



# Supporting intelligent and automated operations with agent technologies in a service architecture

Semantic Days 18-20 May 2009

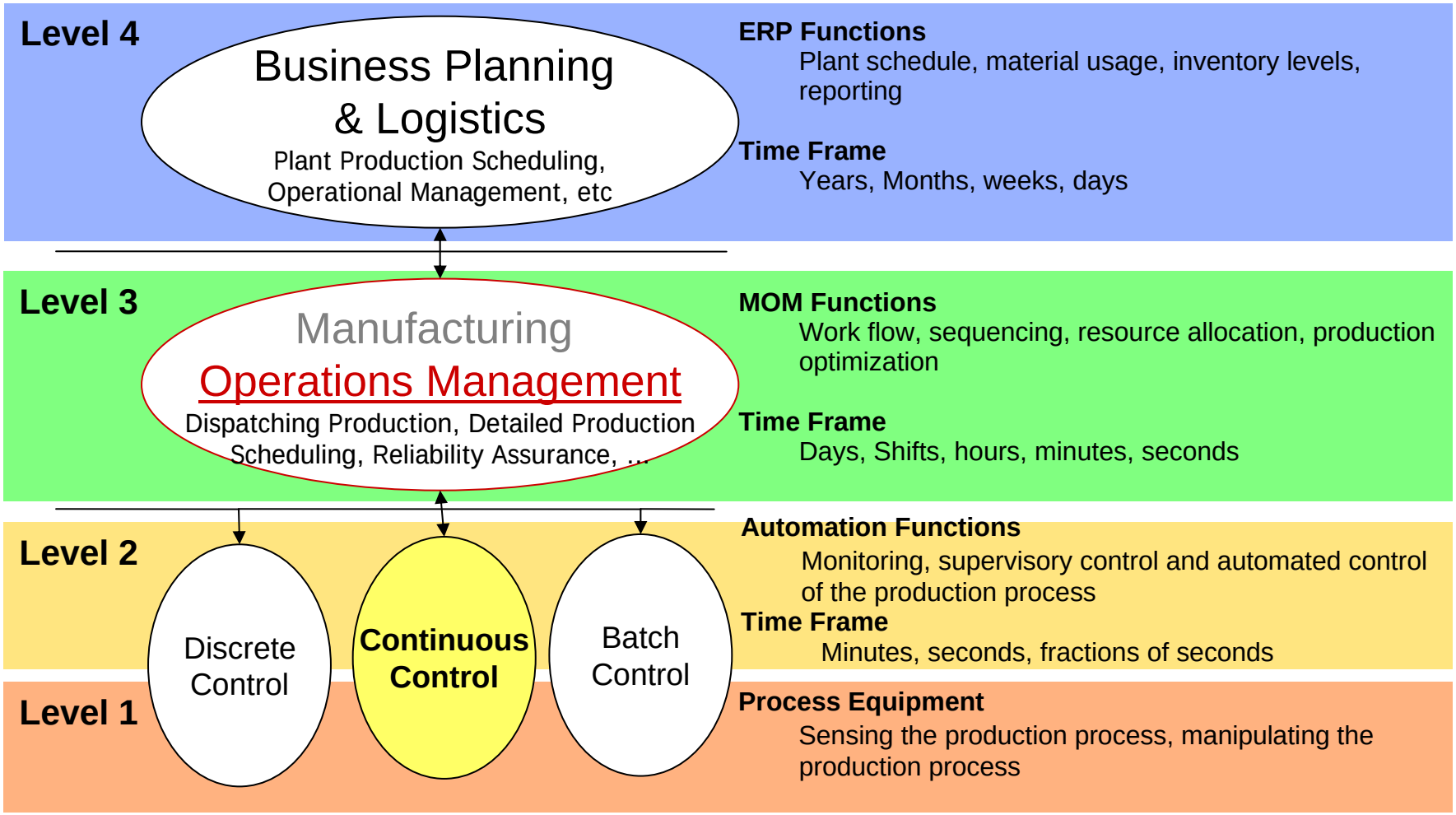
Einar Landre

StatoilHydro

# SHAPE

- Project in EU's 7th framework program
  - Coordinated by SINTEF ICT / Arne J. Berre.
  - StatoilHydro one of two industrial partners (Saarstahl)
- Focus on modelling and architecture
  - How to map the flow of business logic and data to services in a platform independent way?
  - How to integrate the various models of processes, requirements, services and functions in a common model?
- Two industrial use cases
  - Modelling of the production optimization process
  - Agent as modelling concept solving scheduling of cargo's at Mongstad
- Read more here
  - http://www.shape-project.eu/

# Purdue's reference model



# ISA S95 Level 3 activities

MOM Functions
- Scheduling
- Resource Allocation
- Dispatching
- Maintenance Management
- Documentation Management
- Labour Management
- Performance Analysis
- Process Management
- Archiving

MOM = Manufacturing Operations Management

For these to be practical applicable we need

1) A model of activity context
- What resource is scheduled & allocated?
- Where are maintenance planned to take place?

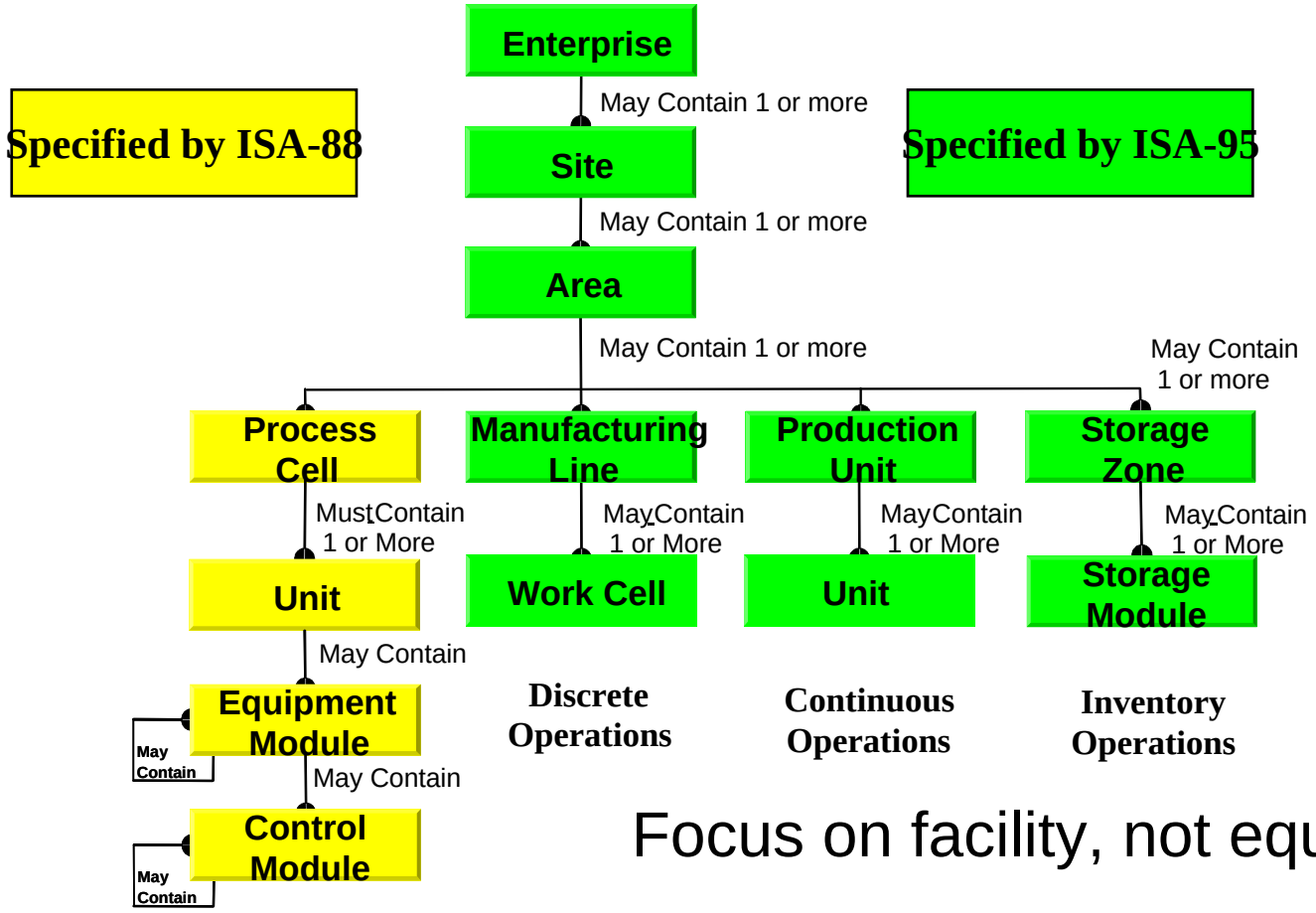
2) Tools and methodology for process modelling
- Domain specific work/business processes
- Business rules capture

3)Tools and methodology for process automation
- Service design and implementation
- Variable autonomy and decision making

#1 were addressed by TAIL project

#2 and #3 addressed by SHAPE project

# Hierarchy and containment

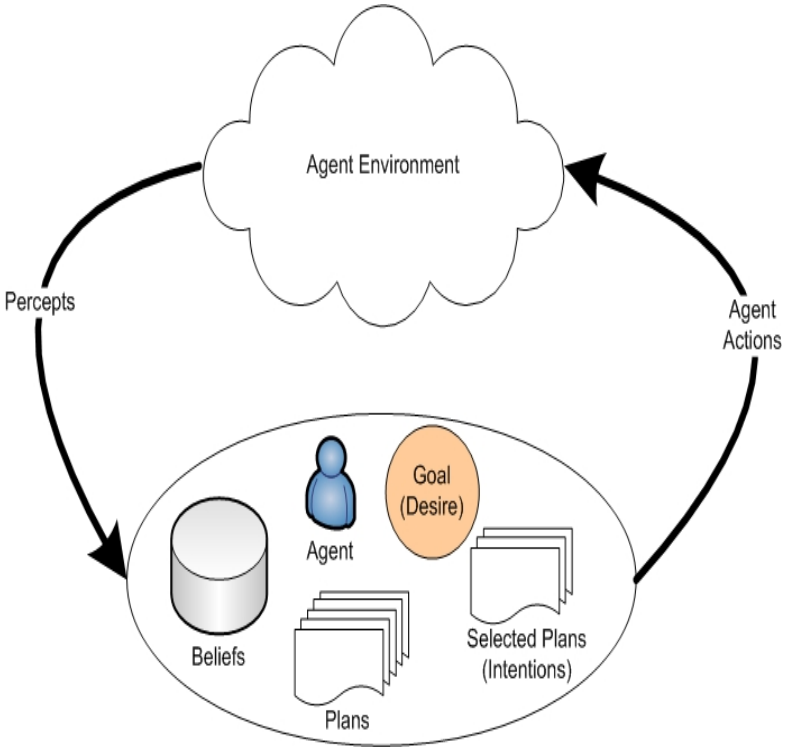



Focus on facility, not equipment

# Software Agents

**A class of computer systems**

- Capable of ***independent, autonomous action*** in order to meet their design objectives…
- Capable of ***deciding for themselves*** what to do in any given situation
- We call them ***rational*** agents because they make ***good*** decisions about what to do"
  - reactive; respond to changing environment
  - proactive: act in anticipation of future goals



# Automation vs. Autonomy

**Automation:**

- An activity carried out by prior arrangement when certain condition are fulfilled without the need for a decision (Encarta)

**Autonomy:**

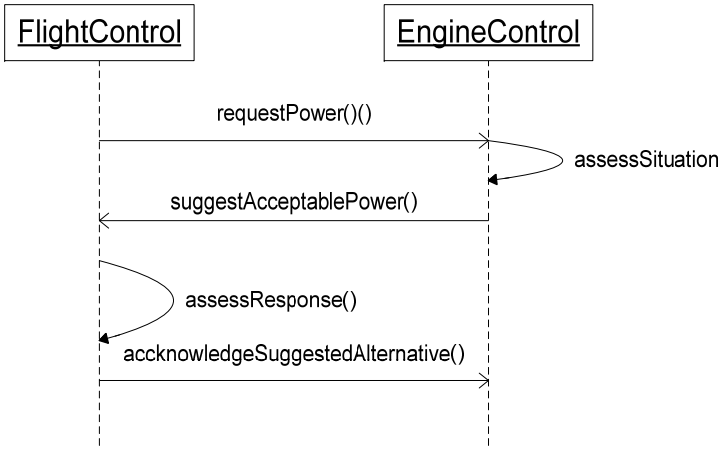
- the capacity of a rational individual to make an informed, un-coerced decision (Wikipedia)
- Having the freedom to determine one's own actions (OED)

## Levels of autonomy (aerospace)

| PACT Level | Levels of HMI (Human Machine Interaction) |
|---|---|
| 5b | Computer does everything autonomously |
| 5a | Computer chooses action, performs it and informs human |
| 4b | Computer chooses action & performs it unless human disapproves |
| 4a | Computer chooses action & performs it if human approves |
| 3 | Computer suggests options and proposes one of them |
| 2 | Computer suggests options to human |
| 1 | Human ask computer to suggest options and human selects |

PACT – Pilot Authority and Control Task

# Example – Autonomous behaviour

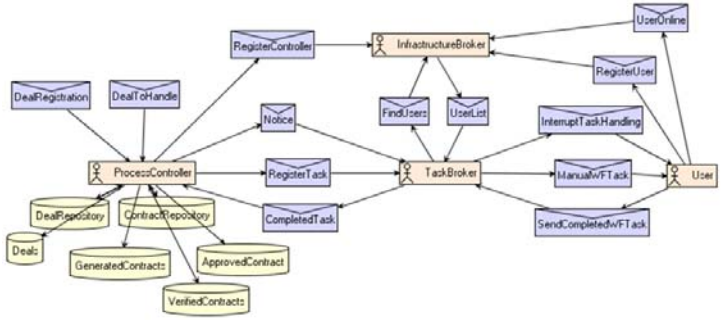



- Flight control requests 100% power for 10 minutes
  - Need to climb to a certain altitude for a given purpose
- Engine control knows that fulfilment of request will ruin engine due some failure condition
  - Suggest 80% power for 15 minutes
- Flight control assesses response and decides:
  - Accept proposal
  - Abort and fly home
  - Climb according to request, take the chance of ruining aircraft

Negotiation

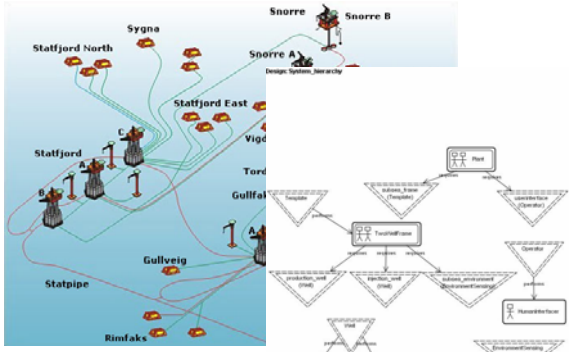
Collaboration

# Experience with autonomy



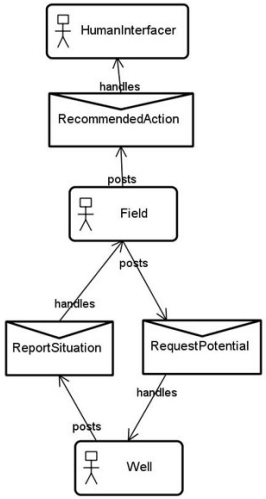

Workflow / Smart Process control

Mongstad Jetty Planner




Production support architecture

(SPE ATCE 2006 / SPE IE 2008)



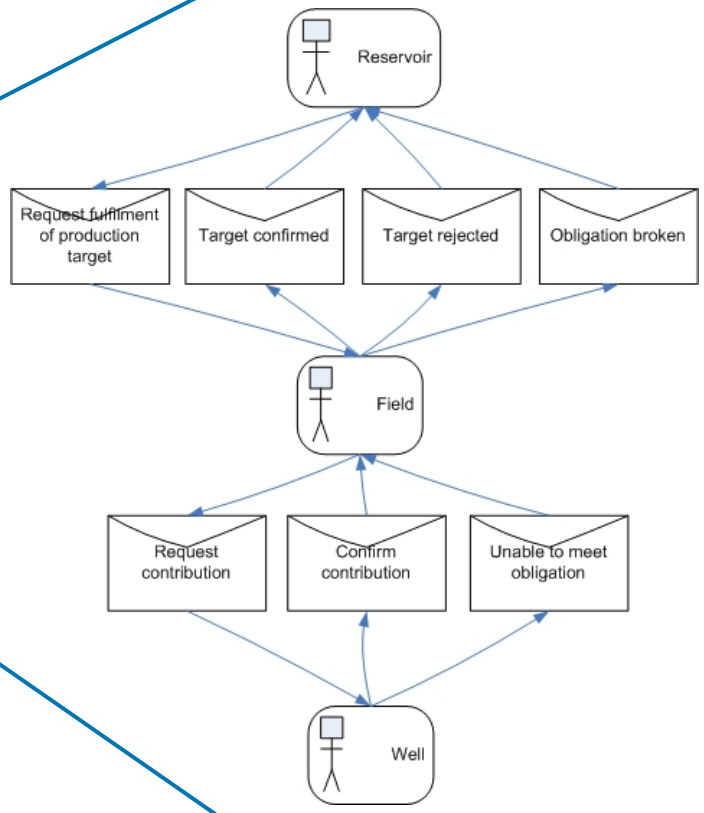

Heidrun Field Demonstrator

# Autonomous capabilities in a production context

Business Planning
& Logistics
(Level 4)

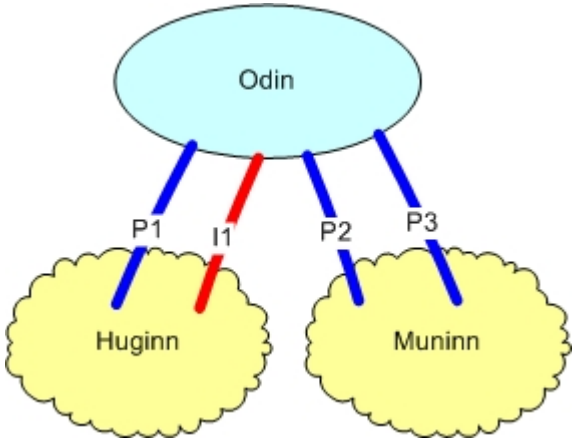
Manufacturing Operations
Management
(Level 3)

Automation
(Level 2 and below)



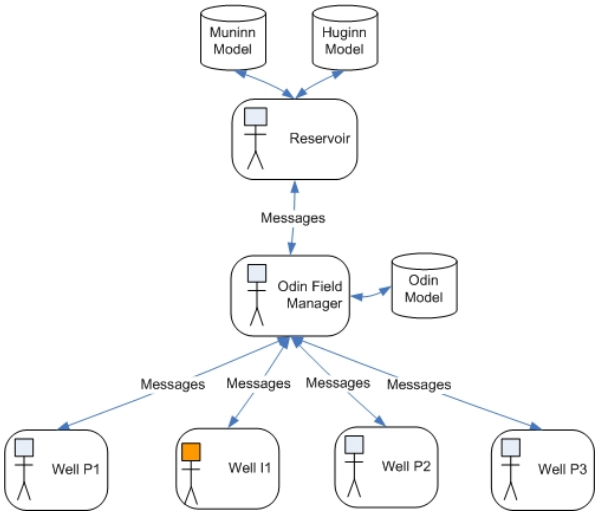
# The Odin Field Reference Model (SPE 112078)

- Fixed platform with storage
- Buoy loader
- Two reservoirs (Huginn and Muninn)
- Four wells
  - Three producers
  - One injector
- Process limited
- Each reservoir produces a different quality
  - Mixing formula: Two parts Muninn and one part Huginn



# Odin Field Operation (SPE 112078)

Architecture




**Normal production**

- Plan a configuration that meets new production objective (volume/quality)
  1. Field manager calculates optimum
  2. Field manager request if the wells are able to according to requested contribution
  3. Field manager confirms ok or report back its ability

**Pressure loss in Hugin**

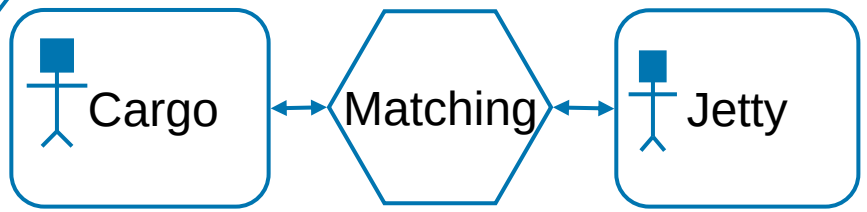
- Re-establish steady state, meet production target
  1. Injector detect pressure loss and starts compensate (from 5a to 4a)
  2. P1 detects pressure loss, and report not able to meet obligation to filed manager
  3. Field manager prioritizes quality, and give P2 and P3 new objectives and negotiate new obligation with Reservoir
  4. Pressure loss is fixed, field manager reports back to reservoir its back on track

# SHAPE – Mongstad Cargo Scheduler

Business Planning
& Logistics
(Level 4)

Manufacturing Operations
Management
(Level 3)

Automation
(Level 2 and below)

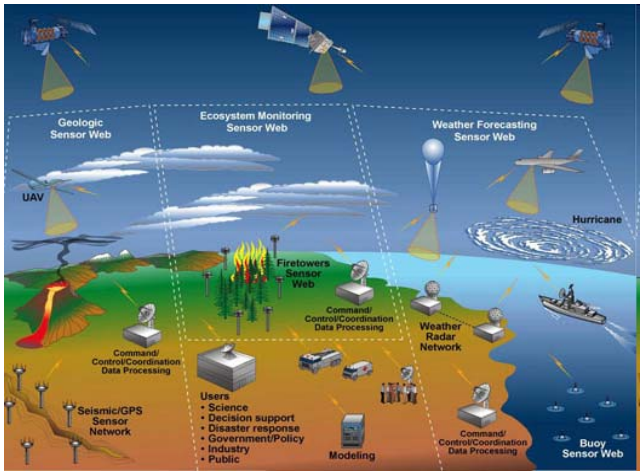


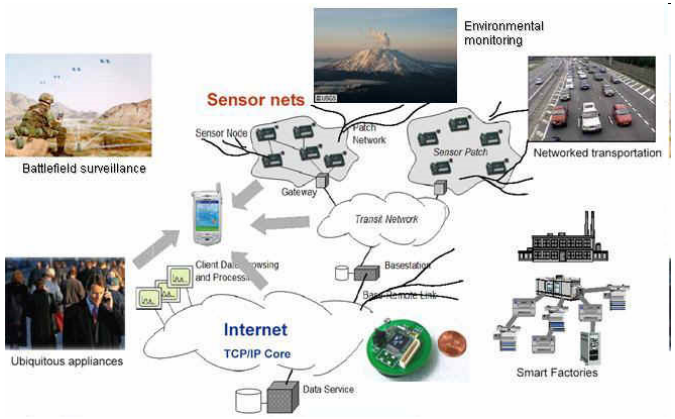

Cargo (Volume of a quality) constrained by
- Ship arrival time
- Component & blender availability
- Slopping

Objective:
- Minimizing demurrage and ship lay time
- Continuous replanning of schedule

Algorithms
- Marketplace (cargos sell/buy) jetty slots
- Planning

# Environmental monitoring & Sensor Networks




- Sensor network applications demands autonomy
  - Data fusion
  - Data quality
  - Collaboration
  - Harsh environment
  - Decentralized coordination
  - Power and bandwidth management
  - Uncertainty (Bayesian)
- IEEE Intelligent Systems, March April issue 2009
  - http://www.aladdinproject.org/

# Conclusion

- Huge potential for autonomous systems in oil and gas operations
  - Production optimization
  - Resource scheduling
  - Decisions support
- We have only seen the beginning
  - Unmanned – autonomous drilling rigs
  - Unmanned – autonomous production systems
  - Autonomous business processes involving humans on demand
- IOHN Explores the potential
  - AutConRig

# Questions?