


Ministry of Defence

Modelling Information Flow in Military and Humanitarian Supply Chains

Netherlands Defence Academy
Tim Grant
LNMB 2012, Lunteren
19 January 2012



Overview

Goal:

- To compare two approaches to modelling information flow in military and humanitarian supply chains: mathematical network theory & SCOR


Structure:

- Introduction
- Supply chains
- Task Force Uruzghan logistics network
- Two modelling approaches
- Agent-based simulation (ABS)
- Conclusions & recommendations

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Introduction (1)

My experience:

- 1966-87: Royal Air Force officer, UK & SG
- 1987-2004: Consultant, Atos Origin, NL
- 2001-9: Professor, U. Pretoria, ZA (20%)
- 2004-date: **Professor, NLDA**, Breda, NL (50%):
 - *Teaching*: Communication, Information & C2 Systems
 - *Research*: **Operational ICT & communications:**
 - > **Network-enabled C2 systems**
 - *Management*: team of 7,5 lecturers

My qualifications:

- BSc Aeronautical Engineering, Bristol, UK (1969)
- Defence Fellowship (Masters), Brunel, UK (1984)
- PhD Artificial Intelligence, Maastricht, NL (1996)

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Introduction (2)

Netherlands Defence Academy (NLDA):

- **Faculty of Military Sciences (FMS)**
- Netherlands Defence College (NDC)
- Advanced Defence Course (ADC)
- Netherlands Institute of Military History
- Human Resource Management Academy

Faculty of Military Sciences (FMS):

- Initial officer education:
 - All Dutch military services
 - Military & personal development
 - Academic education (Bachelor level)
- **Related scientific research**

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Introduction (3)

My OR experience:

- During Falklands War (1982)
- In Department of Chief Scientist (RAF):
 - Operations team
 - Maintenance team:
 - > My role: **tame military officer**
 - > Led 1,5 civilian scientists
 - Psychologists:
 - > Recruitment & training issues
 - > Elsewhere in London
 - Primary OR technique:
 - > **Discrete-event simulation (in ECSL)**

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Supply chains

Features:

- “Chain” suggests linear structure
- Supply chain management:
 - Equilibrium-seeking:
 - > Supply & demand in balance
 - Optimization
- Dynamic instability:
 - Bullwhip effect
 - One solution:
 - > Perfect information flow

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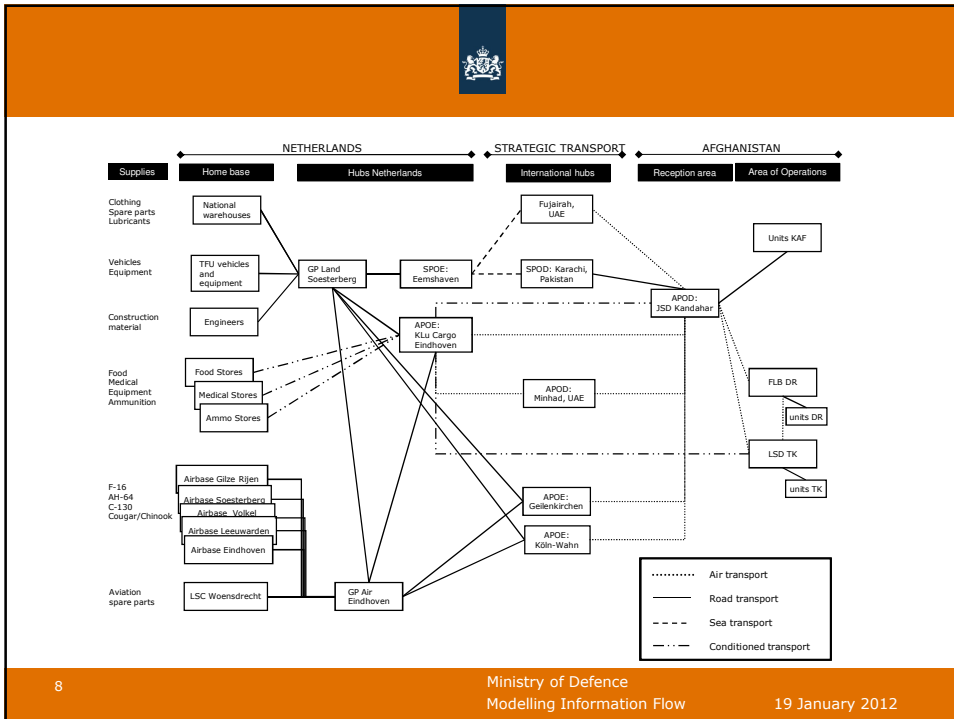



TFU logistics network (1)

Key features:

- Schematic of geographical (physical) network
- Starts at depot, not manufacturer
- Typed nodes:
 - APOD, SPOD, APOE, SPOE, etc
- Typed arcs:
 - Air, land, sea, conditioned transport
- Labelled for forward logistics, but reverse possible
- Does not show:
 - Traffic over network (vehicles & containers)
 - Communications network (hubs, routers, sats)
 - Information network (pieces of information)
 - (Socio-) Organizational network

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TFU logistics network (3)

Unlike civilian supply chains:

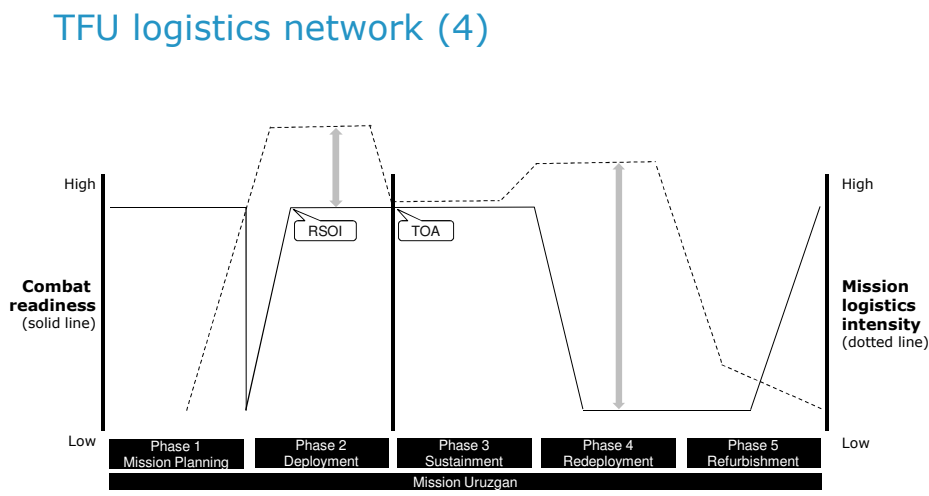
- No central monitoring & control
- Demand & supply highly non-uniform
- Supply chain partners change dynamically
- Some partners not trustworthy:
 - Dare not give perfect information



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TFU logistics network (4)



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Two modelling approaches (1)

Mathematical network theory:

- Biological, technical, cognitive, social networks
- Nodes can represent: Newman, 2003
 - Individual people
 - PCs / laptops / phones (with or without users)
 - Piece of knowledge
 - Organizational teams
 - Complete organizations
- Arcs can represent:
 - *Transport*: passing physical goods
 - *Communication*: requesting & passing information
 - *Interaction*: eg shaking hands, fusion, missile hit
 - *Relationship*: static or dynamic

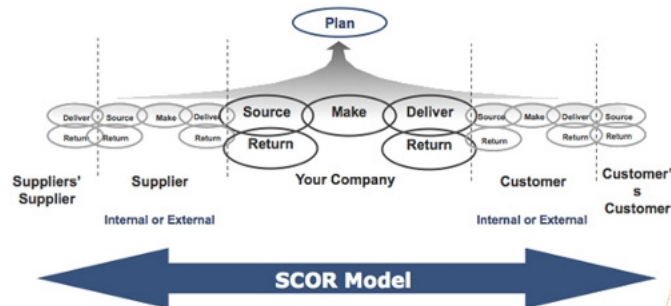
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Two modelling approaches (2)

Supply Chain Operations Reference (SCOR):

- Cross-industry de-facto standard
- Five processes: Plan, Source, Make, Deliver, Return
- From supplier's suppliers to client's clients:



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Two modelling approaches (3)


Problems with network theory:

- Aggregate measures:
 - In TFU every node is unique
 - No perfect information & no equilibrium
- Assumes global viewpoint:
 - In TFU no “bird’s eye view”

Problems with SCOR:

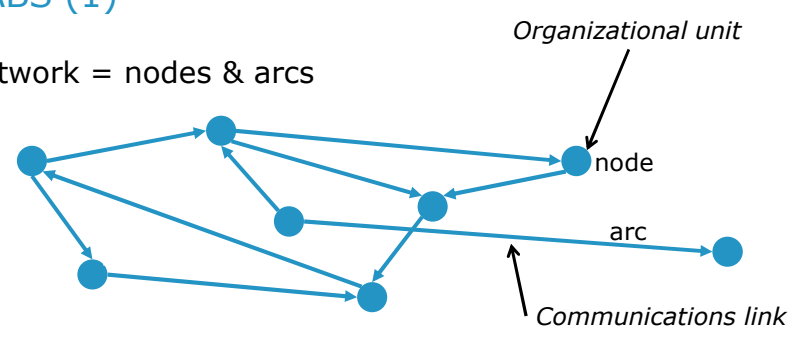
- Limited horizon:
 - TFU ranges more widely
- Relations not fixed:
 - Partners join & leave on-the-fly
 - Reverse flow

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ABS (1)


Network = nodes & arcs



SCOR: supplier relations & customer relations:

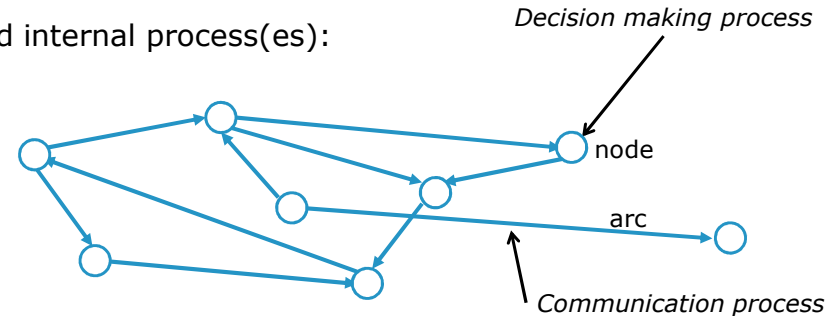


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ABS (2)

Add internal process(es):




Decision making process

node

arc

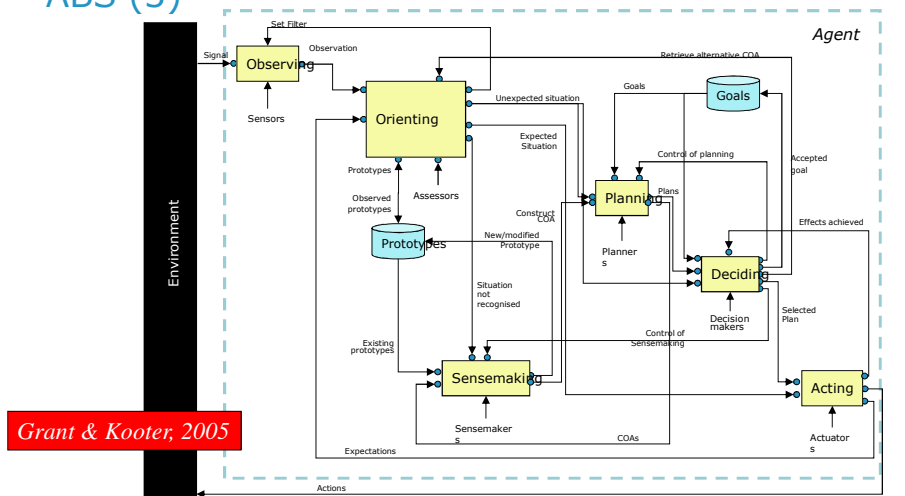
Communication process

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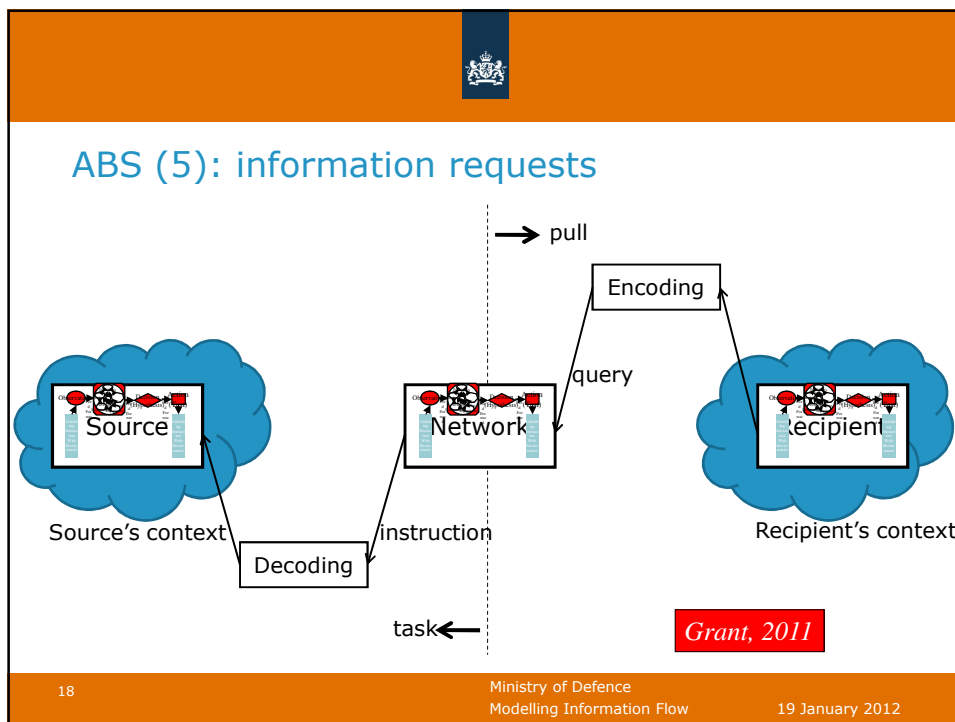
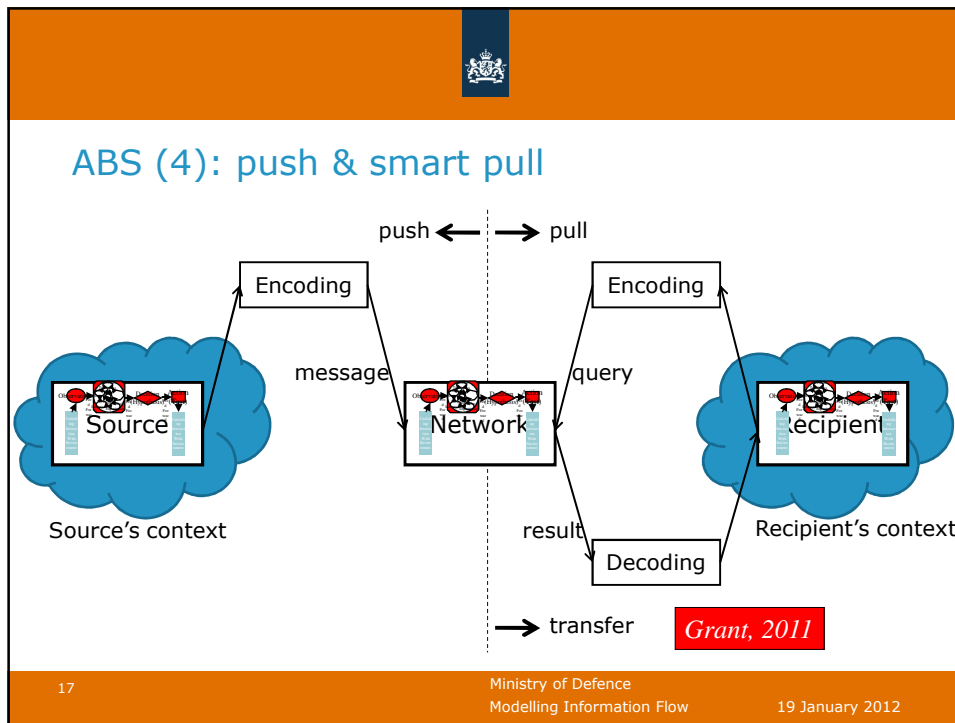
ABS (3)

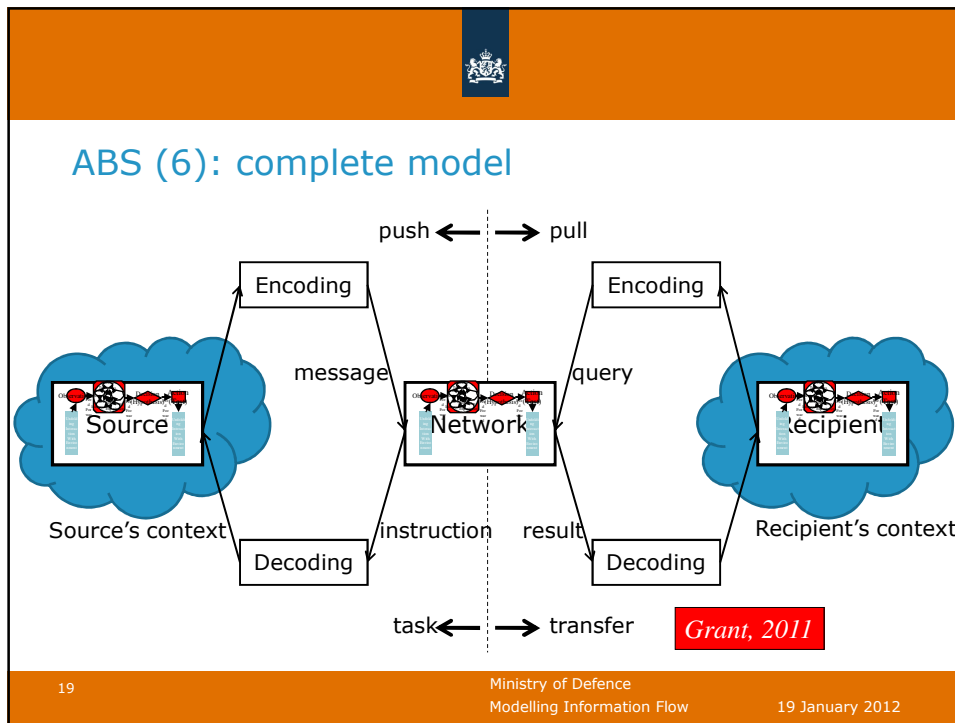
Rationally reconstructed OODA:



Grant & Kooter, 2005

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Conclusions & Further Research

Conclusions:

- Network & SCOR models too simple for real world
- Therefore, (agent-based) simulation:
 - Process model for node (eg OODA-RR)
 - Process model for arc (eg NEC push & smart pull)


Recommendation:

- Correct customers who seek "optimization"

Further research:

- Capture real behaviour of supply-chain elements
- Develop, test & evaluate ABS of TFU logistics network
- Develop peer-to-peer control protocol

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Any Questions?

tj.grant@nlda.nl
+31 (0)638 193 749

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