

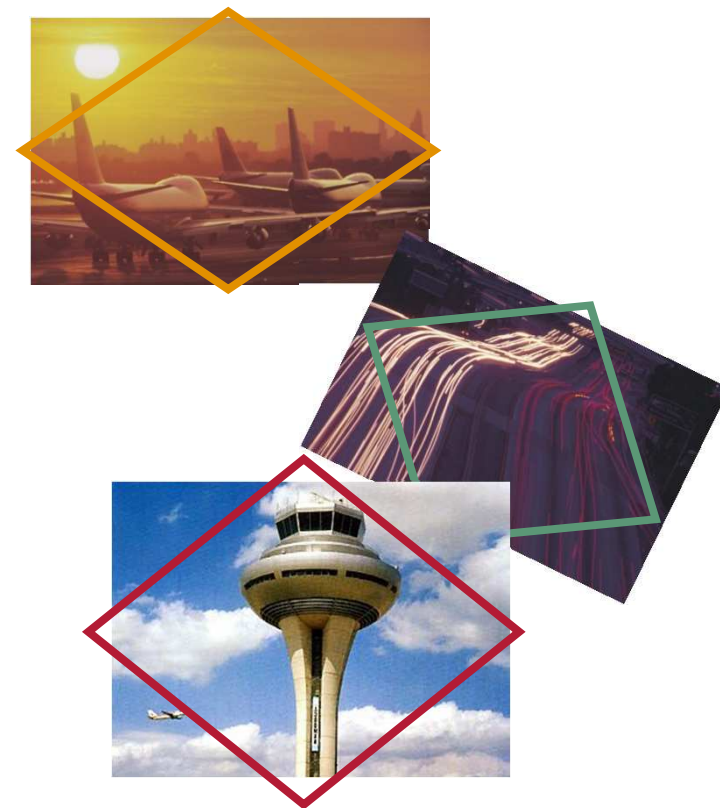


Dynamic Approaches from Complexity to Manage the air Transport Network

SESAR Innovation Days 2011

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Isdefe, Spain



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Outline

1. NEWO Objectives of Research
2. The approach
3. Scenarios and 1st NEWO Workshop outcomes
4. Next Steps



NEWO Objectives of Research



NEWO Objectives of Research

Project funded under SESAR WPE.

- ◆ NEWO stands for “*emerging Network-Wide Effects of inventive Operational approaches in ATM*”. Objectives:

Evaluate changes in behaviour of European air transport network linked to diverse local operational approaches

Prioritisation



Propagation

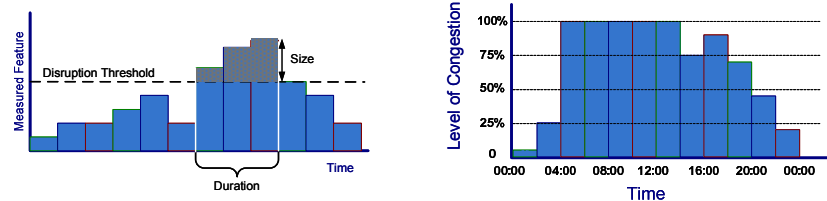


Further develop and explore the potential of innovative modelling and simulation techniques

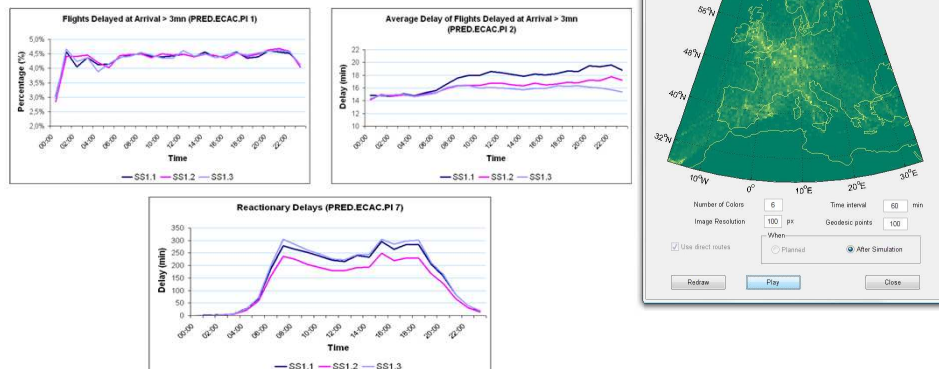


NEWO Scope

- ❖ **Conceptual framework:** common concepts, current strategies, dynamic indicators, etc.



- ❖ Capture **out-of-the-box ideas** for managing complex networks: workshops, questionnaires, interviews, expert groups...
- ❖ Select scenarios and modelling.





NEWO Approach



The Approach: Problem Statement

Air Transportation System a complex system

Irregular structure (neither purely regular nor purely random)
dynamically evolving in time;

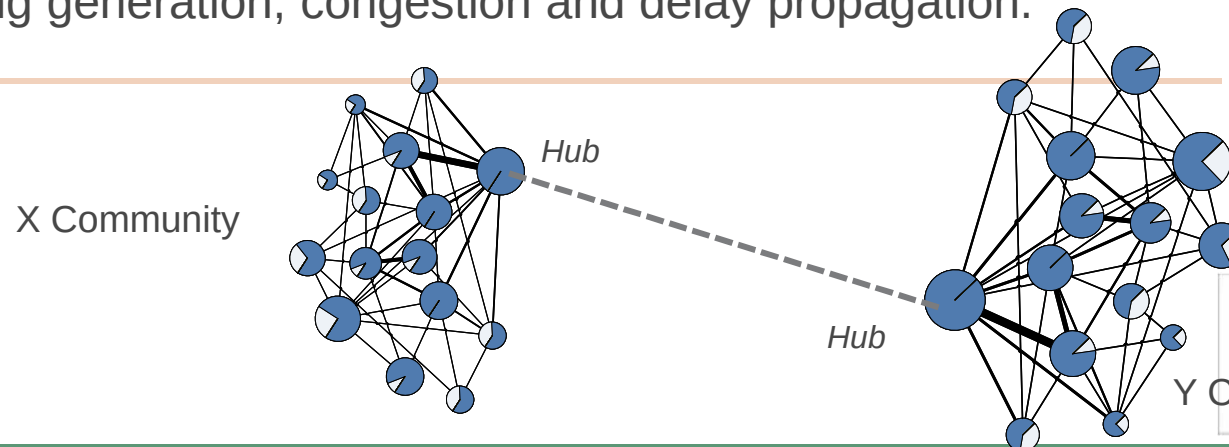
Small world and power law degree distribution;

Communities structures: **vertices connecting different communities are usually hubs** in their own community.

Nodes are **dynamical systems** whose dynamics are both influenced by and influencing other nodes dynamics;

Links between elements: there is more than edges;

Queuing generation, congestion and delay propagation.



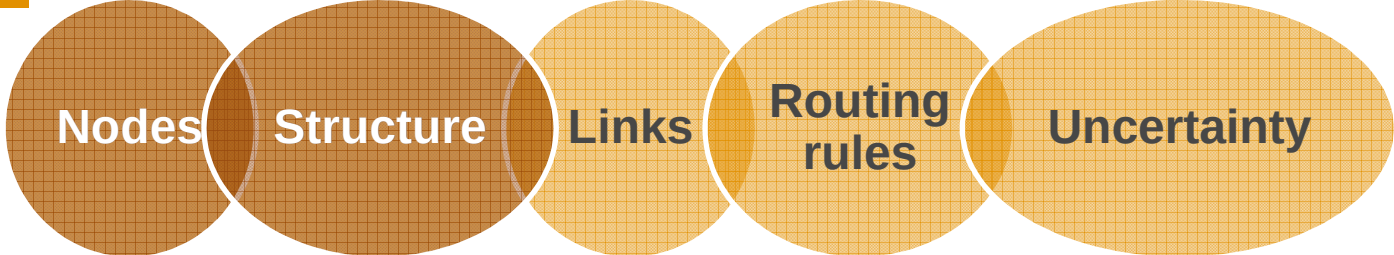


The Approach: Modelling Complexity

Emergent Phenomena are global behaviours which cannot be understood from the behaviour of individual elements:

- ❖ **Dynamic graphs:** structure is not fixed;
- ❖ More links between elements than topology: propagation of noise through the system capturing **interactions between elements**;
- ❖ **Simple behavioural rules** are able to generate complex behaviours;
- ❖ Inter-relationships between **structure and dynamics**;
- ❖ Incorporate “noise” in the behaviour of elements (non-determinism): modelling **uncertainty**.

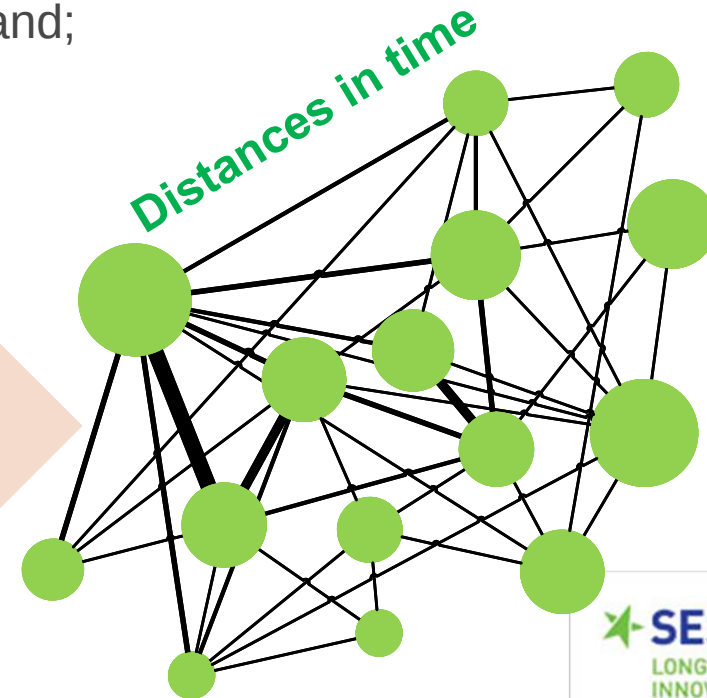
Mesososcopic model



- ❖ **Heterogeneous nodes** with capacity restrictions: airports and high density airspace areas;
- ❖ **Dynamic graph** generated from traffic demand;

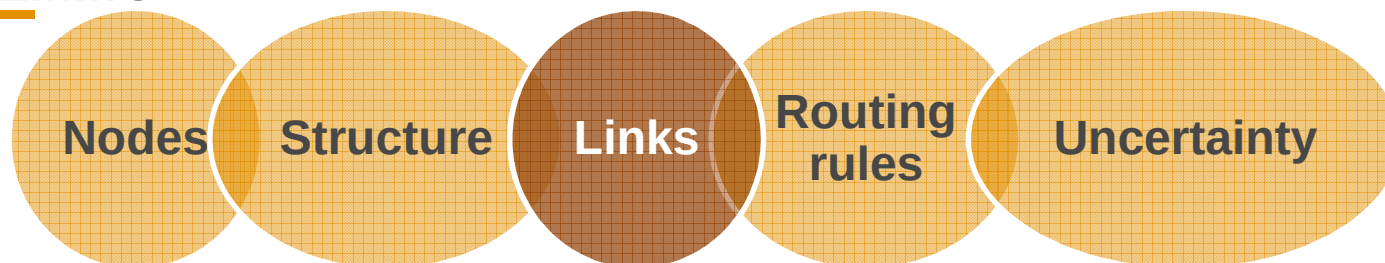


Elements travelling between two nodes are aircraft

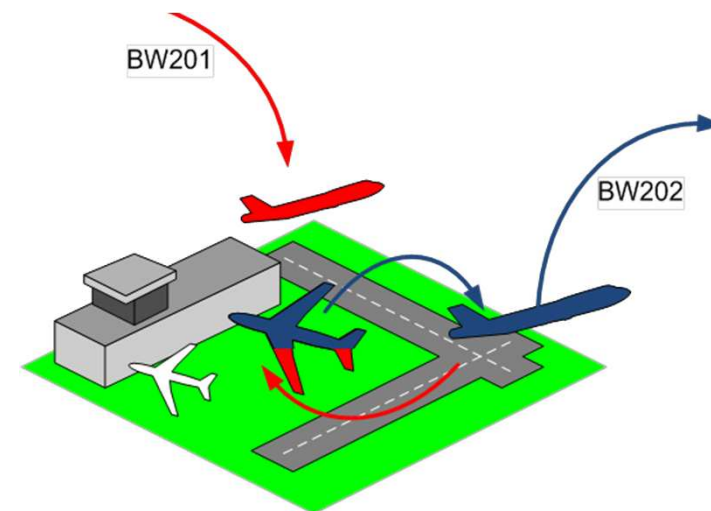




The Approach: ATM-NEMMO



❖ Interactions between elements (propagation, reactionary delays):



Balanced NOP		High Density Areas		Linked Flights	Initial NOP								
Callsign	ETOT	Crossed Areas	Distance	Precedent/ Ensuing	ETOT	DTOT	QTOT	ATOT	ETO	ETA	HTA	ATA	TTA
				— / XXX									
				xxx / XXX									
				xxx / —									



The Approach: ATM-NEMMO

Nodes

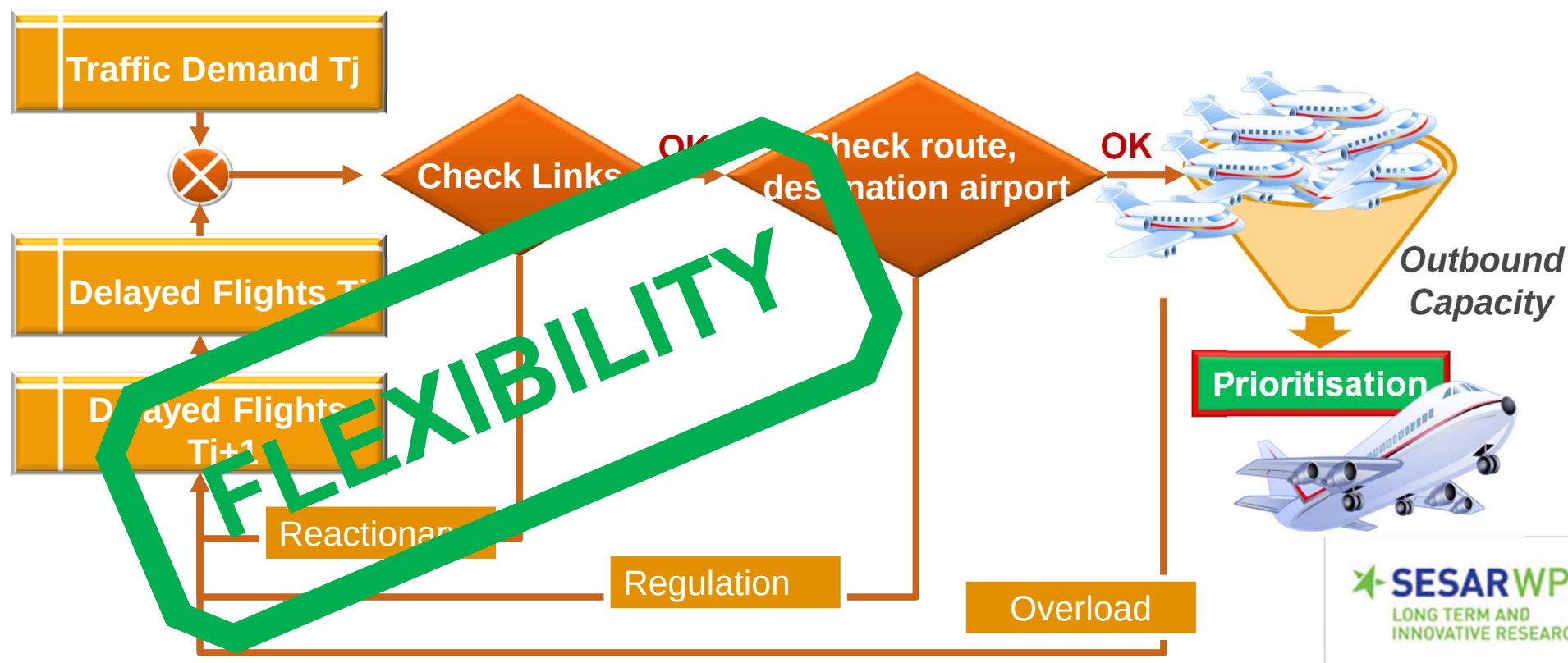
Structure

Links

Routing
rules

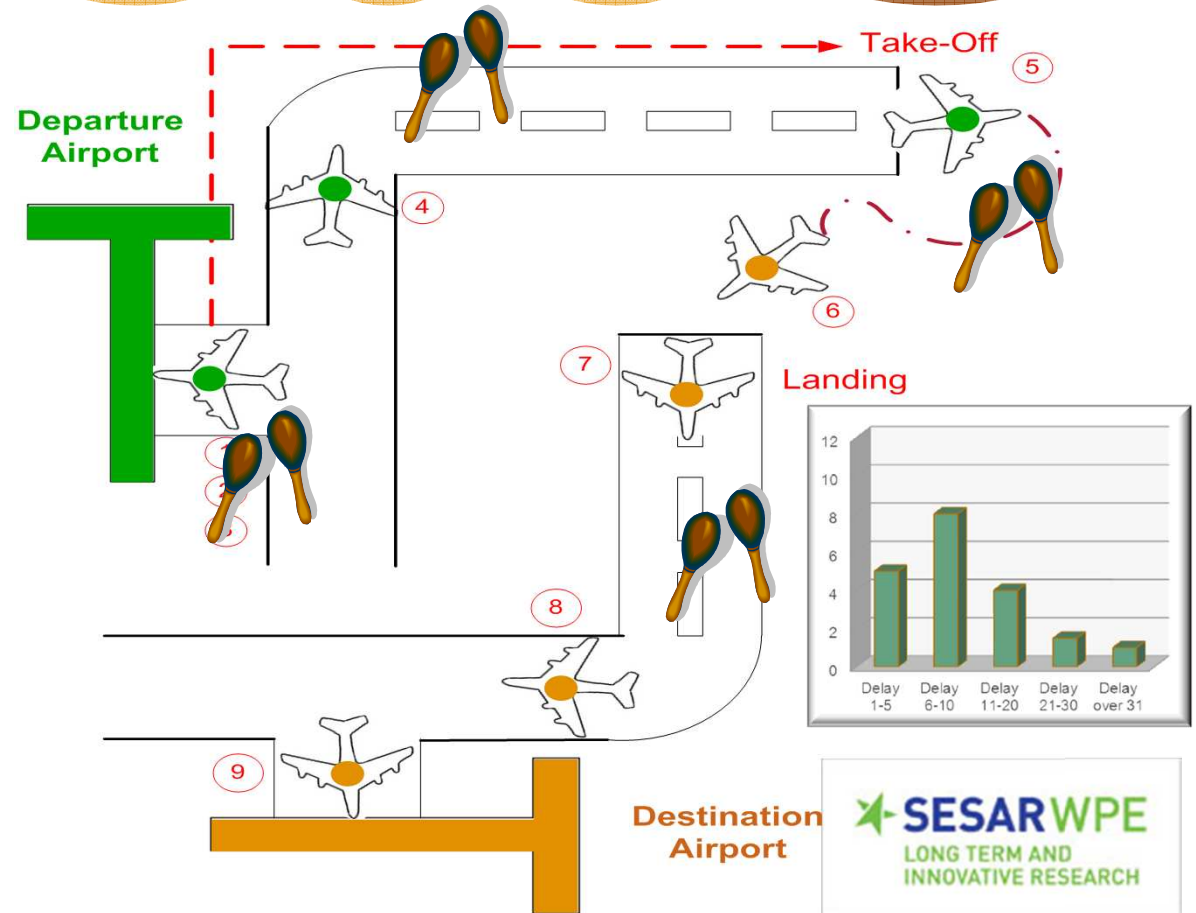
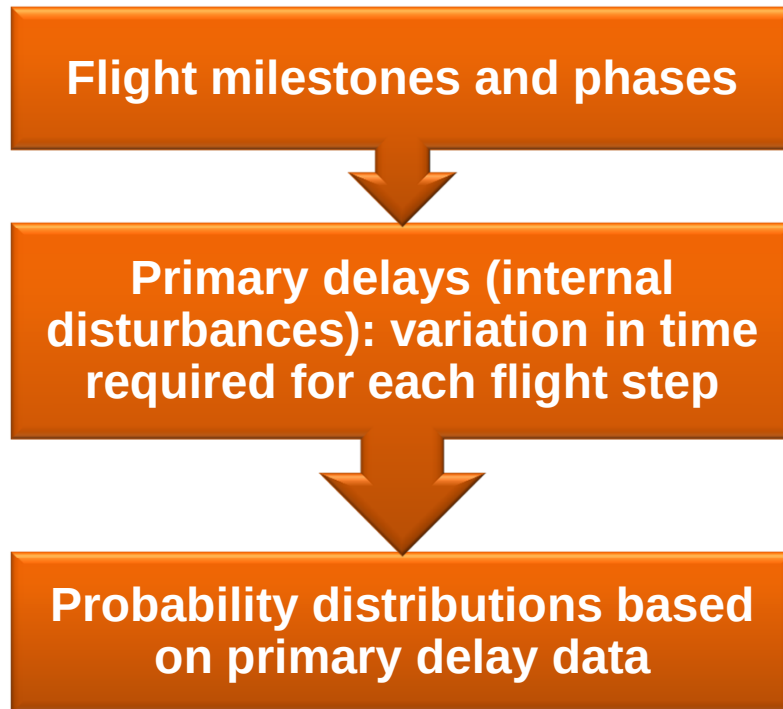
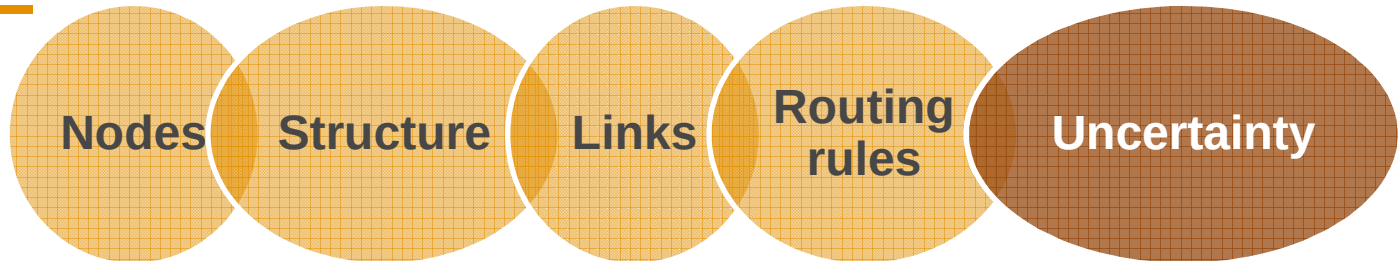
Uncertainty

◆ Within time interval T_j , at each airport for outbound traffic:





The Approach: ATM-NEMMO





Scenarios and 1st NEWO Workshop outcomes



Scenarios...going through

Identify and evaluate flight prioritization rules in case of severe capacity shortfalls affecting departures at airports.

Workshop last 25th
October

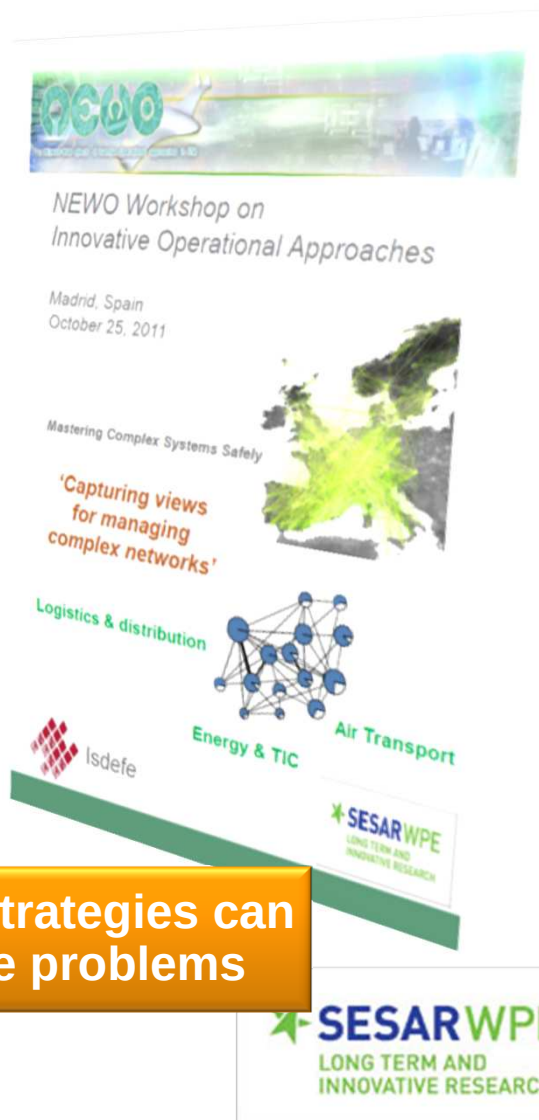
People with diverse
backgrounds

Issue criteria for prioritisation
and solve theoretically specific
scenarios of demand - capacity
imbalance

Selection of most promising ideas

Simulate and capture delay
propagation and overload
bunching with demand increase

Check if different strategies can
palliate or not the problems





Scenarios: some ideas

Discussion about applicability and feasibility

Network approach

Efficiency, capacity: connections, bigger aircraft, better equipped, short-haul...

Airline driven

Business decisions

Random

◆ Flight priority in two parts: $Pr = \alpha (\text{airlines criteria}) + (1 - \alpha)(\text{network criteria})$

α

Airline

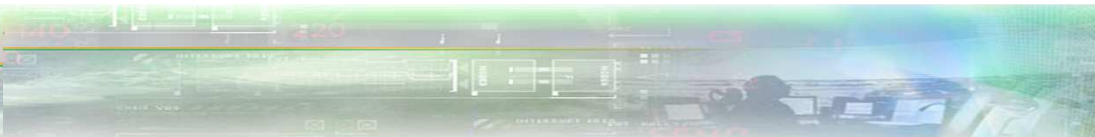
Airline specific, based on business models

Network

...first flights to hubs, to less congested airports, arrival slot at destination...

◆ Equity indicators;

◆ Does negative effect of a decision come back to the same people?



Next Steps



Next Steps

Main Activities

Analysing workshop outcomes;

Communication: gathering feedback;

Select and define scenarios;

Some model adaptation and development.

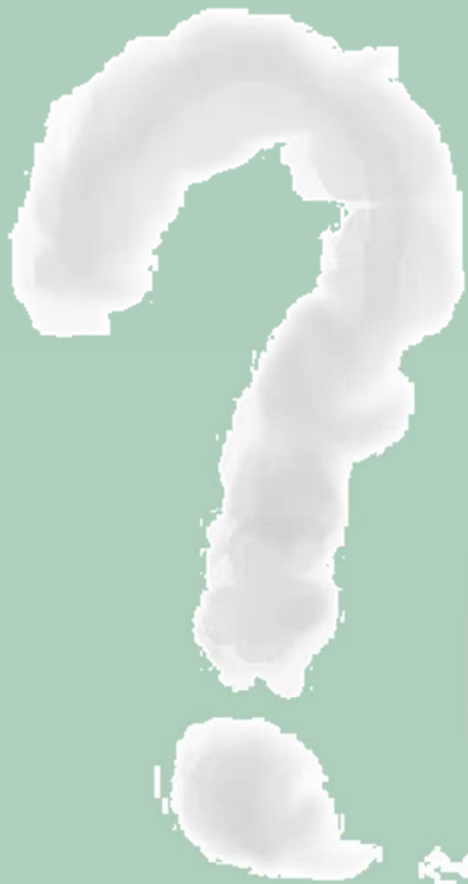
Support activities/ tools

Cross-fertilization in WP-E 'Mastering Complex Systems Safely' network;

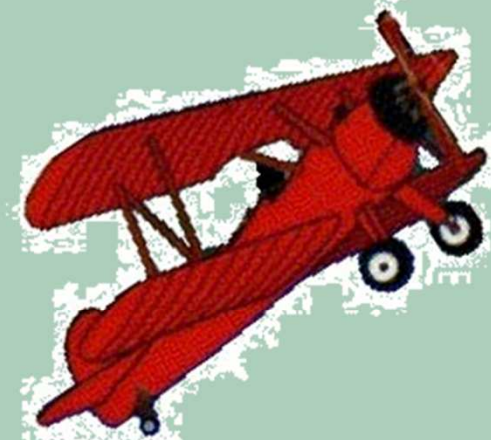
Links with academia;

NEWO webpage and LinkedIn group.





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