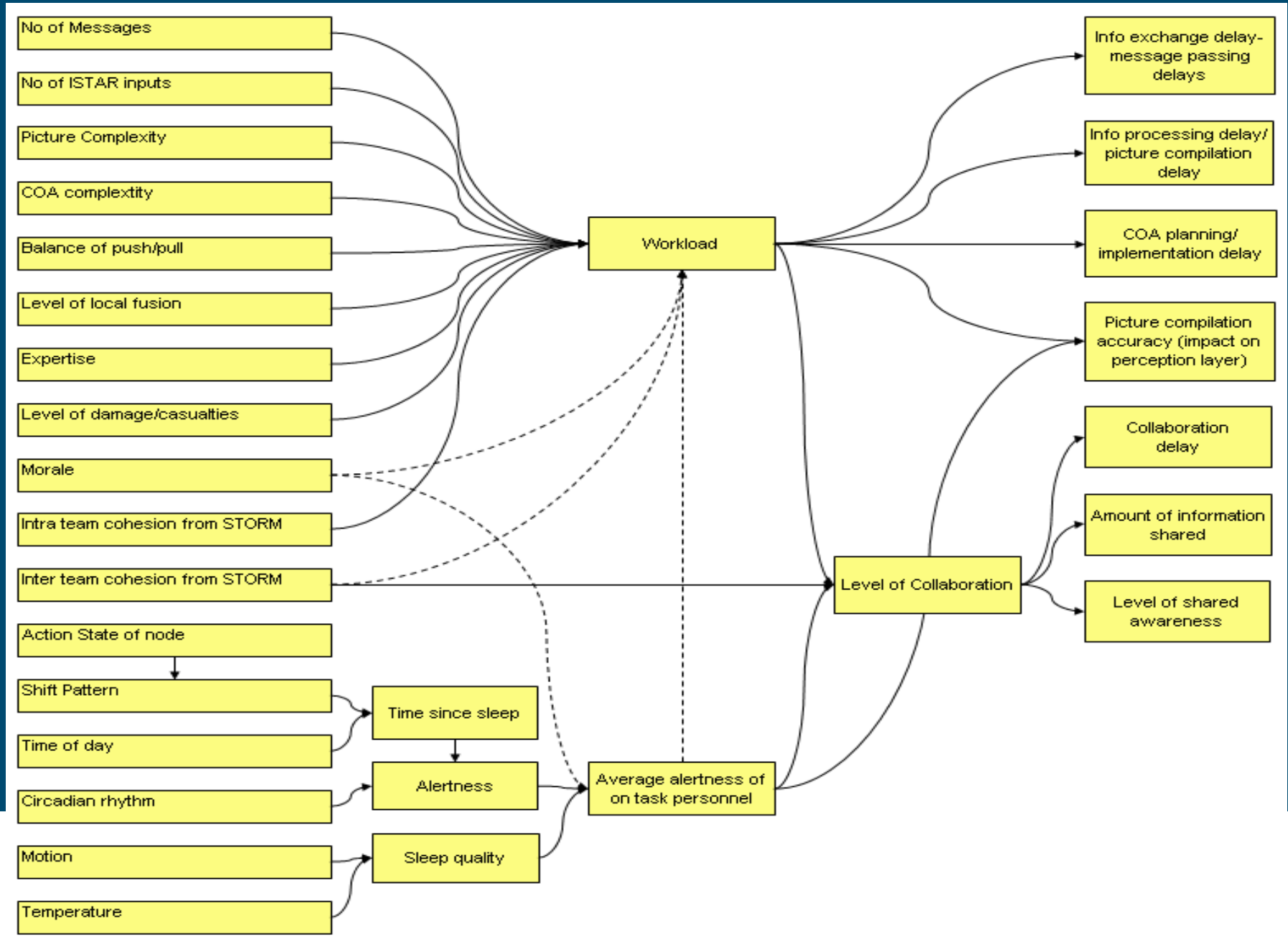


Human Performance

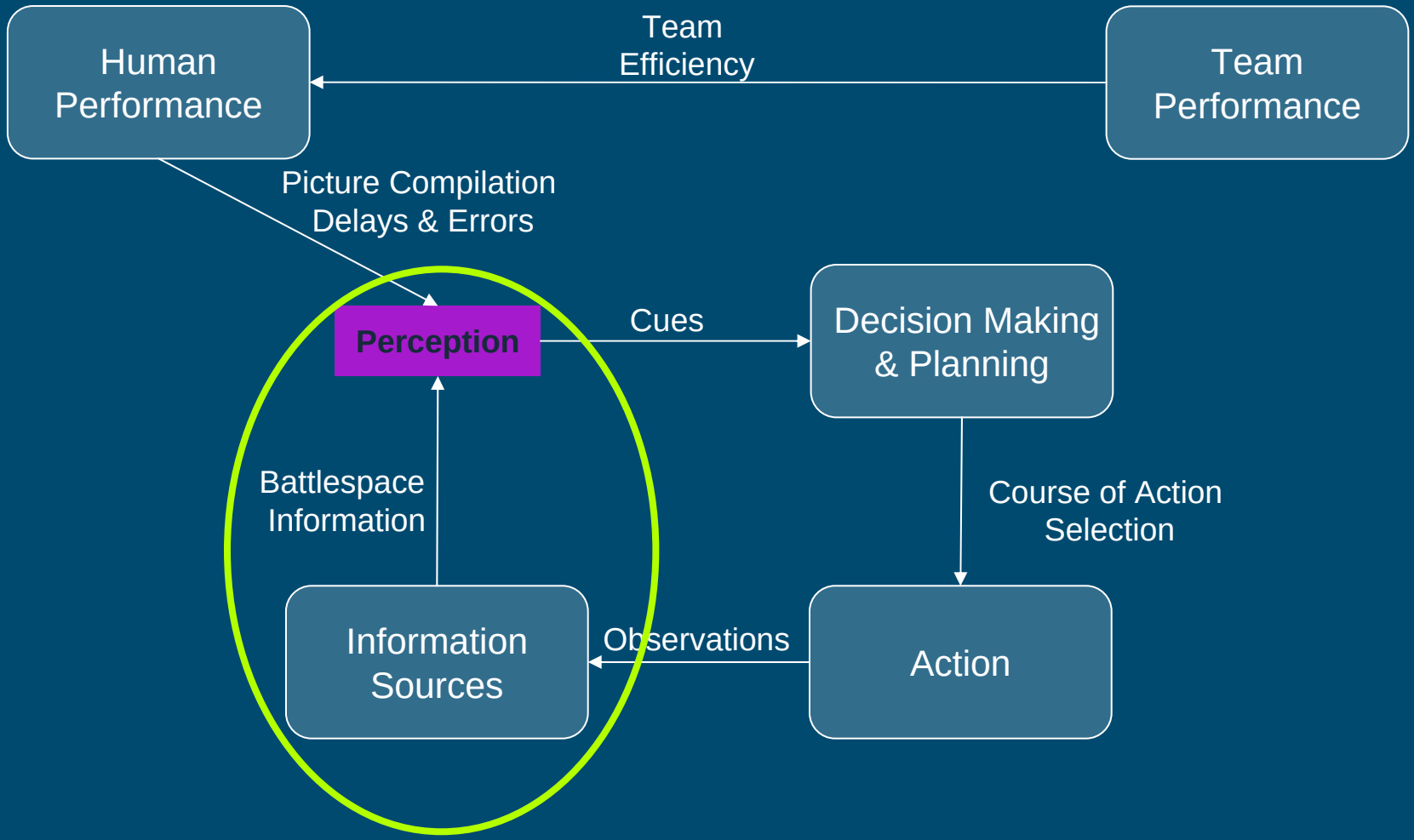
- Alertness State
  - Alertness model incorporates the effects of circadian cycle and work/rest patterns
  - Environmental effects on sleep quality will be captured

- Workload
  - The workload of a node will be derived from the number of information inputs, task complexity, staff size, expertise, teamwork efficiency, morale and alertness state

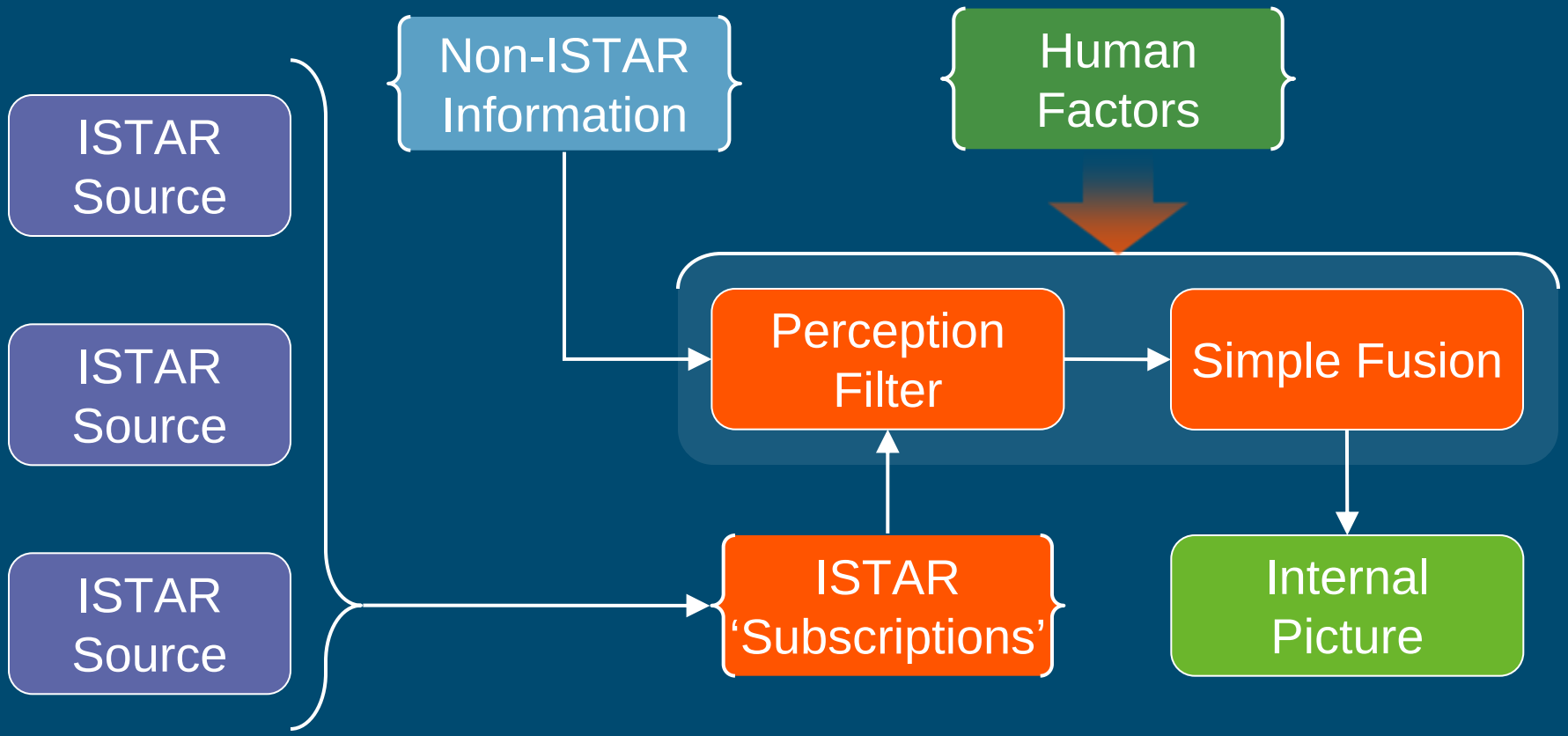
Human Performance Factors



C4ISTAR in SIMMAIR - overview



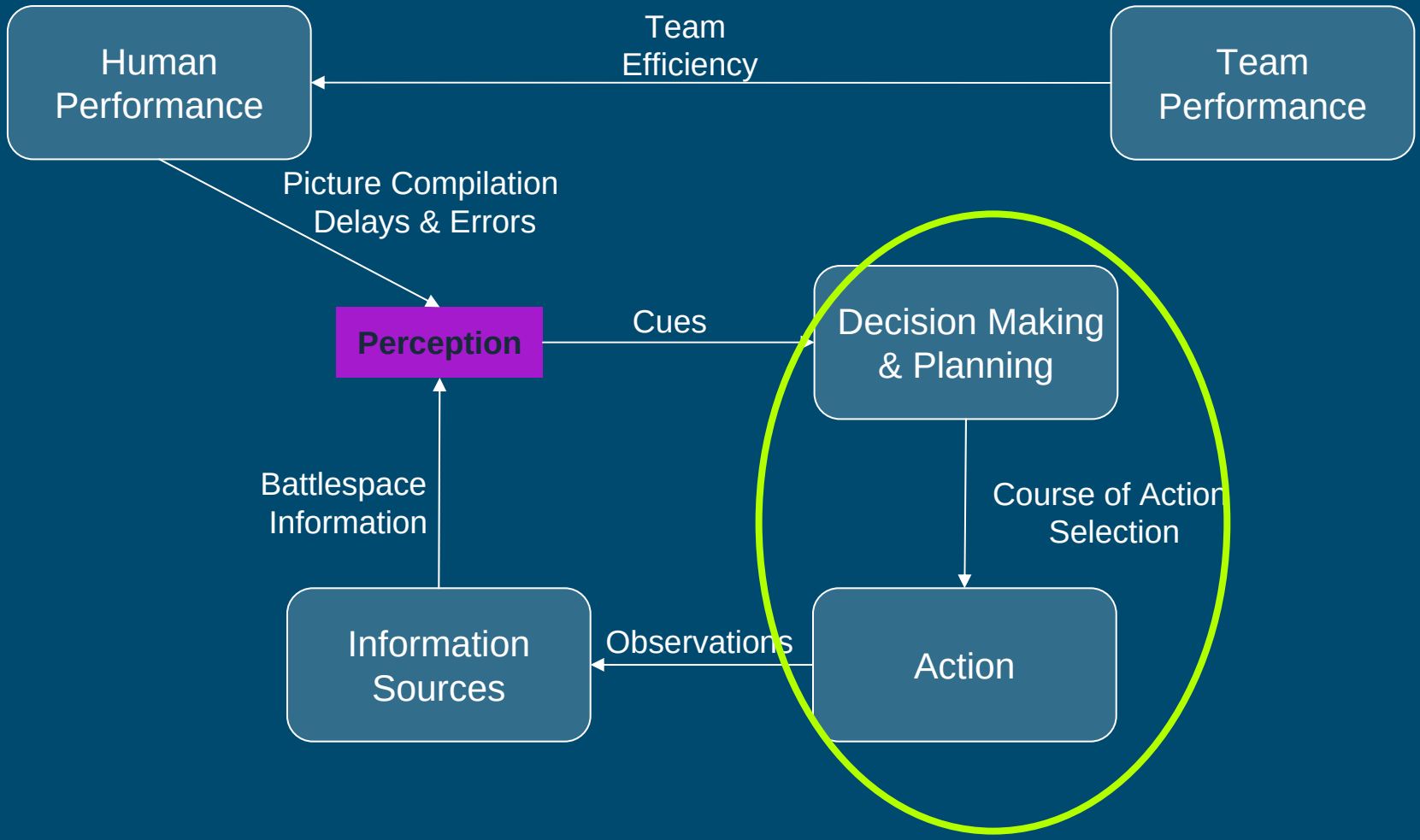
Building the Internal Picture/ Perception Layer



Modelling Effects

- No two decision-makers' internal pictures are the same
  - Representation of available information to make decision
  - Can model effects of perception bias / confirmation bias
  - The impact of trust in information source can be modelled
  - Ability to degrade pictures as workload increases

C4ISTAR in SIMMAIR - overview

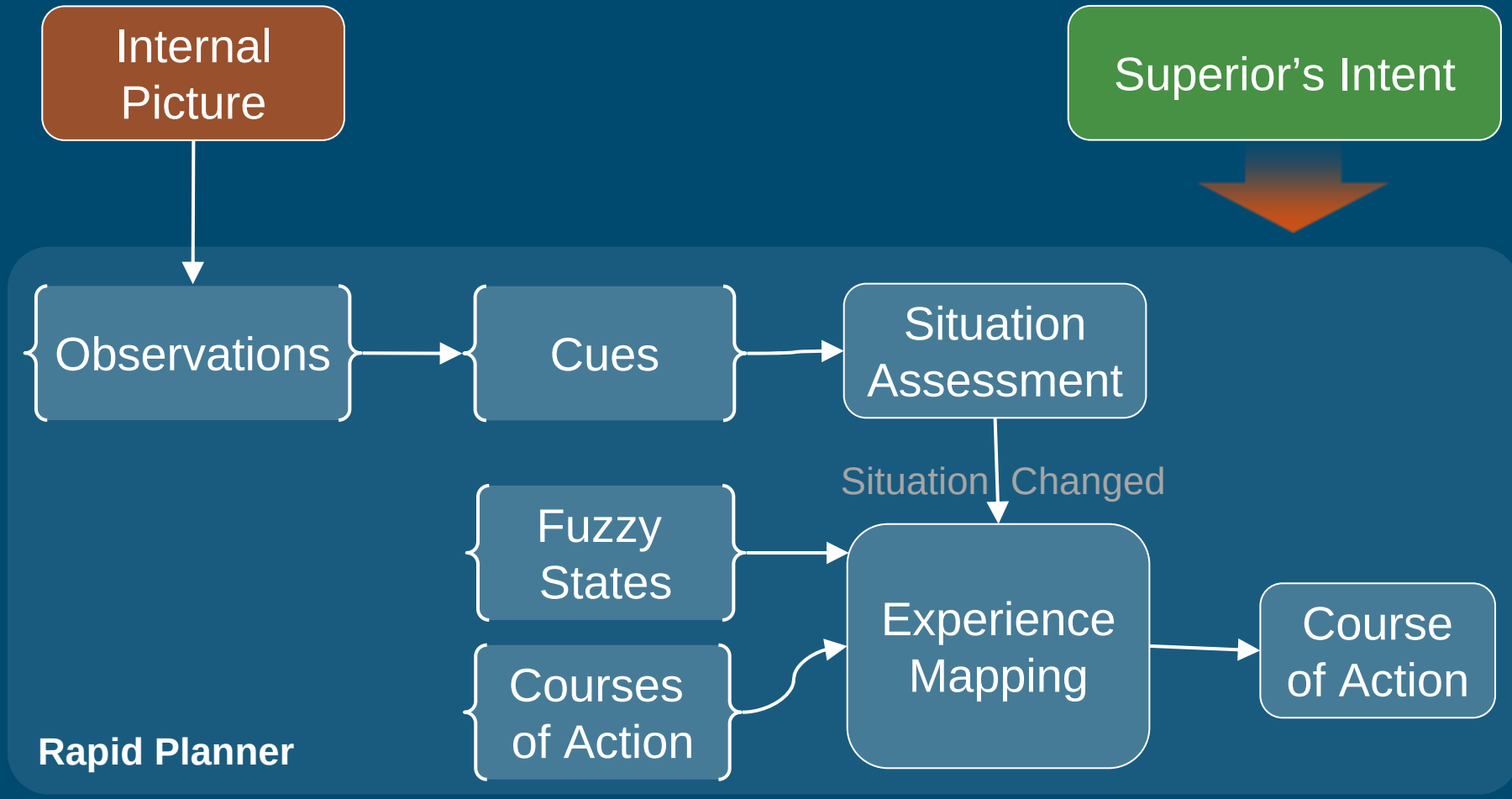


Human decision-making

SIMMAIR represents two types of decision-making

- Deliberate planning
  - Represents traditional decision making
  - User scripting of missions
- Rapid planning
  - Represents naturalistic decision making
  - Recognition Primed Decision Making
  - Course of action based on decision makers perception of the battlespace

Rapid Planning Model



Contents

- Background
- Human Decision Making
- Exploitation
- Conclusions

Exploitation of SIMMAIR

- **SIMMAIR shadowed three studies to:**
  - Smooth transition from a concept to a useful model
  - Confirm the requirement for SIMMAIR
  - Guide model development for SIMMAIR v1
  - Present opportunities for validation of the model
  - Facilitate access to input data sources and streams
  - Increase visibility of the model within the UK Defence Community

Method

- **Concepts of Analysis:**
  - Initial work addressed how SIMMAIR would be applied to each of the studies
- **Vignette based modelling approach chosen to:**
  - Allow scenario development to be based around a set of vignette “building blocks”
  - Allow the complexity of modelling to be steadily increased
  - Inform on the functionality required
  - Provide convenient testing “stepping stones”
  - Vignette workshops were held to obtain extra detail required for SIMMAIR

Method

- **Results from a number of replications of SIMMAIR were reviewed by the study teams to:**
  - Ensure results were representative of input scenarios
  - Identify issues and discuss ways to overcome them
  - Compare results against agreed MoE
  - Determine impact of NEC and Human Factors
  - Determine and discuss contribution of SIMMAIR to the studies

Results – C4ISTAR study

- The study investigated situational awareness and its effect on the campaign measure of effectiveness
- Various Requests For Information (RFIs) were made by the Blue CO prior to carrying out a mission.
- A RFI is a request made by a user for specific pieces of information, for example:
  - A CO of a Frigate may want to know if a minefield exists in a particular region before transiting through it
- By varying the length of time it took to satisfy the various information requirements the impact on the campaign was determined

Results – C4ISTAR study

Variation (hrs delay to RFIs)	% threats Neutralised
Baseline	58
Baseline +24	42
Baseline +48	33
Baseline +72	29

- There is a clear link between the timeliness with which RFIs are satisfied and mission outcome
- The sooner the RFI are satisfied the sooner actions were taken to neutralise the threats

Results – Air Domain Study

- The study investigated the impact NEC had on the ability to provide an accurate and timely air picture to the relevant decision makers
- The Blue decision makers required various feeds in order to compile an air picture of sufficient confidence to allow the missions to proceed
- By varying which information was shared and with whom the impact on the campaign was altered

Results – Air Domain Study

- Baseline case required picture compilation at a central location
- Effectiveness increased when an accurate picture was fed directly to the relevant decision makers
- Effectiveness increased to a point where enemy missions were prevented from starting

Variation (Minutes delay to picture compilation)	% threats Neutralised	Successful enemy missions
Baseline	38	10
Baseline + 60	75	9
Baseline + 20	38	7

Results – Maritime study

- The study investigated the impact of different tanker vulnerability and flight capabilities on the ability of a task group to perform Maritime Interdiction Operations
- The Blue CO was required to patrol a set area and neutralise a number of threats
- By varying the capabilities of the tanker the resulting impact on the campaign was determined

Results – Maritime study

Variation	% missions tanker neutralised	% threats neutralised
Tanker 1 + 2 helos	0	100
Tanker 2 + 2 helos	80	75
Tanker 3 + 1 helos	100	50

- As the tankers capabilities were diminished the overall capability of the task group (when in the Maritime Interdiction role) was reduced

Discussion

- **The chosen method, the use of shadow studies, worked well**
- **Resulting in:**
  - a greater understanding of the domains investigated
  - a more accurate representation of those domains in SIMMAIR
  - correct assumptions used throughout – including during coding
- **Model was validated as we progressed:**
  - Used current knowledge from each of the domains
  - Made use of those SME available as part of the real studies
- **Allowed progressive testing of the model**

Discussion

- **Some issues were encountered**
  - timing the study progress to match the release of new versions of the program from third party contractors
- **Not all the studies had a mature concept**
  - Led to difficulties in deciding what to model
  - The shadow studies needed to drive the real studies forward
- **Real study teams more engaged with the model development**
  - The studies had a significant say in what should be developed
  - Real benefit to future work was obvious

Contents

- Background
- Human Decision Making
- Exploitation
- Conclusions

SIMMAIR Conclusions

- **The use of SIMMAIR provided the real studies with:**
  - A single model environment with dynamic decision making linking the core functional areas
  - Supplemental and unique analysis not available through current models
  - Dynamic decision making based on available intelligence and Human Factors
- **The exploitation work helped SIMMAIR development by:**
  - Successfully guiding the development of the model
  - Providing initial verification of the model
  - Access to various data sources and expertise
  - Increased visibility of model within the UK defence community