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Overview

Research Questions

Approach

Tools

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Overview

Air Transport Complexity

Large # of operations

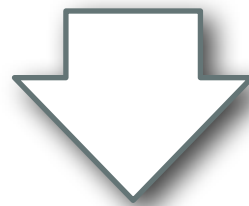
Process fragmentation

Information flow

Large # stakeholders

Heterogeneity in users goals

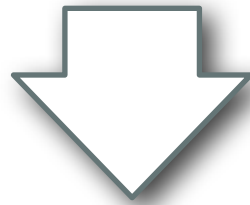
Pervasive uncertainty



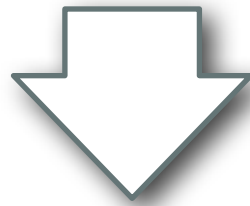
complexity is in the interactions

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Improve Performance

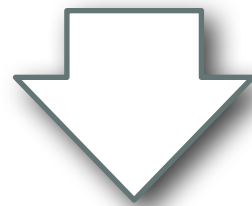


New Technology, New Procedures



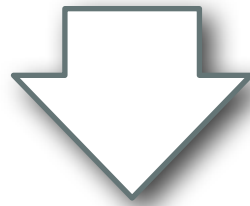
*Need: Model Performance
before deployment*

Need: Model Performance



- 1 Translate ATM stakeholders expectations*
- 2 Define operational requirements in performance terms*
- 3 Build the basis for impact assessment & trade-off analysis*

Need: Model Performance



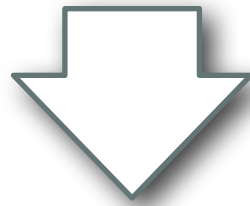
SESAR Performance Framework

drivers → KPIs

*Need: Model Performance
SESAR briefing 2011.05.03*

- ☐ The link between projects and performance targets is still weak, but the culture is changing towards a more performance driven approach

*Need: Model Performance
SESAR Performance Framework*



What's the right approach?

Influence Diagrams?

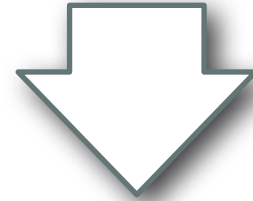
Micro-scale simulators?

Extrapolation of current metrics?

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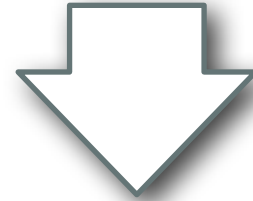
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SESAR Performance Framework
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Research Questions
additional research questions

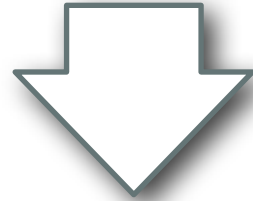
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Research on a Complex Systems
Approach to Performance Modelling

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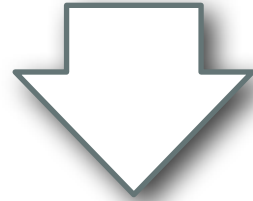
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Three main Modelling Challenges

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Multiple spatial and temporal scales
Emergent Phenomena
Non-determinism and uncertainty

Multiple spatial and temporal scales

Conflict resolution

Minutes

Flow Management

Hours

*Adaptation to heavy disruptions
(e.g., volcanic ash)*

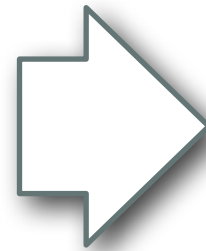
Weeks

Airport slots assignment

Months (current)

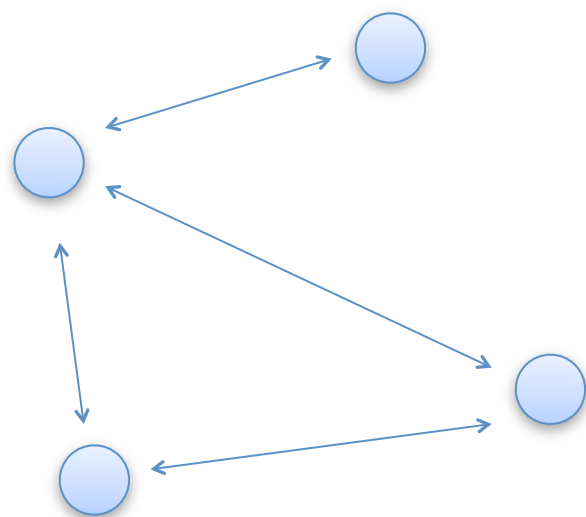
Changes in regulation / technology

Decades



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Multiple spatial and temporal scales

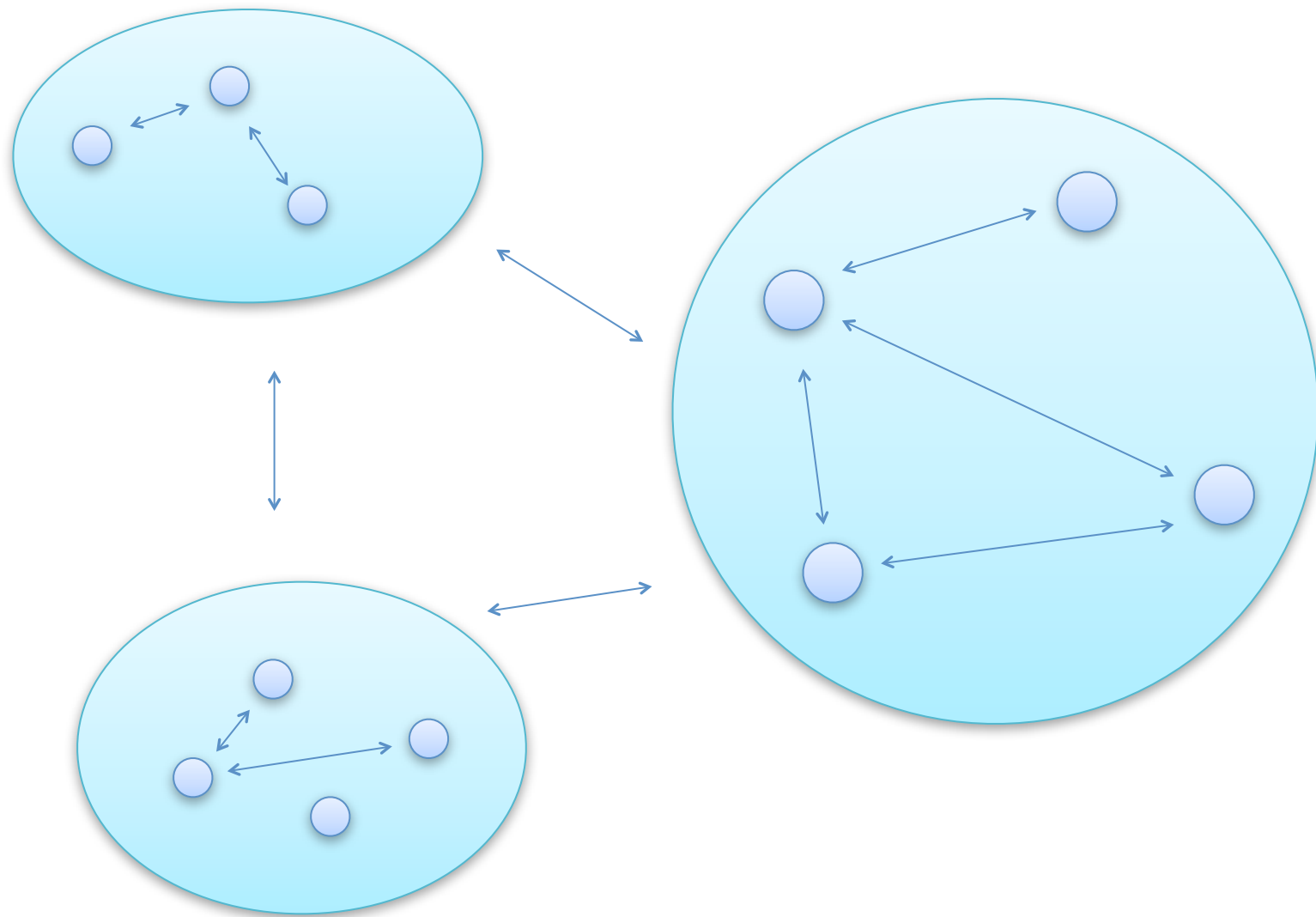


*interactions more
important than individual
behaviors*

*aircraft, crews, ATC
controllers, equipments,
airlines, ...*

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Multiple spatial and temporal scales



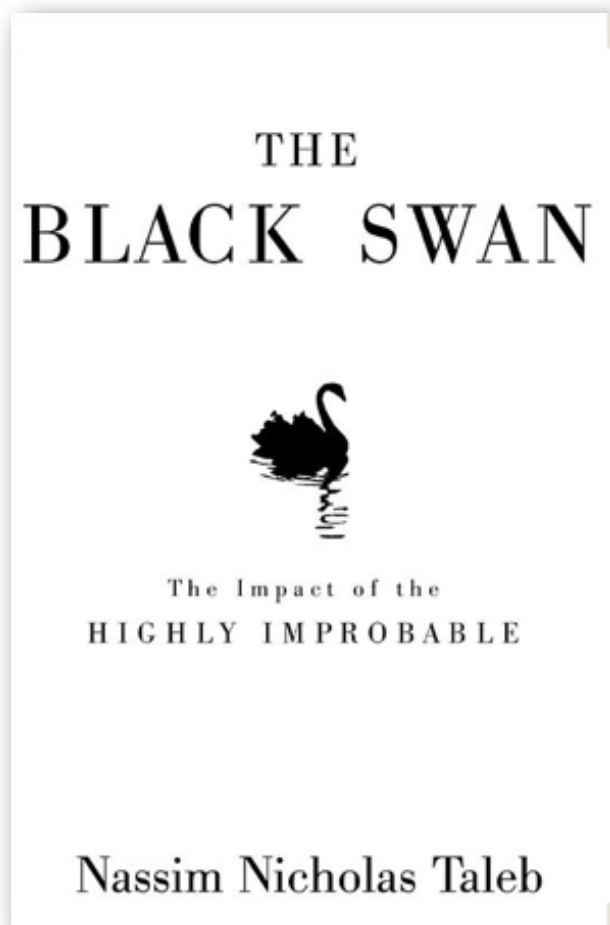
Emergent Phenomena

Interactions between heterogeneous elements give birth to situations that where not expected (nor wanted!)



Complexity aggravates uncertainty

*Human minds are not good at accepting uncertainty
Most would choose unhappiness before uncertainty.*

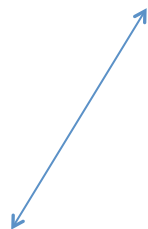


*Many scientists have operated under the
false belief that their mathematical tools
could eliminate uncertainty.*

Interaction between challenges

Different scales

Unforeseeable events usually propagates through different spatial and time scales.



Uncertainty

Emergent behaviours

Interaction between challenges

Different scales

Unexpected and rare events may trigger other unexpected behaviours.

Uncertainty  *Emergent behaviours*

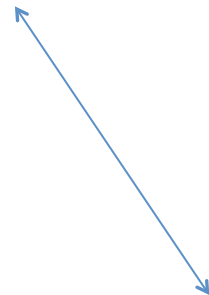
Interaction between challenges

Different scales

Emergent behaviours may appear on scales which are not related with the relations that have triggered the event.

Uncertainty

Emergent behaviours

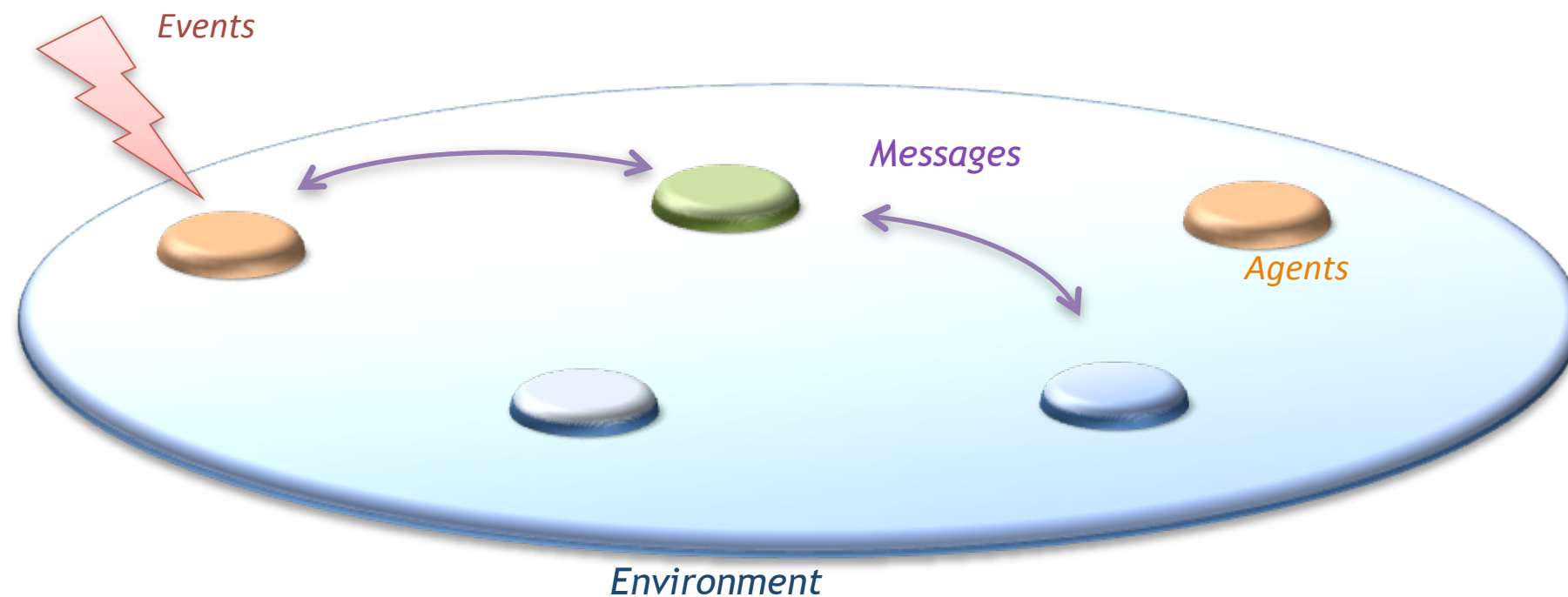


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How?

ABM

Modelling framework for simulating the actions and interactions of heterogeneous elements composing a system.



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ABM

Autonomy

Social behaviour

Re-activeness

Pro-activeness

Game Theory

Modelling approach where a set of players must make decisions in order to maximize their payoff.

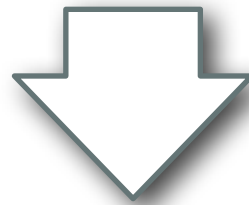
ABM + Game Theory

The outcome of a strategy depends on the choices of other players: importance of interactions between agents.

The payoff may depend on the appearance of external, uncertain factors.

Players may have to optimize multiple objectives at the same time.

Challenge



***Modelling the decision making
process of different stakeholders***

***Changes in regulations, which may result in different
outcomes depending on the reactions of other players;***

Project Status



High Level Specification



Logical Architecture



Software Architecture



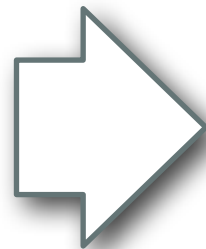
Case Studies

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ATM Performance

CS Modelling

WP1

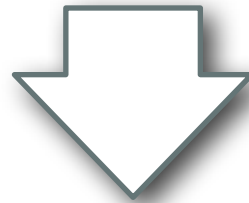


WP2

Case Studies

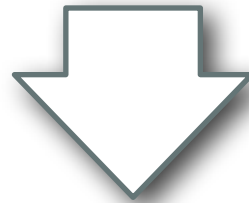
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Case Studies



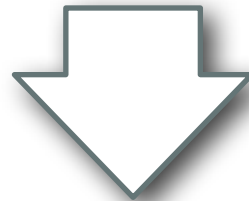
Selection Process

Case Studies Selection Process



*Complexity-focused
Expertise of the team
Relevance to stakeholders*

Case Studies Selection Process

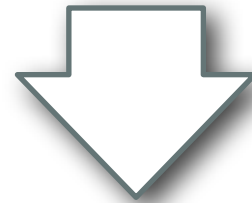


Stakeholder Survey

*Type of change that should be evaluated in terms
of impact in performance*

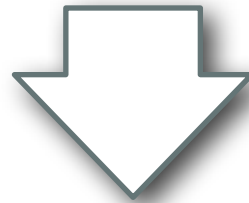
*KPA/KPI to be evaluated and temporal/spatial
scales*

Case Studies Selection Process



ATM Performance Seminar & Workshop
London, January 2012

Case Studies *Selection Process*



- 1 Local environmental restrictions to limit capacity*
- 2 ATFM allocations as tradable commodity*
- 3 Strategic trading of airport slots between airlines*
- 4 Peak/Off-peak pricing in Air Navigation charges/slots*
- 5 Dynamic cost-indexing - fuel consumption optimisation*

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Thanks,

David - dp@innaxis.org

